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Factors affecting reproductive performance and health in dairy cows in Tajikistan

A study in large scale farms

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Factors affecting reproductive performance and health in dairy cows in Tajikistan

Faktorer som påverkar den reproduktiva prestationen och hälsan hos mjölkkor i Tajikistan

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SUMMARY

In Central Asia one can locate the smallest landlocked country of the former Soviet Union; Tajikistan. The country is a presidential republic and has been since the independence from Russian Soviet 1991 and is now one of the 15 former Soviet countries with the lowest per capita GDP. The private sector held most of the livestock, 60% during the Soviet era, which rose to 90% 2006. During 2015, the private sector is producing up to 95% of the total production of raw milk in the country. The large scale farms are few, however uprising and striving for expansion. The average milk yield is 8 liters, ranging from 2.2 liters up to 17.7 liters in a typical commercial dairy farm in Tajikistan.

An effective and financially successful dairy production is based on the efficient reproductive performance by the dairy cow. And the cow’s fertility performance is based on and affected by several factors which make reproductive management a challenge for the everyday farmer; no matter if the dairy production lays in Tajikistan or Sweden, the foundation of an effective production is the same.

Because of the high portion of subsistence farming and no existing central data recording in Tajikistan, there is little insight in reproductive health management of the dairy cows in the country. The purpose of the current study was therefore to assess the reproductive performance and identify the occurrence of reproductive disorders in the dairy cows in Tajikistan, as well as to identify factors in the environment and management that may have an impact on reproductive performance. The study was conducted in five districts bordering the main capital Dushanbe. In total 114 cows from 10 farms were examined in the five districts. A personal interview was conducted at each farm and an adjusted clinical examination regarding reproductive health was performed on a number of random selected cows.

The results show that an immense majority of the cows were not pregnant at an anticipated time point in the intensive dairy production systems. The reproductive performance of the dairy cows in the studied farms was assessed as low. This was mainly based on the high age at first calving, high percentage of non-pregnant cows, low daily milk yield and prolonged calving interval. The majority of the cows had an age of more than 3 years at first calving and the mean amount of milk produced in liters per day per cow was 11.9±7.6 liters. The main reproductive disorders that occurred in the study was anestrus and endometritis. The farmers often lacked knowledge regarding oestrus detection and the economic value of performing standardized pregnancy diagnosis. The handling of documentations of the reproductive dates was also clearly questionable regarding accuracy and availability of the records.

SAMMANFATTNING

I Centralasien finner man det minsta inlandet i före detta Sovjetunionen; Tajikistan. Landet är en republik sedan självständigheten från ryska Sovjet 1991 och är nu en av de 15 f.d. sovjetiska länder med lägst BNP per capita. Den privata sektorn höll mest boskap, 60% under den sovjetiska eran, och 2006 hade den andelen stigit upp till 90%. Under 2015 producerar fortfarande den privata sektorn upp till 95% av den totala produktionen av obehandlad mjölk i landet. De storskaliga mjölkproducenterna är få, men majoriteten strävar efter att expandera sin produktion. Den genomsnittliga mjölkavkastningen är 8 liter, men varierar från 2,2 liter upp till 17,7 liter i en typisk kommersiell mjölkgård i Tajikistan.

En effektiv och framgångsrik mjölkproduktion baseras på en effektiv reproduktionsförmåga hos mjölkkorna. Kons fertilitet är baserad på och påverkas av flera faktorer, vilket gör att tillsynen och hanteringen av den reproduktiva hälsan och förmågan hos korna är en ständig utmaning för mjölkbonden; oavsett om mjölkproduktionen är belägen i Tajikistan eller i Sverige, så är grunden för en effektiv produktion densamma.

På grund av den höga andelen av självförsörjande jordbruk och avsaknaden av en central ko-datainsamling i Tajikistan, finns det lite insikt i hur den reproduktiva hälsan hos mjölkkorna i landet är. Syftet med föreliggande studie var därför att utvärdera reproduktionsförmågan och identifiera förekomsten av reproduktionsstörningar hos mjölkkorna, liksom att identifiera miljö- och skötselfaktorer som kan påverka reproduktionsförmågan. Information erhölls därför från fem distrikt vilka gränsar till huvudstaden Dushanbe i Tajikistan. Totalt 114 kor från 10 gårdar undersöktes i de fem distrikten. En personlig intervju genomfördes vid varje gård och en anpassad klinisk undersökning avseende reproduktiv hälsa utfördes på ett antal slumpmässigt utvalda kor.

Resultaten visar att en överväldigande majoritet av korna inte var dräktiga som förväntat vid den tidpunkt de borde vara i ett intensivt optimerat produktionssystem. Den reproduktiva prestationen hos mjölkkorna bedömdes som låg på de besökta gårdarna. Detta baseras huvudsakligen på den höga inkalvningsåldern, höga andelen av icke-dräktiga kor, låga dagliga mjölkavkastningen och de långa kalvningsintervallen. Majoriteten av korna hade en inkalvningsålder på över 3 år och medelmängden producerad mjölk i liter per dag och ko var 11.9±7.6 liter. De huvudsakliga reproduktiva störningarna funna i studien var anöstrus och endometrit. Bönderna saknade ofta kunskap om brunstkontroll och det ekonomiska värdet av att utföra standardiserade dräktighetsundersökningar. Hanteringen av kalvnings- och inseminationsdatum samt allmän journalföring av djuren var också tydligt bristfällig avseende noggrannhet, användbarhet och sanningsenlighet.

CONTENT

INTRODUCTION AND AIMS

The dairy industry is a huge industry all over the world. The base of the industry is the dairy cow and its reproductive performance and production. The cow gives birth to a calf and lactates to nurture her off-spring; however domestic dairy cows have their calves removed so that the milk can be consumed by humans instead. The high-yielding dairy cow produces a large amount of milk, which is the main goal of the dairy farmer namely to sell as much milk as possible (Dobson et al., 2007). A cow within the dairy industry must produce and thereby she must also have good fertility so that the farmer can gain high profit. Failure to conceive a calf can have various causes but is down to two main issues; failure to become pregnant or failure to maintain the pregnancy. The duration of postpartum anestrus is one major, among several contributing, factors causing delayed conception or failure to become pregnant. There is a handful different individual and environmental factors known to influence the length of the postpartum anestrus (Peter et al., 2009). In short, anything contributing to an impaired animal welfare can affect the reproductive performance. The modern intensive dairy industry has come a long way and has undergone several changes over the recent years and have developed high technology for recording reproductive traits. Despite this, the industry is still tampering with the negative association between reproductive performance and high milk yield (Barkema et al., 2015).

In the majority of high-income countries and in certain low and middle-income countries, the reproductive performance is well described and documented. However, there are still low or middle-income countries which are in need of knowledge regarding efficient high producing dairy systems for achieving a successful industry. In the lower middle-income country Tajikistan the dairy production is mainly based on subsistence farming. The few larger commercial dairy farms that exist have both low production figures as well as low number of yielding cows. Because of the high proportion of subsistence farming and no existing central data recording, there is little insight about the fertility and reproductive health of the dairy cows in Tajikistan (Sattorov, 2016).

The purpose of the study is therefore to assess the reproductive performance and identify the occurrence of reproductive disorders in Tajikistan, as well as to identify factors in environment and management that may have an impact on reproductive performance. The study will focus on a randomly selected sample of dairy cows in large farms in Tajikistan. By identifying and presenting the main reproductive disorders of the dairy cows, and relate them to environmental risk factors, the study can contribute to improve the reproductive health and increase the productivity and efficiency of the milk production. It will also provide awareness about the current reproductive health and performance of the cows. The main statement of the study can also bring basic data for further investigation of the situation regarding reproductive performance of dairy cows in the country.

LITERATURE REVIEW

Tajikistan

Tajikistan is a lower middle-income country located in Central Asia, west of China, surrounded by Afghanistan, Kyrgyzstan and Uzbekistan. The country lies about 3000 meters above sea level and the great majority of the land consists of mountains. Tajikistan is divided into four regions and each region has several districts. The regions are Districts of Republican Subordination (DRD), Gorno-Badakhshan Oblast (GBAO, Pamir region), Sugd and Khatlon region (Sattorov, 2016). The total population in Tajikistan is about 8.2 million people where the majority relates to Islam, and approximately 10% of the citizens live in the capital Dushanbe (CIA, 2016). The main languages are Tajik and Russian but minor groups speak Uzbek, Kyrgys and Pashto (Pamir language) as well. The Tajik language is mainly spoken in the country side and Russian is the main choice in the larger cities, for example in Dushanbe. English is considered a third language and is thereby sparsely spoken. Tajikistan is a presidential republic and has been since the independence from Russian Soviet 1991 and is one of the 15 former Soviet countries with the lowest per capita GDP (UI, 2016). The country has hot and long summers with temperatures well above 30°C and mild short winters (CIA, 2016).

Picture 1. *Two different, older and operating, Soviet collective farms in Tajikistan. Photos by author.*

Agriculture and dairy production in Tajikistan

After the independence from Russian Soviet in 1991, a civil war emerged and did not end until the year of 1997. During that time the agricultural income dropped by 55 %. Today, over 60 % of the population works in the agriculture sector, which has been on the rise since 1997 (Van Weperen, 2011). According to the index of Gross Agricultural Output, Tajikistan's agricultural production shows a remarkable recovery since the end of the civil war. The amount of people employed in the agricultural sector has been on the rise since 1980, from 600 000 to nearly 1.3 million in 2003. In 2008 there were about 1 million cattle and about 3 million sheep and goats in Tajikistan. Agriculture in Soviet Tajikistan was dominated by large collective and state farms. After the Soviet collapse the large collective and state farms where divided into smaller pieces and or put out of service. Even though the individual sector already held most of the livestock during the Soviet era (60 %), it rose to the number of 90% in the year of 2006 (Lernman, 2008).

During the year of 2015 there were 1.1 million cows in Tajikistan and increasing. Approximately 850 000 tons of milk was produced in 2014 and in average 95% of the raw milk is produced in the private sector. Khatlon region holds the largest number of dairy cows, followed by DRD, which includes the main capital Dushanbe. The average small-holder farmer in Tajikistan has low knowledge of proper balanced feed, water and animal welfare which all affects both milk yield and quality (Sattorov, 2016). Most of the milking cows are of local or mixed breeds with low potential of milk productivity, which results in an average milk yield of 2-4 liters per day. In general the larger farms commonly use pure breeds such as Holstein and Simmental or improved black-and-white breed. The average milk yield in DRD region is 8 liters, with a range from 2.2 liters up to 17.7 for an average cow in a commercial dairy farm. The largest dairy farm in the DRD region holds approximately 500 milking cows whereas the smallest farm holds 14 milking cows (Sattorov, 2016).

Picture 2. *Russian Simmental breed (left) and young Holstein breed (right) in Tajikistan. Photos by author and Kajsa Celander.*

Reproductive health in dairy cows

The healthy reproductive cycle

Puberty sets by the heifer’s first ovulation and first signs of oestrus behavior, followed by subsequent cyclic activity in the ovaries and uterus. This event usually occurs between 9 and 16 months of age. The heifers can also have one or several ovulations without external signs of oestrus before they show their first sign of oestrus. The time of puberty in cattle is affected by breed, age and body weight. By that, heifers of dairy breed enter puberty earlier than in beef cattle (Akins, 2016). The start of puberty as well as the following sequences of reproductive traits is regulated by hormones. The reproductive cycle is thereby complex with numerous hormones affecting the genital organs in various ways. The key signaling hormone is gonadotrophin releasing hormone (GnRH) which starts the cascade of reproductive hormones downstream and is initiating the ovulation. It regulates pulsatile patterns of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) which are both essential for stimulating the final stage of developing the dominant follicle and the simultaneous increase in oestradiol secretion leading to oestrus activity and ovulation (Blanc et al., 2001).

The reproductive cycle of a cow is in general 21 days, with a normal variation between 18-24 days. At the end of a cycle the cow is in oestrus and the dominant follicle ovulates. The follicle collapses after ovulation and forms a *corpus luteum* which produces progesterone. Progesterone is high mid-cycle (diestrus) and declines when the *corpus luteum* undergoes luteolysis (dissolves) (Peter et al., 2009). Luteolysis appears when responding to prostaglandin F_{2a} from the endometrium of the uterus at the end of the cycle if the animal is not pregnant (Wiltbank et al., 2002). If the animal is pregnant the uterus wall will not secrete prostaglandin and the *corpus luteum* will remain until last day of pregnancy.

