Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Veterinary Medicine and Animal Science
Department of Clinical Sciences

Reproductive management and performance in smallholder dairy farms in Tajikistan

Local farmer caring for her calf. Authority of participation given. Photo by author.

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Utvärdering av reproduktiv prestationsförmåga och påverkande skötselfaktorer hos mjölkkor hållna i småskalig produktion i Tadjikistan

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SUMMARY

Tajikistan is classed as a lower-middle-income country with 1/3 of its population living in poverty, facing several challenges restraining its development. One contributing factor of restraining the development is the low level of income – individually and nationally. Agriculture constitutes a substantial percentage of the GDP of Tajikistan, and dairy production is important for the agricultural economic gain of the country. However, 95% of the dairy cows are held under smallholder conditions and dairy production levels are low in Tajikistan, both compared to high-income and neighbouring countries. With reproductive performance being a main pillar of a high-yielding dairy production, studies aiming at evaluating and improving reproductive performance would inarguably be beneficial to increase production in the country. No such studies have, to the author's knowledge, previously been conducted in Tajikistan. Therefore, the aim of this study was to assess the reproductive- performance and management of smallholder dairy cows in Tajikistan.

70 farms and 88 individual cows were included in the study, distributed in 5 different districts around the capital Dushanbe. The study was performed by 1) interviewing the farmers regarding management routines with possible effects on reproduction and 2) performing a clinical evaluation on individual cows to assess the reproductive performance and occurrence of clinical disorders possibly affecting it. This clinical evaluation consisted of a reproductive and general anamnesis, a general observation of 6 parameters including Body Condition Scores (BCS), examination of the udder and milk, vaginal inspection and rectal palpation. If needed cow-side milk-progesterone test was also performed. The criteria to be included in the study was to have a farm with <20 dairy cows and for examined animals to be female cows with a history of ≥1 calf and ≥20 days postpartum.

Results showed that the reproductive performance was affected with the most prominent challenge being a high proportion of cows with prolonged days open, leading to a prolonged calving interval and consequently production and economic losses. Prolonged days open was seen both in cows with a healthy, cyclic reproductive tract and in cows with the reproductive disorder of dominance: anoestrous. The general health of the cows was good with few overt signs of clinical disease. However, a majority of the cows had an abnormally low BCS and the cows with BCS 1 were significantly ($p<0.009$) less likely to be pregnant that cows with BCS 3. There was also a substantial mismatch regarding anamnestic statements and subsequent clinical findings, indicating possible gaps in management. In deed, interview answers revealed several basic management factors possibly contributing to the reduced performance and anoestrous. In conclusion, a reproductive inefficiency seems to be evident in the investigated cows in Tajikistan, leaving room for improvement in the management factors that may contribute to its existence. Improvement could lead to productive, nutritional and socioeconomic gains. However, the means to implement improvement need further investigation - even if the current results contain clues as to where one might start.

SAMMANFATTNING

Tadjikistan är klassificerat som ett låg-medelinkomst land med en befolkning där 1/3 lever i fattigdom och landet står inför flera utmaningar för att kunna utvecklas. En bidragande faktor som hämmar utvecklingen är den låga inkomst-nivån, både på individuell och nationell nivå. Jordbruket utgör en väsentlig andel av Tadjikistans BNP, där boskapshållning och mjölkproduktion i stor utsträckning bidrar till jordbrukets ekonomiska vinning. Trots det upptar småskaliga gårdar 95 % av jordbruket i landet och produktionsnivåerna är låga – både i jämförelse med höginkomstländer och grannländer. En viktig grundförutsättning för en effektiv mjölkproduktion är en fungerande reproduktion och studier med mål att utvärdera och förbättra reproduktionen hos mjölkkorna vore fördelaktiga för att öka produktionen i landet. Inga sådana studier har, i författarens vetskap, utförts tidigare i Tadjikistan. Därför var målet med denna studie att utvärdera den reproduktiva prestationsförmågan och skötselfaktorer som kan påverka denna hos mjölkkor i småskalig produktion i Tadjikistan.