GnRH regulates both LH and FSH. FSH is stimulating the follicle growth even during high progesterone levels such as during pregnancy or during diestrus. The follicles develop into large follicles and one is selected as dominant, however the dominant follicle will be unable to ovulate as long as the progesterone stays high. This implies that several follicle waves emerge during one cycle. It is not until the progesterone declines that the LH surge and oestradiol levels are able to rise high and thereby induce the follicle to ovulate (Peter et al., 2009). However, during pregnancy, the progesterone concentrations will achieve negative feedback suppression of GnRH, which causes minimal follicular activity in the full-term pregnant animal. Before birth, the progesterone levels decreases but the negative feedback suppression will remain a certain amount of time. During this period, post-partum, the cow is then naturally in anovulatory anoetrus e.g. no follicular activity (Sakaguchi, 2010).

The post-partum anoestrus interval is the recovery period which occurs between parturition and mating behavior at the onset of next ovulation. It also involves uterine involution and repair. There are many factors affecting the length of this period, for example poor body condition, season, parity, infection, calf presence and under-nutrition, etc. To maintain reproductive success in farmed animals it is therefore important to keep this interval as short as possible (Blanc et al., 2001). For that achievement it is also important to detect oestrus expression. This depends on both the intensity of the oestrus expressions by the animal but also the detection by the farmer. The level of oestrus expression is generally defined by behavioral signs and its intensity, frequency and duration. Standing to be mounted is one of the strongest behavioral signs of oestrus. Other signs can be mounting other cows, lordosis, sniffing other cow's vagina, bellowing, licking, chin-resting, restlessness and clear mucus vaginal discharge (Van Eerdenburg et al., 1996; 2002). Furthermore it is considered that the level of oestrus expression highly increases by the presence of at least one other cow in oestrus in a group of cows (Brun-Lafleur et al., 2013).

Factors causing delay to conception

Ovarian disorders

After parturition, the ovarian cyclic activity is returned and is characterized by an increase of peripheral plasma FSH concentrations. FSH affects the ovary, where a wave of ovarian follicles emerges, and a single dominant follicle will be selected during the second week postpartum. In the majority of healthy dairy cows, this follicle will soon enough ovulate and form a *corpus luteum*. For other cows where fertility is affected, the dominant follicle may not ovulate in the following oestrus, but instead undergo atresia and the ovary enters prolonged anovulatory anestrus or the follicle persists and forms a cyst (Wiltbank et al., 2002). Both of these reproductive conditions cause substantial delay to conception (Sheldon et al., 2006).

A follicular cyst is in general defined as a follicle that continues to grow to a diameter of >20-25 mm over a period of 10-40 days, by the absence of a corpus luteum (Peter et al., 2009). The dominant follicle continues to grow due to lack of negative feedback by oestradiol. When this occurs, progesterone levels are low, while oestradiol levels are high above normal (Wiltbank et al., 2002). Thus in early phase of a follicular cyst, the cow can express strong oestrus behavior which then is followed by a complete absence of oestrous behavioral signs in the other half of the cyst's lifetime (Crowe, 2008). However, the complete etiology is not thoroughly known (Peter et al., 2009). During the early phase of the follicular cyst, no new follicle waves can emerge because of the active production of oestradiol. However, as soon as the cyst becomes inactive, new follicular waves can emerge. Although during this time, the cyst will be morphologically identical to the early period (Crowe, 2008).

Another cause of delayed conception that commonly occurs once the dairy cow has resumed ovulation is a prolonged luteal phase. Prolonged luteal phase is associated with a disruption of prostaglandin production from the uterus, which generally is due to an unhealthy uterine environment (Ghanem et al., 2015). The *corpus luteum* will persist and the time between oestrus is prolonged (>20 days) (Ranasinghe et al., 2011). It is considered that several risk factors are associated with delayed ovulation as a consequence of prolonged luteal phase, e.g. postpartum complications, abnormal vaginal discharge, parity and earlier resumption of ovulation (Crowe, 2008). The postpartum complications are the most important factors increasing the risks for a prolonged luteal phace, such as metritis, endometritis, dystocia or retained placenta (Ranasinghe et al., 2011).

Even though ovarian cysts and prolonged luteal phase have a major influence on the postpartum interval, the most common ovarian dysfunction is prolonged anovulatory anestrus which is a state of ovarian acyclicity (Wiltbank et al., 2002). This occurs when the dominant follicle that should ovulate, undergoes atresia instead and is accompanied by complete sexual inactivity without expression of oestrus. The postpartum anestrus is the period of time after parturition where the cow does not show signs of oestrus and is considered as a normal part of the reproductive cycle (Rhodes et al., 2003). Delayed cyclicity or prolonged anestrus is considered when the cow is exceeding 56 days postpartum. However, the majority of dairy cows should be in normal cycle within one month postpartum (Petersson et al., 2006). In tropical regions, prolonged anestrus periods of more than 150 days postpartum is one of the most essential infertility problems and results in huge economic loss because of failure to obtain the profitable calving interval of 12 months (Montiel and Ahuja, 2005). A substantial and main factor affecting the duration of postpartum anestrus is the nutritional status of the animal. Both excessive and inadequate body fat is associated with prolonged anestrus periods (Wiltbank et al., 2002). Other risk factors are suggested to be suckling, breed, age, number of calvings, milk yield, calving season, absence of the bull, delayed uterine involution, dystocia and general health (Blanc et al., 2001, Montiel and Ahuja, 2005, Wiltbank et al., 2002).

Factors causing reproductive failure

There are several factors that have been proven to affect the postpartum anestrus duration of the dairy cows; in fact any variety of stress is able to negatively affect the reproduction (Dobson and Smith, 2000). A major impact of stress is the reduction of feed intake, which is proven to be a risk factor of prolonged period of postpartum anestrus (Peter et al., 2009). Cows with undernutrition together with high milk yield in the early postpartum period, take more than 10 days longer to conceive pregnancy compared to healthy well-nutrient cows (Dobson et al., 2007). It has also been established that undernutrition

is the main interfering factor of bovine reproduction and milk production in tropical regions (Montiel and Ahuja, 2005).

Negative energy balance (NEB), due to an inadequate intake of nutrients relative to the metabolic demands for milk production or pregnancy, is a major factor of prolonged postpartum anestrus (Peter et al., 2009). The energy balance is in general defined as the relationship between dietary energy intake and energy output, NEB appears when the cow does not manage to eat sufficient amount of feed (intake) because the output is too great. If the cow reaches NEB, this metabolic condition can persist for weeks (Butler and Smith, 1989). The state of NEB makes especially the high yielding cow distribute the nutrients mainly to the udder and milk production and thereby do not prioritize the reproduction neither the normal body maintenance nor functions (Montiel and Ahuja, 2005). Also in low or-middle- income countries, NEB is an arising disorder when genetically high-merit cows suffer from inadequate feeding (Whitaker et al., 1999). NEB interferes with reproduction by for example affecting ovulation, expression of oestrus and progesterone concentrations (Peter et al., 2009). It also predisposes to gynecological disorders such as dystocia, retained fetal membranes, endometritis and metritis and NEB itself affects the prevalence of metabolic disorders such as hypocalcemia, ketosis and fatty liver disease (Roche, 2006). Hence NEB and undernutrition are the most important factors influencing ovarian acyclicity during the early post-partum period, which is a main cause of delayed conception (Robinson, 1990). The same theory applies for cows with excessive body fat, where the incidence of dystocia and fatty liver are higher, as well as lower milk yield and reproductive failure (Montiel and Ahuja, 2005).

A well-known and recommended method of evaluating undernutrition or NEB and body reserves is body condition scoring (BCS). Body condition score is a visual method of evaluation of the nutritional status of an animal (Edmonson et al., 1989). The BCS reflects the body fat that is indicative of the energy stored available for basic metabolism, growth, lactation and activity (Montiel and Ahuja, 2005). The methods of BCS are by sight and touch to assess the amount of subcutaneous fat and muscles. It is important to evaluate BCS and thereby nutritional management, in particularly dairy cows, for maintaining health, reproductive function and productive capacity (Edmonson et al., 1989). It is not only the reproductive function that is affected by low BCS. The mal-nourished dairy cow has a greater probability of suffering from diseases, metabolic disorders, reduction in milk yield and a higher age of puberty in heifers (Robinson, 1990, Edmonson et al., 1989).

Heat stress is also one great factor that affects the health of dairy animals by disturbing both normal physiology, metabolism, hormonal and immunity system. The thermoneutral zone of dairy cows are 16-25°C, nevertheless, air temperature reaching above 20-25°C in temperate climate can induce heat stress as well (Kadzere et al., 2002). As a consequence, body surface and rectal temperature raises along with respiration rate and heart rate which follows an effect on feed intake, milk yield and reproductive efficiency of the dairy cow. It is considered that native breeds tolerate warmth better compared to exotic breeds and their crosses under tropical and hot temperate conditions. This may be due to lack of the exotic genes to adapt under such conditions (El-Tarabany and El-Tarabany, 2015). Sensitivity to heat stress also escalates with the increase of milk production (Das et al., 2016). Another direct consequence of heat stress is the reduction of length and intensity of oestrus and the elevated incidence of anestrus in dairy animals (Kadowaka et al., 2012). Additionally, the appetite center of the hypothalamus is directly affected by an elevated environmental temperature which decreases food intake. Intake of food declines at air temperatures of 25-26 °C in lactating cows and reduces even more rapidly above 30°C (Eslamizad et al., 2015). A great source of heat production in ruminants is feed intake, thereby the cow can in some extent prevent heat production with reduced feed intake (Kadzere et al., 2002).

Clinical conditions affecting fertility

Painful conditions, which cause the animal stress, reduce fertility by interfering with the mechanisms in the hypothalamus-pituitary-gonadal system, which are disrupted by activation of the parallel hypothalamus-pituitary-adrenal stress pathways (Sheldon et al., 2006, Dobson and Smith, 2000). The most common conditions of disease (both chronic and acute) in dairy cows are mastitis, lameness, retained fetal membranes and hypocalcemia (Dobson et al., 2007). Lameness, followed by mastitis, is the most important disease in dairy herds. Pain and thereby stress reduces appetite, feed intake and affects the productive performance, reducing milk yield and extending calving intervals (Esslemont and Kossaibati, 1996). Lameness is associated with up to 40 days lost in prolonged calving interval even when the lameness has been treated. Compared to mastitis, where the luteal activity starts 7 days later than in healthy cows, lameness is a definite higher reproductive loss (Dobson et al., 2007).

Among important infectious diseases affecting conception and reproductive efficiency are *Brucella sp*., *Leptospira sp*., bovine viral diarrhea virus, bovine herpes virus type 1 (IBR), *Trichomonas foetus*, *Campylobacter sp.* and *Neospora caninum* etc (Sanderson and Gnad, 2002, Sheldon et al., 2006, Lindahl et al., 2015). The importance of regular veterinary health evaluation, use of vaccination strategies and implemented appropriate biosecurity plans to prevent these infectious agents is underlined (Sheldon et al., 2006). Unfortunately, far from all of the abortions are sent to be examined at a diagnostic laboratory and are diagnosed with a specific agent (Sanderson and Gnad, 2002). This results in several undiagnosed and untreated reproductive disorders that may have a major influence in the reproductive performance of the dairy cows.

Uterine disease

The main uterine disease with a substantial influence on fertility and conception is endometritis. The disease is a superficial inflammation of the endometrium with the presence of pathogenic bacteria in the uterus persisting for more than three weeks after parturition (Sheldon et al., 2006). LeBlanc et al. (2002) demonstrated that cervical diameter >7.5 cm along with the presence of purulent vaginal discharge were the main indicators influencing fertility rate. However, clinical findings also include enlarged uterine horns, thickened uterus wall, palpable uterus lumen and commonly a corpus luteum is present (LeBlanc et al., 2002). *Eschericia coli* is considered the most frequent bacteria isolated from the uterus during endometritis. The lipopolysaccharide (LPS), a pathogenic product from the E. coli, is the main reason for disrupting the prostaglandin secretion from the endometrium. LPS affects the cells of the endometrium, which express a specific receptor complex, where the LPS can switch prostaglandin secretion from $F_{2\alpha}$ to E_2. Thereby, prostaglandin cannot cause luteolysis of the present *corpus luteum* (Dobson et al., 2007). As stated earlier, uterine infection is commonly associated with prolonged post-partum luteal phases and is by that considered as a risk factor for delayed ovulation (Ghanem et al., 2015). Endometritis causes infertility at the time of present infection and subfertility even after successful treatment, and causes a prolonged calving to conception interval of median 30 days more (Sheldon et al., 2006, Dobson et al., 2007). Similar to endometritis there is another uterus infection named metritis. Metritis is defined as a bacterial infection involving all of the layers of the wall of the uterus. A history of difficulty calving, retained placenta or twin birth predisposes for metritis and is proved to subsequently affect fertility as well. (Ordell et al., 2016)

Dairy production in intensive systems

The management of dairy cow reproduction is of profound importance in successful dairy herds. Aims and objectives for reproductive performance and monitoring/keeping record of these should be a great part of the farm's organization (Sheldon et al., 2006). There are established objectives regularly used in farming reproduction systems, such as fertility measures or reproductive traits. They are used for setting goals, following the development of fertility and to identify risk factors and for benchmarking. There is no single trait that can describe the herd's fertility development overall, it requires evaluation of several parameters for being able make the whole picture. The monitored herd statistics are historical measures which makes a system of records important (Smith, et al, 2009).

Important fertility measures

To monitor reproductive performance, time interval measurements requires to be registered frequently for being possible to use as indicators for reproductive performance. Several of the measurements are calculated in relation to the cow's individual calving date. Examples of some indicators are the calving interval, days to first service, days to conception, age at first calf, percent culled due to reproduction failure, percent of conception per insemination etc. (Löf et al., 2012).

One basic and valuable indicator is age at first calving. For optimal production, it is recommended to aim at starting the first lactation at 24-25 months of age. This requires a heifer with optimal growth rate, body weight and a good physical size for safe calving (Akins, 2016). The goal is then to manage a calving interval of 11.5-13 months (Dobson et al., 2007, Dohoo, 1983, Petersson et al., 2008). This implies that the cow needs to be pregnant at least 85 days postpartum (Petersson et al., 2008). However, during the first period after parturition, in early lactation, the cows are intentionally not inseminated even though they show signs of oestrous; this is the voluntary waiting period (VWP). This period allows uterine involution, resumption of ovarian cyclicity and important recovery from negative energy balance for the cow. The large farms set the VWP in general between 50 and 60 days postpartum (Chebel, 2008). The calving to first service interval is thereby determined both by the time required for the cow to start cycling postpartum but also involves farm management as ability to detect oestrous signs and the VWP. Another way to determine the number of days non-pregnant, besides the calving to first service interval is by calculating the number of days to conception, where number of services per conception also are included (Dohoo, 1983). Thus, days to first service, oestrous detection and number of successful services all combine to prolong the calving interval which causes a large economic loss for the farmer (Petersson et al., 2008).

Oestrous detection is a crucial part of obtaining optimal calving intervals, especially in herds using artificial insemination (AI) but also for natural service herds. According to Smith et al. (2009) detecting the first oestrus cycle postpartum provides a reference point when to expect following oestrus cycles as well as to determine whether the cow is recovering well from the calving.

There are several more indicators of reproductive performance commonly used in large herds, such as percent culled due to reproduction failure, conception rate per insemination, non-return rate, number of inseminations per series, number of treated animals due to reproductive disorder, heat detection rate etc. (Ben Salem., 2006, Smith, et al, 2009, Chebel et al., 2004). Many of these measurements require thorough and large collection of cow data for being able to be calculated.

Reproductive health management on herd level

For the herd data to be valid there must be authentic and coherent animal identification for the data collection to be both effective and accurate. Successful reproductive performance requires frequent evaluation of the data so that intervention is made on time. For being able to maintain the health of the herd and to lower the number of interventions, it is recommended to have regular veterinary routine visits that perform reproductive examinations and inspect the farm regarding cow health. Reproductive examination commonly includes assessment of body condition score, vaginal examination, trans-rectal palpation of the uterus and ovaries as well as an external inspection (Sheldon et al., 2006). Nowadays, trans-rectal ultrasonography is commonly used to provide a more accurate diagnosis, thus it is considered being a preferable tool of diagnosis rather than rectal palpation only (Balhara et al., 2013). The findings and diagnosis of each animal should thoroughly be recorded and actions of treatment taken (Sheldon et al., 2006).

The current most crucial component affecting reproductive efficiency in dairy cows is poor oestrus detection. Detection of oestrus signs provides accurate and optimal time for artificial insemination (AI) or arranged natural mating. It is recommended to search for signs of oestrus more than two times per day and for longer periods of more than 30 minutes for successful oestrus detection and conception rates (Lucy, 2001). Today, AI is regularly used in modern dairy farms which make failure of oestrus detection the most common and also the largest economical loss. The reason is that cows are regularly inseminated despite not being in oestrus, i.e. when time of conception is impossible (López-Gatius, 2012). By this reason, researchers have developed oestrus synchronization which makes timed AI for insemination possible without oestrus detection. However, the rate of embryonic loss is higher and calving rates after timed AI are lower than in cows inseminated after a spontaneous oestrus, which still makes timed AI a challenge for modern dairy farmers (López-Gatius, 2012). One should also bear in mind that timed AI requires multiple hormone treatments and is therefore controversially discussed among veterinarians and farmers as well as the financial question regarding timed AI. If the co-occurring treatment with hormones is applied, it is somewhat considered that it may diminish the requirement to tackle the root causes of poor reproductive performance a have an impact on animal health and welfare (Higgins et al., 2013).

Artificial insemination is considered to have had a major impact on the science of animal breeding. By the control of venereal diseases, improved genetic gain and cost-effectiveness, artificial insemination has been a major success compared to natural service (López-Gatius, 2012). Even so, it is still regarded that a bull increases the reproductive performance, simply by his presence and his greater ability to detect oestrus. Despite this, there are main risks with natural mating such as failure of a bull health examination regarding libido and semen quality, infertility of the dominant bull, both lameness in bulls and injuries in cows, danger to farm workers and introduction of venereal and non-venereal diseases (Vishwanath, 2003). As a result, AI thereby provides several advantages for the dairy farmer, which is if oestrus expression is caught at the accurate time (López-Gatius, 2012).

After AI, it is then highly important to verify if pregnancy has been established for optimal reproductive management. An early and accurate pregnancy diagnosis is a crucial way to decrease the calving interval. By determining open animals as well as having the opportunity to treat diseased animals and/or to rebreed them as early as possible, one can shorten the calving interval (Balhara et al., 2013, LeBlanc et al., 2002). A simple method to determine pregnancy is if the cow fails to return to oestrus 18-24 days after insemination or natural mating (Fricke et al., 2016). This method of pregnancy diagnosis is very uncertain because it requires a precise and effective detection of signs of oestrus and that all cows continue a normal and regular oestrus cycle post insemination (Sheldon and Noakes, 2002). It is shown that about 6 per cent of normal healthy cows show behavioral signs of oestrus during pregnancy and can even be willing to stand to be mounted during this time (Thomas and Dobson, 1989). This also implies the inaccuracy of this method of determining pregnancy, but it is of outmost importance to identify the non-pregnant cows and rebreed them as soon as possible.

The recommended method of choice for determining pregnancy is trans-rectal palpation or even better, trans-rectal ultrasonography for even earlier and more accurate diagnosis (Balhara et al., 2013, Stevenson et al., 2003). Rectal palpation of the uterus is an old and commonly used method of pregnancy detection and an experienced practitioner can determine pregnancy as soon as 35 days after insemination (Balhara et al., 2013). However, a more accurate and precise diagnosis of pregnancy is made later, approximately 45-60 days after gestation (Sheldon and Noakes, 2002). As stated earlier, it is recommended to accurate verify a pregnancy as soon as possible, trans-rectal ultrasonography is therefore a well-established tool that can accurately determine pregnancy as soon as 20 days after insemination. Trans-rectal ultrasonography allows assessment of fetal age, growth and progression, fetal sex and pregnancy disorders (Y. Ribadu and Nakao, 1999). It is regarded that detecting non-pregnant animals should be done at least 60 days post insemination for keeping the calving interval short (Balhara et al., 2013). 22 per cent of the embryos die before day 18; this decreases remarkably after day 42 to 5 per cent, meaning that an early pregnancy diagnosis should have a subsequent examination of pregnancy for further accuracy (Sheldon and Noakes, 2002).

Additionally, there are several indirect methods for pregnancy diagnosis as well. One example is by measuring pregnancy associated glycoproteins produced by the placenta that can be analyzed in blood and milk from 28 days of pregnancy. This diagnostic method is on the rise and is considered to be more accurate than progesterone testing, which is another useful method. Progesterone testing is used by measuring high levels of progesterone in milk to diagnose cows in early pregnancy. Pregnancy prolongs the life of the *corpus luteum* and progesterone levels reaches their maximum value in 13-14 days after oestrus and will continue high levels from the 21 day and until the end of pregnancy. However, detection of high progesterone levels during the period of oestrus (day 18-24) is not specific of pregnancy because the levels of progesterone are high during diestrus as well and the duration of oestrus cycle can vary between cows (Balhara et al., 2013). Despite of this, progesterone testing can be beneficial if used regularly and can be helpful in both detecting early pregnancy and also delayed ovarian cyclicity in postpartum cows, which is reported to be more accurate than other methods (Petersson et al., 2008).

The optimal reproductive performance of the dairy cow is multifactorial. It has been stated that health, management, heat control and AI, season as well as nutrition and genetics does have a great impact on reproductive performance (Zebeli et al., 2015). Regarding seasonal effects; it has been proved to have a major effect on fertility, whereby high temperatures (i.e. heat stress) have the strongest link to low fertility, although heavy rain, high humidity and strong wind are also considered to have negative effects (López-Gatius, 2012). Considering this, it is important to protect the animals from hard weather and thereby have an accurate housing system which corresponds to the season. In northern countries dairy cows are mainly held in tie-stalls or loose housing systems. Reports have shown that loose housing systems have better reproductive performance together with reduced incidence and prevalence in disease in comparison to tie-stalls. The prevalence of lameness was in another case higher in loose housing systems compared with tied up stalls which may be correlated to concrete slatted, dirty and slippery floors which affects fertility negatively (Barkema et al., 2015, López-Gatius, 2012).

Regardless type of stall system, the farmer also has to consider accurate amount and composition of the feed. The nutritional status of the dairy cow has a substantial role in both productive and reproductive performance. This applies to both the risks of inadequate energy supply and overfeeding hence both conditions have ha negative impact on production and health (Garnsworthy, 2007). The farmer should have sufficient knowledge regarding feeding management which makes sure that the cows calve in a convenient nutritional state with adequate, but not excess, body reserves with a sufficient mineral balance for the demand of both calving and lactation (Sheldon et al., 2006). In general the successful farmer should be well educated and have knowledge about dairy production, reproduction and new technologies considering management and health of the cows. Today, dairy farms are commonly drifted by staff workers which should also have a good education and knowledge about animal management for the farm to achieve the best of production (Barkema et al., 2015).

Final but not least, it is important for the successful dairy farmer to have a proactive plan regarding biosecurity of the farm to protect the animals from infectious disease. Control programs have been successfully implemented in northern Europe, officially declaring the countries free from several infectious diseases (Barkema et al., 2015). The programs of biosecurity are of great importance and they should include testing of disease, quarantine, vaccinations and visitor hygiene (Sanderson and Gnad, 2002). A successful program is mainly characterized by substantial routine practices considering diagnostic testing when purchasing cattle, embryos or semen for monitoring diseases in the herd. It is also by profound value that the farmer pays attention to the routines of visitor hygiene and the role of transmission of pathogens among farms, people and animals. It has commonly occurred that the veterinary practitioner has been the one responsible for transmitting infectious disease from one farm to another, which could have a significant impact of the animal's health as well as production (Barkema et al., 2015). The veterinarian's knowledge and understanding of disease epidemiology is highly valuable and should provide a guide for the farmer to implement a proper biosecurity plan based on the herd's present disease status (Sanderson and Gnad, 2002).

MATERIAL AND METHODS

Study area

The study was performed in five districts in the region Districts of Republican Subordination in Tajikistan, bordering the main capital Dushanbe. The districts were Shahrinav, Hissor/Gissar, Rudaki, Varzob and Vahdat. The collection of data was performed during seven weeks in the early fall in 2016, September to November. In total 114 cows from 10 farms in 10 village clusters (jamoats) were examined in the five districts. Thereby, in total 10 interviews were conducted. Two of the farms were situated in the Shahrinav district, another two in Hissor/Gissar, three farms in Rudaki district, two farms in Vahdat and one farm in Varzob district.

Study procedure

A personal interview was conducted at each farm. Questions were mainly answered by staff that was head responsible for the animals.

The questions were applied as open questions, translated orally into Tajik or Uzbek. The answers were then categorized into the most appropriate category by the author. During the questions regarding animal care, the collaborating local farm veterinarian where asked temporarily to leave the interview for the achievement of unbiased answers.

A general clinical examination, followed by udder palpation, milk evaluation and gynecological examination based on the clinical examination form was performed on randomly selected dairy cows of the farm that were within the inclusion criteria stated in the study design.

Picture 3. *Author performing an interview at one of the participating farms. Photo by Kajsa Celander.*

Ethical approval

All handling of the animals in this study was conducted in accordance to the ethical standards of the Ministry of Agriculture in Tajikistan and the Tajik Agrarian University. The chief of State of Veterinary Service and the Veterinary chief in each district approved all handling of the animals before the study was carried out. All of the participants were informed about the purpose and method of the study, that the data was handled anonymously and that the participation was voluntarily, which they all consented before starting the questioning and examinations.

Study design

Post-pubertal cows with a history of at least one calf and at least 20 days since last calving were included in the study. The data was collected from large farms with ≥50 cows in total that were selected by convenience, based on the farms availability and willingness. The number of selected cows at each farm depended on time requirement, availability of the cows and the daylight, in average 7-14 cows were selected on each farm depending on the total number of cows at the farm. The study included two forms, wherein one was a questionnaire based on oral records considering the farm and the other was based on oral records, observations and clinical examinations regarding the individual cows during the visit.

The farm interview

The interview consisted of six categories of questions; basic farm-data, basic animal-data, management, consultation of animal care, reproductive health and environment. Each category had questions regarding the dairy production, management and reproductive performance of the farm. The questions were constituted regarding important reproductive traits and management factors which are proved to have a substantial impact on reproductive performance stated previously. The questionnaire is included as Attachment 1.

The routines of hygiene and biosecurity were based on the general knowledge of the farmer regarding these management factors. The categories were based on if the farmer seemed to have routines or not and if they had routines, how closely were these followed. For example if the farmer simply only scraped the ground from faeces on a daily basis, it was not regarded as structured routines of hygiene. However if the farmer changed his clothes every day, made a disinfection of the stable every 3 months and cleaned the teats before milking every time, it was regarded as structured routines. If the farmer had a system of quarantine and separating diseased animals from healthy it qualified as structural routines.

Picture 4. *Interviewed farmer explaining their system of recording reproductive dates (left) and author performing interview in tied-up stable (right) in Tajikistan. Photos by author and Kajsa Celander.*

Clinical examination of the individual cow

The clinical examination form consisted of five categories; anamnesis, body condition score, general clinical examination, udder examination, trans-rectal gynecological examination and milk progesterone test. The environmental temperature where the animals were kept was measured by a mobile outdoor thermometer and noted in the form. The anamnesis was based on information regarding last calving date, days since last mounted or inseminated, days open, age, lactation number, milk yield/day and known illness at the moment. The features included in the clinical examination form were chosen to capture important reproductive traits and clinical conditions which are proved from literature to have a substantial impact on reproductive performance. Procedures included in the examination were the following;

Body Condition Score: Evaluation was based on a 1-5 scale (where 1 stands for extremely thin and 5 obese and selected by whole-score increments) by ocular and palpable evaluation of the subcutaneous fat placed on the lumbar and sacral region (Edmonson et al., 1989).

General clinical examination: Examination was based on ocular findings regarding general state of health, injuries, and signs of lameness, cleanliness and rumen distention. Cleanliness were based on three categories: 1) was defined as 'clean or splash of feaces on udder, hind and sides', 2) 'multiple, ≥ 3 sites with dry feaces, ≥ 10 cm diameter per site', 3) 'dry feaces covering in total 1/3 of udder, hind and sides'. Signs of lameness were simply a 'yes' or 'no' question. The cows were most of the times tied up during examination which made a thorough lameness evaluation in walk and trot not manageable in those cases. The lameness evaluations were then based on that the cow placed her weight equally on all feet and had a straight backline; she was then categorized as 'no'. The evaluation of injuries were based on three categories where 1) was defined as 'injuries summed together as one palm', 2) '< 2 palms of injuries summed together', 3) '> 2 palms of injuries summed together or one single injury of ≥1 palm in diameter. Rumen distention was also based on three categories where 1) was defined as 'filled rumen which slightly bends outwards', 2) 'filled rumen', 3) 'not filled, forms a triangle'.

Udder examination: The complete udder examination was based on 'yes' and 'no' findings. Palpation of the udder and teats revealed cardinal signs of inflammation and/or teat lesions where both injuries and skin lesions was noted. A milk sample revealed ocular and olfactory modification of the milk, such as lumps, discoloration or smell of pus.

Gynecological examination: The external genital organs were examined for the appearance of the vaginal mucous membrane (pink, pale, red or signs of vestibulitis/vaginitis) and vaginal discharge (clear and viscous i.e. typical for oestrus, bloody (metestrus bleeding) or mucopurulent). A trans-rectal palpation was then performed of the genital tract where cervix, uterus and ovaries were evaluated. A subjective evaluation regarding cyclicity, pregnancy and disease was made based on the findings summed together. Method of palpation of the genital tract was used as followed;

Rectal palpation

The trans-rectal palpation was based on the following palpation findings and classified into these categories.

Uterus

- *Diestrus*; the uterus wall perceived as smooth and soft and had a small diameter of the uterine horns.
- *Oestrus*; uterus wall felt firm and elastic and had a small diameter of the uterine horns. Excessive clear and viscous vaginal mucus could appear during palpation (Bonafos et al., 1995).
- *Endometritis/Pyometra*; the cervix of the uterus felt widened and the uterus horns were enlarged. The uterus wall perceived as pulpous and thick.

Ovaries

- *Cyclic*; a corpus luteum grown into full size of 25-30 mm diameter or declining/arising in size of 10 mm diameter was palpated. Or, a large follicle in size of 13-17 mm diameter and a firm and small corpus luteum from previous cycle was palpated.
- *Anestrus*; no follicular structures or corpus luteum was palpated and both of the ovaries were small in size.
- *Ovarian cyst*; a follicle of >20 mm diameter was palpated on one of the ovaries.

Picture 5. *Performing trans-rectal examination of a Russian Simmental breed (left) and milk progesterone testing by P4 Rapid (right). Photos by author.*

Rectal palpation for pregnancy diagnosis

The trans-rectal palpation for pregnancy diagnosis was based on the following palpation findings and classified into the category ‘2-9 months pregnant’. If the cow were to be reported as less than two months pregnant, she was then classified as non-pregnant in the ‘diestrus’-category.

- *Two months of pregnancy;* the uterus was asymmetric, the pregnant uterine horn was enlarged due to accumulation of allantoic fluid, ipsilateral to the ovary with the corpus luteum. The uterus wall became thinner and the lumen felt fluctuant.
- *Three months of pregnancy*; the uterus was larger and barely reachable by its full size. A counterthrust could be felt when tapping against the uterus wall from the fetus in the allantoic fluid.

- *Four months of pregnancy*; placentomes (cotyledons and caruncules) was palpated as discrete circular structures on the uterus wall. The vibration from the *Arteria uterina media* was also palpated, called fremitus, which can be palpated from the fourth month until the last day of gestation (Sheldon and Noakes, 2002).
- *Five to six months of pregnancy*; the uterus was so enlarged that it was difficult to reach. However, fremitus remained.
- *Seven to nine months of pregnancy*; the fetus parts and the movements of the calf was palpated within the uterus.

Milk progesterone testing: When the gynecological examination was inconclusive, a milk sample was collected for a cow-side progesterone analysis (P4 Rapid, Ridgeway Research Science, St Briavles, UK) which demonstrated the categories 'high' or 'low' progesterone. Then depending on whether the progesterone was classified as high or low, the examined cow was categorized as 'cyclic' (high progesterone) or 'anestrus' (low progesterone).

Statistical analysis

The data were entered in Excel (Microsoft) and analyzed on herd level by using descriptive statistics in Minitab version 17.3.1. Charts and tables were constructed in Microsoft Excel.

Picture 6. *A dairy farm with a loose-housing system (left) and trans-rectal examination at the same farm (right). Photos by author and Kajsa Celander.*

RESULTS

The farm interview

The median number of cows in all 10 visited farms was 91 cows (range 54-1109 cows). Mean and median number of cows excluding the farm with 1109 cows, was 121.4 and 70 cows respectively. The numbers of cows at the farms are demonstrated in Figure 1.

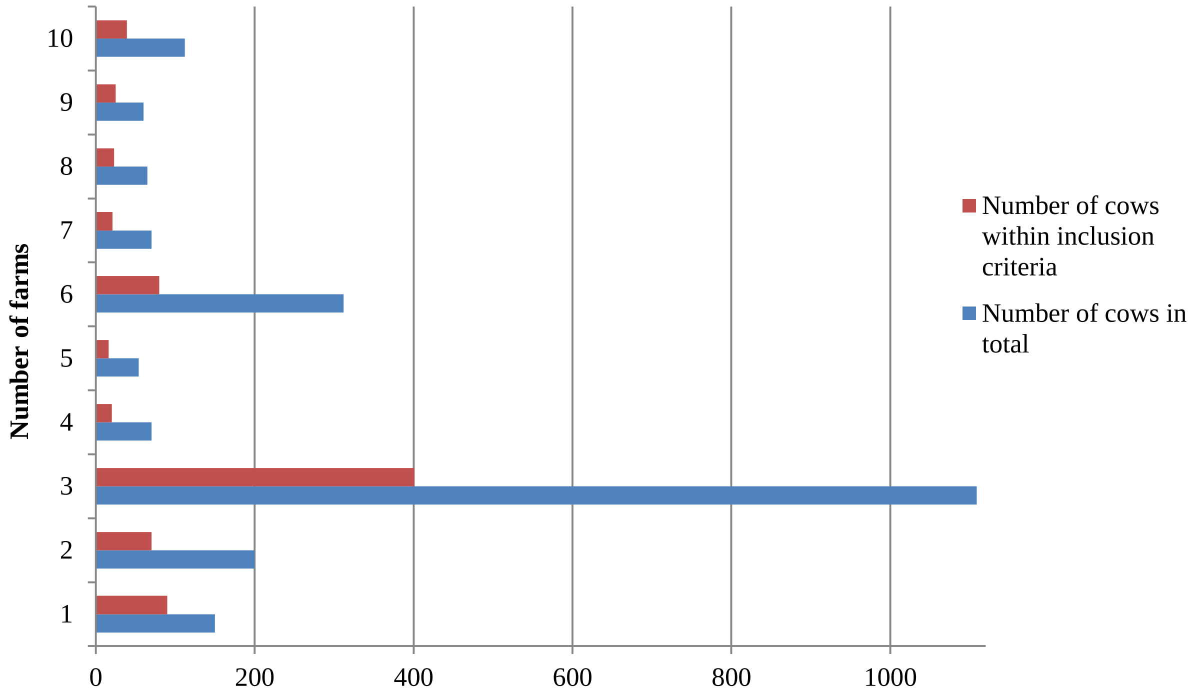

Figure 1. *A bar diagram of number of cows in total at ten farms in Tajikistan, as well as number of cows within the inclusion criteria's which were post-pubertal cows with a history of at least one calf and at least 20 days since last calving.*

Basic farm data

One hundred percent of the main cow caretakers that were interviewed were reported to be staff and 30% of these cow care takers reported to have no education. Sixty percent and 10% (1/10 farms) had primary education and further education respectively. The majority of the interviewed cow care takers (80%) had >10 years of experience with cows and no one had less than two years of experience. In 60% of the farms there were both men and women taking care of the cows, the women's only assignment was to milk the cows in all of the farms. The remaining 40% had only male cow caretakers. Seventy percent of the participating farms reported to have a commercial purpose of production and 30% reported to have both commercial production and kept milk for themselves as well. Ninety percent reported that their goal of the production was to expand and one farm just wanted to keep the production in the same level as currently. The production of milk per day and farm varied from 110 to 7000 liters with a mean and median of 1029 and 325 liters respectively.

Basic animal data

The majority of the farms kept only pure bred cows or a mix of several variations of both a local mixed breed, a local improved breed and pure breed (see the distribution in Figure 2). Half of the farms reported to produce less than 10 liters milk on average per cow a day, 40% reported a milk yield of 10-20 liters and one farm (10%) reported to produce more than 20 liters per cow a day.

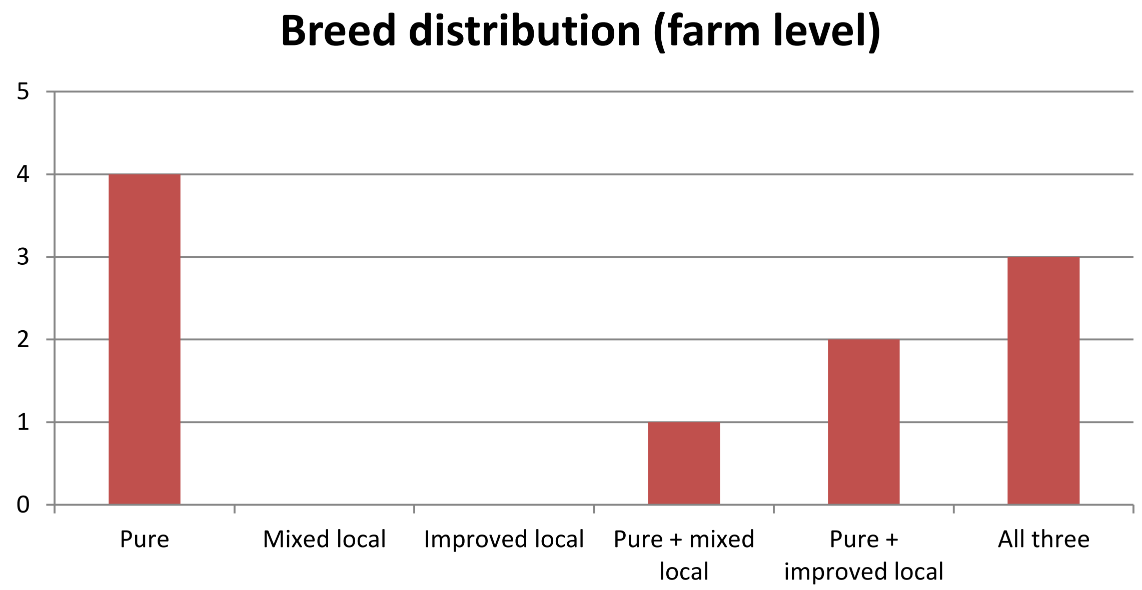

Figure 2. *Distribution of cow breeds within the 10 interviewed farms in Tajikistan*

Half of the farms reported to keep a tag or an ID-number of their cows and half used both ID-number or tag and names. The results of calving interval, age at first calving and number of living born calves/year are demonstrated in Table 1.

Table 1. *Reported fertility parameters on the farms and number of calves born per year stated by the main cow care takers at the farms (n=10) in Tajikistan*

	Farms	
Fertility parameters and number of calves	Number	Per cent %
Calving interval		
<13 months	9	90
13-18 months	1	10
Age at first calving		
<25 months	0	0
2-3 years	4	40
>3 years	6	60
Number of living born calves/year		
<50	6	60
50-100	3	30
100-150	0	0
>150	1	10

Management

Nine out of ten farms used a recording system for the animals. Everyone kept record of animal health, economy and reproduction. Nine out of ten farms also milked by hand, one farm used both milking by hand and milking machine, using a milking parlor pit for eight cows to be milked at the same time. Two farms (20%) did not have structured routines of hygiene regarding environmental management, half of the interviewed farms had verbal routines and the remaining 30% had a written policy. Six out of ten farms had verbal routines of biosecurity and 40% had a written policy. No one lacked structured routines regarding biosecurity of the animals.

Consultation of animal care

All of the interviewed farms (100%) had veterinary consultation. The majority (60%) of the farms had an employed farm veterinarian who visited the farm daily. The remaining 40% had visits by a veterinarian on a weekly basis. In all of the cases (100%) the main purpose of the visits where preventative. Except veterinarians, the main consult of health care was zootechnicians (50%), other than that there was one out of ten farms who consulted an agronomist and one out of ten consulted other educated. All of the farms used disease testing on the healthy animal population and 90% reported that they tested for brucellosis. One of the farms did not know which diseases they tested their animals for. The farms also reported to test for bovine piroplasmosis, bovine leucosis, tuberculosis, foot and mouth disease and theileriosis. Ninety percent tested for disease on a regular basis and 10 % tested when needed.

Reproductive management

The distribution of different breeding methods is demonstrated in Figure 3. Ninety percent (9/10 farms) of the farms performed oestrus detection. Which type of oestrous signs the farmer controlled is shown in Table 2. In one out of these nine farms, the owner was the main responsible for controlling signs of oestrus, the remaining eight farms (88.9%) had staff controlling for oestrus signs. One farm reported to do oestrus detection when oestrus was expected, the other eight farms reported to look for signs every day. The majority (66.7%) reported that they looked for signs all day, i.e. no specific time of the day, see Figure 4.

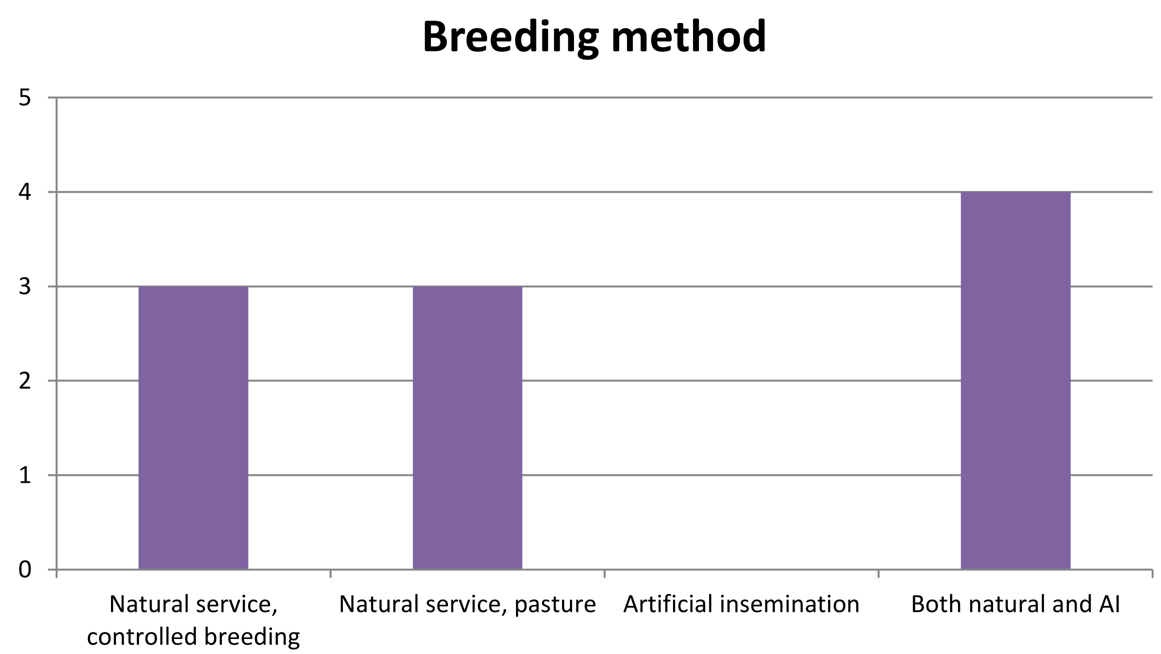

Figure 3. *Breeding methods reported to be used in the visited farms (n=10) in Tajikistan. Natural service is divided into two groups whereas at 'controlled breeding', the cow is taken to the bull by the farmer for mating and at 'pasture' the cow is together with the bull at all time during pasture*

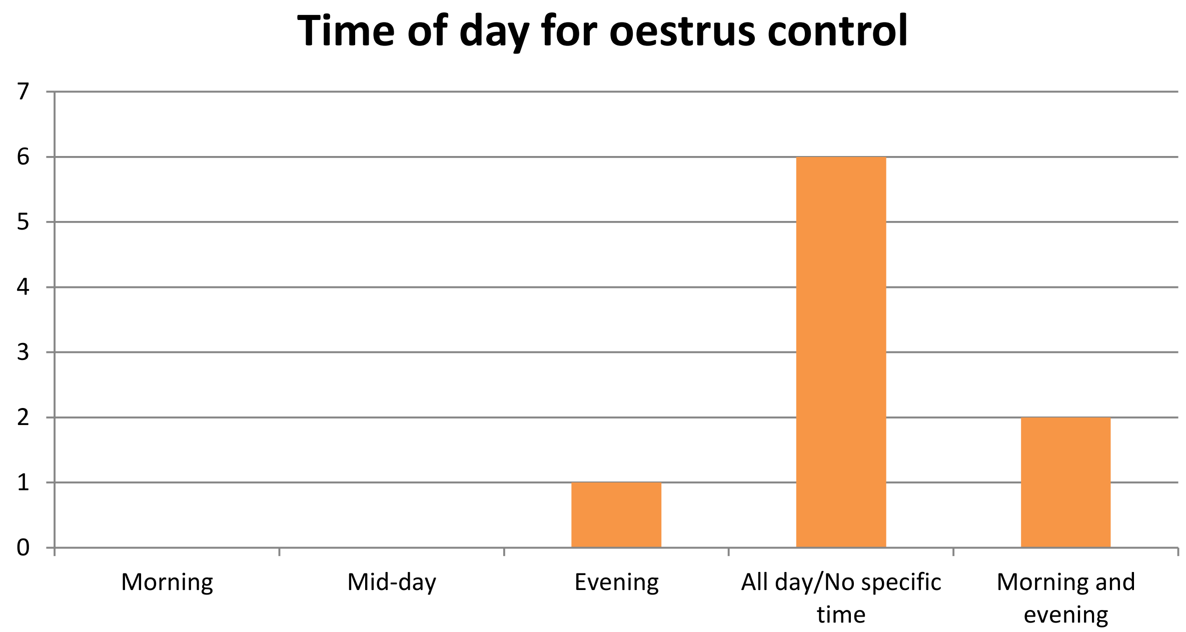

Figure 4. *The time of day the farmers (n=9) reported to control the signs of oestrus in Tajikistan.*

Table 2. *Proportion of different oestrous signs reported to be controlled by the main cow care takers at the visited farms (n=9) in Tajikistan.*

Sign of oestrus	**% of the farms controlling the sign**
Vaginal discharge/Vulvar swelling	100
Mounting other animals	55.6
Bellowing	44.4
Decreasing milk yield	44.4
Allowing others to mount	33.3
Restlessness	33.3
Flehmen	0
Chin-resting	0
Smelling other cows vagina	0
Frequent urination	0
Lordosis	0

Seventy percent of the farms reported to perform pregnancy diagnosis of the cows. Out of those, all reported to consult a veterinarian for pregnancy diagnosis. Five out of seven farms (71.4%) used trans-rectal examination as method of pregnancy diagnosis. And one farm used external signs, and one other farm used both trans-rectal and ultrasonic examination to determine pregnancy of the cows. Pregnancy diagnosis was mainly performed at three months after insemination (71.4%) and one farm (14.3%) diagnosed at more than three months after insemination. One farm examined their cows earlier than three months and confirmed the diagnosis by repeated examinations at three and seven month of pregnancy.

Environment

Results regarding environmental factors are presented in Table 3. One out of seven farms had visible water contamination. The majority (90%) reported to only provide shade for the animals when hot weather to minimize heat stress, for example taking them inside the stable during mid-day. One farm reported to use shade as well as washing or having access to a river/pond or lake to cool the animals down.

Table 3. *Environmental factors stated by the farmers (n=10) in Tajikistan as to what type of feed the cows were given and the availability of water and how often they were given food and water. Out of the feeding regime classified '>Once a day', the majority fed their cows 2-3 times per day and those without free access of water were given water by buckets 3-4 times per day*

	Farms	
Stable type	Number	%
Tied-up	2	20
Loose housing	8	80
Type of feed		
Forage and concentrate	3	30
Forage, concentrate and pasture	7	70
Feeding regime		
Once a day	0	0
>Once a day	7	70
Free access (e.g. pasture) and feeding >once a day	3	30
Water regime		
Once a day	0	0
>Once a day	2	20
Free access	8	80
Water availability		
Visible at visit	7	70
Not visible at visit	3	30

The clinical examination of the individual cow

The number of examined cows at each visited farm is displayed in Table 4. The mean number of examined cows per 50 cows within the criteria was 15±8 and the median number was 16 cows.

Table 4. *Number of cows within the inclusion criteria, number of selected and examined cows and calculated number of examined cows per 50 cows within the inclusion criteria in the 10 visited farms in Tajikistan (n=114). The inclusion criteria´s were post-pubertal cows with a history of at least one calf and at least 20 days since last calving.*

Farm	Cows within criteria	Examined cows	Number of examined cows per 50 cows within the criteria
1	90	10	6
2	70	13	9
3	401	20	3
4	20	11	28
5	16	7	22
6	80	15	9
7	21	10	24
8	23	8	17
9	25	9	18
10	39	11	14

Thirty-two point five percent (37/114 cows) of the examined cows were reported to have a period of days open within the interval of 20-60 days. Twenty-three point seven percent (27/114 cows) were reported to have more than three months open. In 26.3% (30/114 cows) of the cows, the main cow caretaker did not have the information about calving date and/or date of insemination. More than half (50.9%) of the examined cows were 5-10 years old, 8.8% were older than 10 years old, 5.3% were 2-3 years old, 7% had an unknown age; the remaining 28.1 % were 3-5 years old. The distribution of lactation numbers of the cows are presented in Figure 5. The majority of the cows were of pure breed (64%), 23.7% of the cows were of a local improved breed and the remaining 12.3% were of local mixed breed.

Reported pure breeds were Holstein, German-, Belarus- Kazak- and Israel breed, Russian Simmental and Brown Latin. The mean amount of milk produced in liters per day per cow was 11.9±7.6 liters with minimum amount of 0 liters and a maximum amount of 31 liters, see Figure 6.

The results of the general clinical examination and body condition scoring are presented in Table 5.

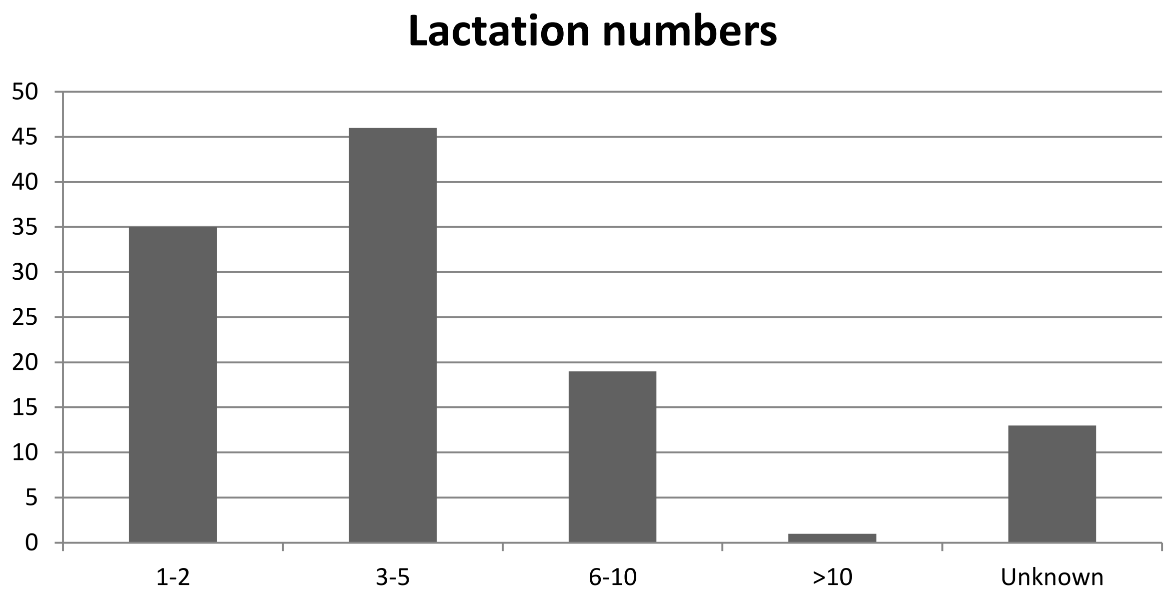

Figure 5. *Distribution of number of lactations of the examined cows stated by the farmers. (n=114)in 10 farms in Tajikistan*

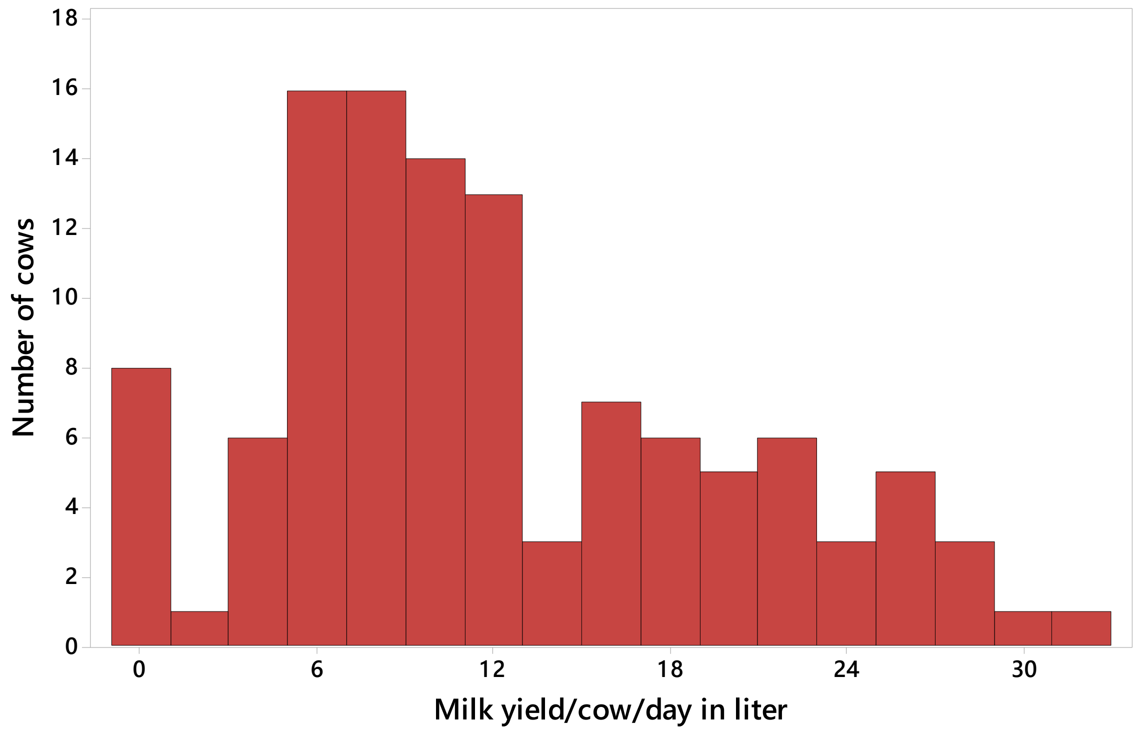

Figure 6. *Current milk yield (liters) per cow and day of the examined 114 dairy cows stated by the farmers in 10 farms in Tajikistan*

Table 5. *Results of the body condition scoring and general clinical examination of the examined dairy cows (n=114) in 10 farms in Tajikistan*

	Examined cows	
Clinical examination	**Number**	**%**
Body Condition Score		
1	11	9.7
2	27	23.7
3	47	41.2
4	26	22.8
5	3	2.6
General state of health		
Without remark	110	96.5
Reduced	4	3.5
Cleanliness		
Clean or splash of feaces on udder, hind an legs	62	54.4
Multiple, ≥3 sites with dry feaces, ≥10 cm diameter per site	37	32.5
Dry feaces covering in total 1/3 of the udder, hind and sides.	15	13.2
Signs of lameness		
No	114	100
Yes	0	0
Injuries		
Injuries summed together as the size of one palm	109	95.6
In size of <2 palms of injuries summed together	4	3.6
In size of >2 palms on injuries summed together or one single injury of ≥1 palm in diameter	1	0.88
Rumen distension		
Filled rumen which slightly bends outwards	22	19.3
Filled rumen	81	71.1
Not filled, forms a triangle.	11	9.7

The main temperature measured on animal level, was above 20°C and 59.6% (68/114 cows) of the examined cows were held in this temperature. The remaining 40.4% of the cows were held in a temperature of 10-20 degrees Celsius.

One cow out of 108 examined cows was judged to have cardinal signs of mastitis. However, 27.1% had teat lesions. No cows had olfactory milk modification but 11.22 % of the cows had ocular modification of the milk. A total of 112 cows were vaginally examined, of these 93.75% (105/112 cows) had no signs of vaginal discharge and 75 % (84/112 cows) had a standard normal pink vaginal mucous membrane. Two cows had clear viscous (oestrus) discharge and 14 cows (12.5%) had pale mucous membrane. One cow had bloody discharge and four cows were examined with mucopurulent vaginal discharge. Signs of vestibulitis/vaginitis or a red vaginal mucous membrane were defined at 6.25% (7/112 cows) of the cows, respectively. All of the included cows (n=114) in the study were gynecological examined, the uterine findings of the cows are presented in Figure 7 and the ovarian findings are presented in Figure 8.

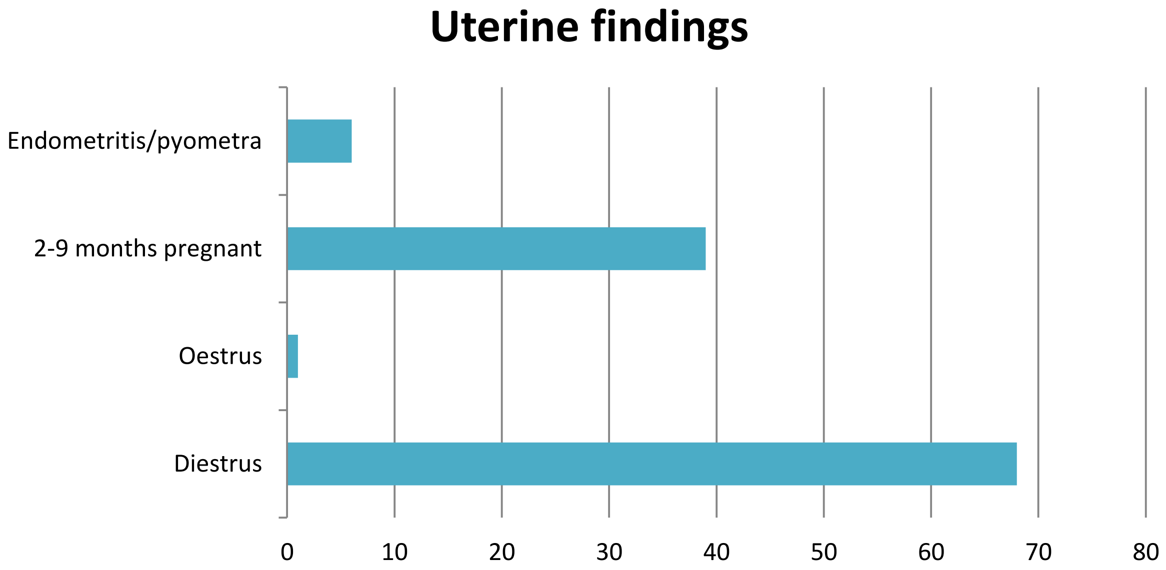

Figure 7. *The distribution of cows according to trans-rectal palpation findings of the uterus. (n=114) in 10 farms in Tajikistan*

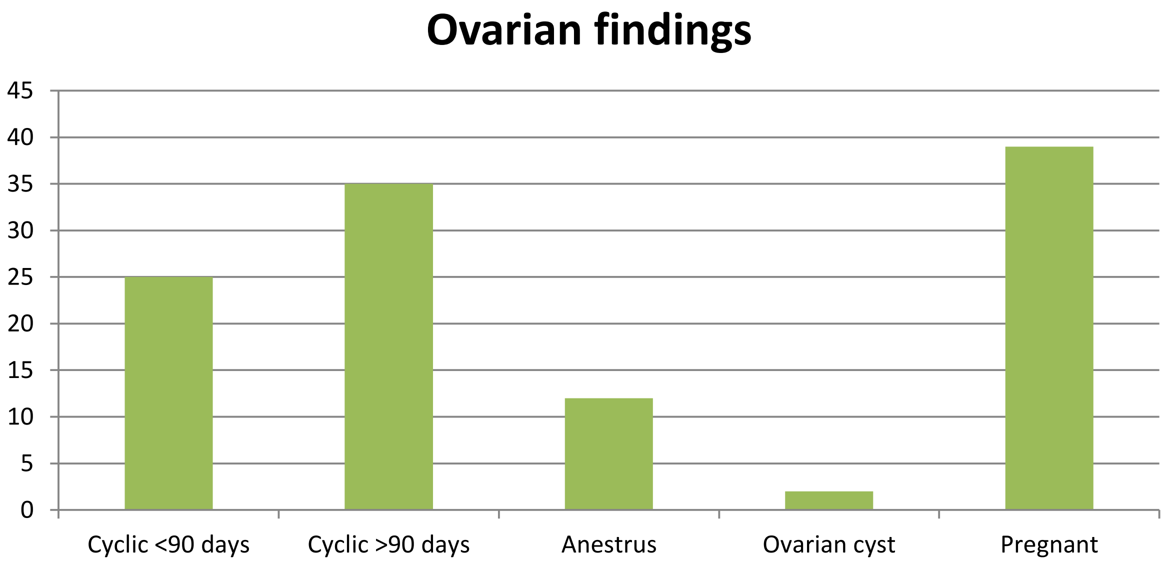

Figure 8. *The distribution of cows according to trans-rectal palpation findings of the ovaries. Number of categorized cyclic cows (n=60) are also classified after days since their last calving. (n=113) in 10 farms in Tajikistan*

For 34 of the 114 examined cows, the farmer were asked why the period of days open exceeded 90 days and if an examination of action were taken to prevent or cure the issue. The two main answers were that the farmer did not know why or that the cow did not show any signs of oestrus. The answer could also be that the cow gave so much milk at the moment that the farmer decided to wait to inseminate her or that she has had a history of endometritis. A few times the farmer claimed that it was because she was too skinny, too old or that it was because that the weather was too cold or too warm.

Table 6. *A comparison between reported days open by the caretaker and the clinical findings displaying the true days open and if this correlated. The rows display numbers of cows with reported days open. The columns display number of cows with true days open after trans-rectal examination. The green boxes display numbers of cows where the reported days open correlates with the observed days open. The reported days open are calculated by the reported calving date and insemination date. The unknown category is based on the missing information regarding last calving date or insemination date, or that the cow was not reported to be pregnant. The observed days open are calculated by the reported calving date and month of pregnancy classified by rectal examination of the uterus. (n=114) in 10 farms in Tajikistan.*

		Observed Days Open				
		20-60 days	*2-3 months*	*>3 months*	*Unknown*	*All*
Reported Days Open	*20-60 days*	9	4	11	13	37
	2-3 months	1	6	9	4	20
	>3 months	0	2	25	0	27
	Unknown	0	0	15	15	30
	All	10	12	60	32	114

Table 6 is demonstrating a comparison between reported days open by the cow caretaker and the true days open based on uterine findings which shows how well they correlated. The reported pregnant cows are correlated with the number of observed pregnant cows based on uterine findings are demonstrated in Table 7.

Table 7. *A comparison between the number of reported pregnant cows and the number of diagnosed pregnant cows by rectal palpation. The rows display numbers of cows where the farmer reported that the cow was more than 2 months pregnant and the columns display the numbers of cows that were diagnosed as pregnant by rectal examination. Cows that were reported to be less than 2 months pregnant are not included in the table.*

		Diagnosed pregnant	
Reported status		*Yes*	*No*
	≥ 2 months pregnant	28	21
	Not pregnant	3	17
	Unknown	1	6

The accuracy between all reported information regarding the cow's reproduction dates and observed information based on uterine findings and gynecological examination is demonstrated in Table 8. Table 9 is demonstrating the distribution of cows diagnosed as anestrus compared to how long time it has been since they had their last calving.

Table 8. *Correlation between the reported information, such as date of calving and/or insemination date, which implies how far along pregnant the cows should be, and the observed clinical finding after rectal examination such as pregnancy diagnosis. E.g. if the reported month of pregnancy is four months pregnant and the pregnancy diagnosis is sixth months pregnant, the information will not correlate. Correlation is made on 114 examined cows in 10 farms in Tajikistan.*

Reported information about the cows regarding pregnancy and observed information regarding pregnancy	*Number of cows*	*%*
Does not correlate	39	34,2
Correlates	75	65,8

Table 9. *Number of anestrus cows diagnosed by rectal palpation distributed over their reported last calving date. (n=12) in 10 farms in Tajikistan.*

Days after calving	**Number of anestrus cows**
<90 days	4
>90 days	8*

DISCUSSION

The farm based data

Nearly all of the farms stated to have a calving interval of less than 13 months. Every one of them further stated to keep records of the cows regarding their calving and insemination dates. When examining and asking about the selected individual cows at the farms, the days open regularly exceeded the limit of managing to maintain a calving interval of less than 13 months. There is no similar study performed in Tajikistan, however a study made by Saleem et al. (2012) in Pakistan, close to Tajikistan in similar conditions, reported that the majority of cows in northern Pakistan had calving intervals within the range of 13 months. This is not displayed in Hunde et al. (2015) at similar conditions in Ethiopia where the interval exceeded a calving interval of 13 months. The majority of the cows in Tajikistan had an observed number of open days for more than 90 days calculated after a trans-rectal examination. It was also unusual that the information regarding calving and insemination dates were correct. All of the participated farms kept their records on paper, generally in different notebooks, often making the records inaccessible and inconvenient to use. The interviewed staff worker often claimed to know all of the records of the cows by heart instead. The observed days open were calculated by the trans-rectal examination and the calving date reported by the farmer. This means that even the observed days open cannot be totally reliable since they also depend on the statement by the farmer regarding the date of calving, which may not be true.

More than half of the farms reported that their cows had their first calving at more than three years of age. Since there is no similar study performed in Tajikistan one can compare with a study performed by Hammoud et al. (2010), under similar conditions in Egypt where the age at first calving also exceeded the recommended age of 25 months. It is recommended that the heifers do not exceed more than 25 months of age at first calving for optimal profitability and production efficiency. In general, the value of these figures gives that the lifetime productivity of the dairy cows in Tajikistan is low regarding their age at first calving, which causes financial loss (Akins, 2016). However, the Tajik cows have more lactations than the average cow in intensive dairy systems making them last longer within the production. Exactly what is contributing to the high age at first calving in Tajikistan remains unclear in this study; an important factor may be undernourished heifers. Under-nutrition at an early age has a stated effect on growth rate and the age of puberty (Akins, 2016).

Not all of the interviewed farms reported to perform a pregnancy diagnosis of the cows, in fact only 70% of the farms performed pregnancy examinations. As previously stated, by pregnancy examination one can determine non-pregnant animals as well as get the opportunity to treat diseased animals and/or to rebreed them as early as possible and therefore saving money by detecting empty cows and shorten the calving intervals (Balhara et al., 2013). It is a devastating and major financial loss for the farmer to have non-pregnant cows for several and long periods of time. As demonstrated in a study performed in the neighboring country Kyrgyzstan by Bozymov et al. (2015) the cost-effectiveness of early pregnancy detection can be calculated as the cost of a calf as $190.94 and a farm’s loss from a dry cow as $0.93 per day. This makes the farm’s total loss from one open animal for the entire reproductive cycle at $486.45 per animal. Despite the low frequency of pregnancy examinations, the majority of the farms still consulted a veterinarian daily or weekly for other preventative measures. The lack of pregnancy examinations could therefore be an issue of knowledge from either the local veterinarian or the farmer regarding the strong connection between pregnancy diagnosis and the economic gain from it. Only one farm did report to use trans-rectal ultrasound for pregnancy diagnosis and one farm actually reported to only use external signs for pregnancy diagnosis. External signs of pregnancy are not useful until the eight month of pregnancy for a reliable diagnosis and non-pregnant cows may then be empty for as long as more than eight months before discovered, which, as stated above, contributes to a major economic loss for the farmer (Bozymov et al., 2015).

Nine of the farms reported to control signs of oestrus, i.e. one farm did not control oestrus at all. The majority of the farms only controlled three or fewer oestrous signs. Every one of them controlled signs of vaginal discharge and several of the farms used that as the single sign or together with other signs such as mounting other animals, bellowing or decreasing milk yield as significant signs of oestrus. The knowledge regarding various oestrous signs, as well as which signs that are more accurate than others, seems be to lacking. The majority also stated that they are not controlling oestrus at any specific time of day and claimed that they controlled oestrous behavior 'all day'. Two of the farms reported that they specifically controlled oestrous behavior in the morning and evening and one farm only controlled during the evening. It is generally recommended to control oestrous behavior at least twice per day and during a period of 30 minutes for successful detection of oestrus (Lucy, 2001). By this information, it seems that the farmers lack knowledge regarding what type of signs, which time of day and how often they should look for the signs for being able to detect cows in oestrus properly and thereby having good pregnancy rates.

The individual cow data

More than half of the cows currently produced ≤10 liters of milk per day during the study, including cows milking 0 liters and a large proportion of the dairy cows were reported to be of pure breed and the majority as Holstein breed. The Holstein breed is genetically predisposed to produce an average milk yield of 30 liters a day according to Dobson et al. (2007), if fed accordingly. The commercial dairy farms in Tajikistan need to improve their production for enabling greater financial profit by producing more milk. A reason for this inefficient production may be the very large proportion of non-pregnant cows being empty for a long period of time (>90 days), demonstrating that a majority of the dairy cows in Tajikistan could not be producing a calf each year as necessary. The long-term non-pregnant cows are a financial burden to the farmer according to several publications (Dobson et al., 2007, Lucy, 2001, Sakaguchi, 2011, Sheldon et al., 2006).

Based on a calculated optimal production scenario with the recommended reproductive traits, one can calculate the most optimal amount of pregnant cows at a farm. The optimal production year is based on a period of 85 days open and thereby 280 days of pregnancy. A normal recruit and culling percentage is about 30% of the cows, which gives about 70% anticipated pregnant cows. During 23% of the year (85/365) the cows are expected to be non-pregnant and thereby based on that calves are born all year round, one can expect that 54% of the cows are pregnant at any point of the year. The diagnosed pregnant cows in this current study were 34%. This demonstrated example suggests that the reproductive performance in large dairy farms in Tajikistan is low.

There is a huge variation of factors proven to affect the fertility and reproductive performance as mentioned earlier on. An important factor, which may be questionable in Tajikistan, is the fertility and health of the bulls, which has not been evaluated in this study. One does not have the information regarding quality of semen or soundness of the bulls used for natural mating in Tajikistan, which is important for receiving a good pregnancy rate (Vishwanath, 2003). Since the great majority of the farms used natural mating as breeding method, the bull fertility must be evaluated as well. A few of the farms used the artificial insemination technique as an addition to natural mating. However, in this study we did not evaluate the technique itself. If the wrong technique is used or insemination is performed at the wrong timing, the farmer could cause damage to both the embryo and the cow, which causes pregnancy loss. The semen could also be deposited at the wrong site if an un-experienced or un-educated inseminator (López-Gatius, 2012). Another unevaluated, however, very important subject is the evaluation of early pregnancy loss in Tajikistan, which was not done in this study. One should really consider that early embryonic death could be an important factor contributing to the large scale of non-pregnant dairy cows in the current study. According to Wiltbank et al. (2016) early pregnancy loss during first trimester is commonly occurring; stating that 20-50% of the high-producing lactating dairy cows experience pregnancy loss during first week of gestation. Among factors proven to affect early pregnancy loss are heat stress, inflammatory diseases and body condition loss (Wiltbank et al., 2016). One can only speculate regarding embryonic loss in dairy cows in Tajikistan, however by considering the external factors contributing to pregnancy loss and the high percentage non-pregnant cows in this study, it is by the author's recommendation to investigate early embryonic death in dairy cows in Tajikistan in further studies.

During the farm visits a local veterinarian supported the study by contributing with help regarding information or handling the cows. Out of the veterinarians that took interest in the study design, very few had ever seen a body condition scoring chart before and had never heard about the system of classifying the body fat of the cows. The results of the BCS examinations were various; it was a great variation between obese and undernourished cows. One fourth of the cows had BCS above 3 and one third had scoring beneath 3. The variation commonly appeared within individual farms as well and not only at a regional scale perspective. As described previously, both excessive and lack of body fat are documented to have a negative effect on both reproductive and general health of the dairy cows. For example, the risk of fatty liver is significantly increased if the BCS is higher than 3.5 at calving, excessive BCS loss in early lactation and in dry period and high BCS at calving are associated with an increased risk of dystocia, retained placenta, metritis, milk fever, mastitis and lameness according to several publications (Garnsworthy, 2007). It is also considered that the larger proportions of BCS the cow is losing, the longer it takes for her to conceive according to López-Gatius et al. (2003). This means it is not beneficial to keep the cows in high BCS at calving and should therefore be held with restricted feeding in dry period. The recommended BCS at drying off/calving and service varies from 2.5-3.5 and 2.0-3.5

respectively, according to a summary of Garnsworthy. (2007). Considering this, it is by the author’s opinion that information regarding BCS should be implemented in Tajikistan thus it could contribute to better general health of the dairy cows in the country.

Notable reflections

Close to all of the examined cows did not have any signs of mastitis or inflammation in the udder. However, the accuracy of the testing would have been highly improved by the access to California Mastitis Test (CMT); unfortunately this test was not available in the veterinary clinics in Dushanbe nor-fairly recognized by the local veterinarians. With help from the CMT, the evaluation of the udder could have been more accurate, valid and subclinical mastitis could have been detected. Unfortunately the milk could only be evaluated in 98 out of the 114 cows in the study. This is explained by cows that did not produce milk and in some occasions were too dangerous so that no milk could be sampled.

Out of all of the 114 examined cows in the study, 41 milk samples were taken for progesterone testing by P4 Rapid field test. The test was based on the interpreter’s eyes by having to read out two lines in whether the test-line was darker, equal or lighter than the baseline. This made the test difficult at some occasions and could raise a disagreement within the field group to determine whether the test presented a high or low progesterone value. The test result was then decided by the majority of the group as well as combined with the findings of the trans-rectal examination of the cow. However, the test was very easy and convenient to use. An alternative would have been to perform an ELISA which is a more accurate way of testing the progesterone and provides actual values instead of only ‘high’ or ‘low’ results. The ELISA would have been more suitable for this study, but requires preservation of the milk, laboratory equipment and requires more time to perform. Ingenhoff et al. (2016) proved that the P4 Rapid cow-side test had similar diagnostic sensitivity and specificity to other progesterone ELISAs reported in literature. The study presented that the P4 Rapid test had a sensitivity of 0.901 and a specificity of 0.987. Since the accuracy of the P4 Rapid cow-side milk test is similar to ELISA and very easy and quick to use, it is then beneficial for both the farmers and/or veterinarians in Tajikistan to determine oestrus and/or pregnant cows.

Only six cows were classified to have endometritis based on the vaginal examination and trans-rectal palpation. However, it is possible that the true prevalence is higher due to the difficulty of diagnosing clinical endometritis based on rectal palpation and external vaginal examination alone (LeBlanc et al., 2002). Based on the high prevalence of non-pregnant cyclic cows in the examined farms, it is a possibility that the prevalence of subclinical endometritis is high. This may be due to the fact that prolonged luteal phase is strongly associated with uterine bacterial infection affecting the luteolysis of the corpus luteum (Ghanem et al., 2015). However, in this study one cannot truly define that the concerned cows have a prolonged luteal phase since there could not be a second examination which could confirm the prolonged luteal phase. It was not possible to determine or diagnose subclinical endometritis neither in this study due to the definition of subclinical endometritis. Subclinical endometritis is defined as a histologically change in the endometrium and presence of bacteria in the uterus and cannot be palpated by clinical examination. For a correct diagnosis a cytological swab or biopsy should be taken of the uterus wall (Ghanem et al., 2015). It may be recommended to design a similar study which only focuses on the prevalence of subclinical endometritis in Tajikistan for further investigation regarding this topic.

During the current study the only tools for evaluation of the reproductive tract were trans-rectal palpation and external vaginal examination. This is questionable by at least two means; trans-rectal palpation requires an experienced practitioner for a correct diagnosis and the evaluations would have been more accurate by the use of a complementary trans-rectal ultrasound. For example, by the use of a trans-rectal ultrasound the early pregnancies (1-2 month gestation) could have been diagnosed and thereby included in the study as well (Bozymov et al., 2015).

CONCLUSIONS

- The reproductive performance of the dairy cows at large scale farms in Tajikistan was assessed as low in this study. Mainly based on the high percentage of non-pregnant cows, low daily milk yield, high age at first calf and prolonged calving interval.
- The main reproductive disorders that occurred in the current study were anestrus, endometritis and ovarian cysts. However, the prevalence of these reproductive disorders was surprisingly low. The main reproductive issue is considered to be the long-term cycling dairy cows, even though at the individual cow-perspective it is not regarded as a disease, it is regarded as a major financial disorder by the farmer's perspective.
- There were several fundamental factors regarding environment and management that are considered to affect the reproductive performance. Among them was the clear difficulty of handling the records of the reproductive dates accurately and convenient as ought to. As well as the knowledge regarding oestrus detection and thereby managing to select the optimal time point for insemination seemed to lack in this study. The recommendation that all of the dairy farmers in Tajikistan starts to apply a standard routine for determination of pregnancy, two to three months after insemination is also underlined. These observations can certainly improve the calving interval and thereby manage a major economic improvement if interventions are made. These interventions will require investment in skills and optimal routines rather than financial inputs only.

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Picture 7. *Dairy cows at pasture in Tajikistan. Photo by author.*

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ATTACHMENT 1

The farm interview questionnaire.

Basic farm-data

Question	Response	Comment
Main cow caretaker(s)	1. Owner 2. Family members or friends 3. Staff 4. Owner and family members or friends 5. Owner and staff 6. Family members or friends and staff 7. All three of the above 8. Other	
General education of cow caretaker(s)	1. None 2. Primary school 3. Further education	
Experience of cow caretaker(s)	1. 0-2 years 2. 2-10 years 3. >10 years	
Gender of cow caretaker(s)	1. Male 2. Female 3. Both	
Purpose of production	1. Commercial 2. Self-sufficiency 3. Both 4. Other;	*Please write purpose; meat/milk, selling animals in market, keeping them as bank, for transportation..;*
The goal for the dairy herd size	1. Keep existing 2. Expansion 3. Contraction	

Basic animal-data

Question	Response	Comment
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	
Cow identification	1. No specific id/Signalement 2. Name 3. Tag/Id-number 4. Name and Id-number	
Calving interval	1. < 13 months 2. 13-18 months 3. >18 months 4. Unknown	

Age at first calf	1. < 25 months 2. 25-35 months (2-3 years) 3. >36 months (3 years or more) 4. Unknown	
Number of living born calves/year, smallholder	1. <1 2. 1-3 3. 3-6 4. >6; 5. Unknown	
Number of living born calves/year, farm	1. <50 2. 50-100 3. 100-150 4. >150 5. Unknown	
Milk yield/day at the moment Total in L Household	1. <5 2. 5,1-10 3. >10 4. Unknown	
Milk yield/day at the moment Total in L Farm		
Milk yield/day at the moment Average/cow in L Household	1. <2 2. 2,1-5 3. >5 4. Unknown	
Milk yield at the moment Average/cow in L Farm	1. <10 2. 10-20 3. >20 4. Unknown	
Average weaning age of calf	1. 0-3 months 2. >3 months 3. Natural weaning 4. Unknown	

Management

Question	**Response**	**Comment**
System of registration/journal applied	1. Yes 2. No	
If yes, specify which type of journal	1. Animal health 2. Reproduction 3. Production/Economy 4. Combination *including reproductive* 5. Combination *exclusive of reproductive*	
Milking equipment	1. By hand 2. Automatic; 3. By hand and automatic	
Routines of hygiene in environmental management	1. No structured routines 2. Verbal routines 3. Applied written policy	*E.g. handwashing, change of clothes, milking gear disinfection, teat hygiene, disinfection, cleaning of stable*

Routines of biosecurity	1. No structured routines 2. Verbal routines 3. Applied written policy	*E.g. concerning animal purchase and usage of quarantine, transmission barriers, separation from other animals (other species, ages, health conditions and wild animals), order of handling the animals (illness and age)*

Consultation of animal care

Questions	**Response**	**Comment**
Veterinary consultation	1. Yes 2. No	
If veterinary visits, estimated frequency	1. Daily 2. Weekly 3. Monthly 4. Yearly 5. <1/year	
Main purpose of veterinary visits	1. Preventative 2. Curative	
Visits by other persons regarding animal care except veterinarians	• Zootechnicians • Paraveterinarians • AI-technicians • Agronomist • Other educated; • Un-educated; • No	
Disease testing on the healthy animal population	1. Yes 2. No	
If yes, estimate frequency	1. When needed 2. Regularly; 3. Unknown	
If yes, which type of disease		

Reproductive health

Question	**Response**	**Comment**
Breeding method	1. Natural service, organized 2. Natural service, pasture 3. Artificial insemination 4. Both natural and AI	
Routines of heat control	1. Yes 2. No	
Method(s) of detecting heat	• Allowing others to mount • Lordosis • Bellowing • Mounting other animals • Flehmen • Smell other cows vagina • Chin-resting • Frequent urination • Vaginal discharge/vulvar swelling • Restless • Other;	

Amount of signs used for detection	1. ≤3 2. >3	
Person main responsible for detection of heat	1. Owner 2. Family members or friends 3. Staff 4. Other;	
Detection of heat	1. Every day 2. Not every day; when heat is estimated 3. Other;	
Time of day for detection heat	1. Morning 2. Mid-day 3. Evening 4. All day 5. Morning and evening	
Verification of pregnancy is always applied	1. Yes 2. No	
Background of person performing pregnancy diagnosis	1. Veterinarian 2. Other trained person; 3. Untrained;	
Method of pregnancy diagnosis	1. Rectal 2. External signs 3. Other; 4. Ultrasound 5. Rectal and Ultrasound	
When is verification examination performed	1. <3 months 2. 3 months 3. >3 months 4. No specific time	

Environment

Question	**Response**	**Comment**
Stable type (when/if not in pasture)	1. Tied-up 2. Loose-housing 3. Combination	
Type of food given this season	1. Forage 2. Concentrate 3. Pasture 4. Forage and concentrate 5. Pasture and forage 6. Pasture and concentrate 7. All three	
Feeding regime	1. Once a day 2. >Once a day 3. Free access (eg pasture) 4. Free access (eg pasture) and feeding once a day 5. Free access (eg pasture) and feeding >once a day	
Water regime	1. Once a day 2. >Once a day 3. Free access	

Water availability	1. Visible at visit 2. Not visible at visit	
Water hygiene	1. No visible contamination 2. Visible contamination	
System used to minimize the heat stress in warm periods	1. Shade 2. River/Pond/Lake 3. Fan 4. Sprinkles/washing 5. Shade in combination with washing or river/pond/lake 6. Nothing	