70 gårdar och 88 individuella kor från 5 olika distrikt runt huvudstaden Dushanbe inkluderades i studien. Den genomfördes genom att 1) intervjua lantbrukarna angående skötselfaktorer som kan påverka reproduktionen och 2) kliniskt utvärdera individuella kor angående den reproduktiva prestationsförmågan samt förekomsten av kliniska störningar som kan påverka den. Den kliniska utvärderingen bestod av en generell samt en reproduktionsinriktad anamnes, en allmän observation av 6 olika parametrar inklusive Body Condition Score (BCS), undersökning av juver och mjölk, yttre inspektion av vagina och rektal palpation. Vid behov gjordes även ett progesteronprov från mjölken. För att inkluderas i studien krävdes att gården hade <20 mjölkkor och att undersökta djur, förutom att vara honor, även haft ≥1 kalv och var ≥20 dagar postpartum.

Resultaten visade en påverkad reproduktiv prestationsförmåga, där främsta utmaningen var att en stor andel av korna hade ett förlängt intervall mellan kalvning och nästa dräktighet. Det leder oundvikligen till ett förlängt kalvningsintervall med både ekonomiska och produktionsmässiga förluster som konsekvens. Det förlängda intervallet mellan kalvning och dräktighet sågs både hos korna som var kliniskt friska med en normal cyklicitet och hos korna som hade den dominerande reproduktionsstörningen i studien: anöstrus. Kornas generella hälsa visade få kliniska tecken på sjukdom. Däremot hade en majoritet av korna onormalt låga BCS och kor med BCS 1 hade en signifikant ($p<0,009$) lägre sannolikhet att vara dräktiga än kor med BCS 3. Dessutom visades att anamnestiska uppgifter från lantbrukaren ofta inte stämde överens med påföljande kliniska fynd, vilket skulle kunna peka på brister i skötselrutinerna. I enlighet med detta visade intervjuerna brister i flera grundläggande skötselfaktorer som potentiellt kan bidra till den påverkade reproduktiva prestationsförmågan och prevalensen av anöstrus. Sammanfattningsvis verkar det finnas en ineffektivitet i reproduktionen hos korna i Tadjikistan, där flera påvisade skötselfaktorer kan vara en del av förklaringen och skulle kunna förbättras. En effektivare reproduktion vore positiv då det kan leda till ökade produktionsnivåer, förbättrade socio-ekonomiska faktorer och bättre livsmedelsproduktion. Hur man bäst går tillväga för att nå en sådan förbättring kräver vidare undersökningar, även om dessa resultat kan ge ledtrådar i var man kan påbörja arbetet.

CONTENT

INTRODUCTION AND AIMS

The milk yield of dairy cow production in Tajikistan is several times lower than neighbouring countries Kyrgyzstan, Kazakhstan and Uzbekistan (Lerman, 2008) and one cow does not even yield 1/10 of the average numbers in large-scale production systems in high-income countries. Nonetheless, dairy products play an important role in the economy of both local inhabitants and government. With more than 95% of Tajik dairy cows being held under smallholder conditions (Sattorov, 2016) a higher productivity could positively influence poverty by raising income and improve nutrition with possible subsequent effects on other socio-economic factors.

The productivity of dairy cows largely depends on their reproductive performance (Mukasa-Mugerwa, 1989) and reproductive efficiency is a pre-requisite for a high lifetime production (Balhara *et al*., 2013). In other words, to increase productivity, optimizing reproduction is a vital piece of the puzzle. In accordance, Bahmani et al. (2011) states that to create improvement, sustainability and profitability in milk production of smallholder dairy farms an evaluation of both reproductive performance and the factors affecting it is required. To the author's knowledge no such study has been performed in Tajikistan in spite of its necessity.

The aim of this study was therefore to; 1) assess the state of reproductive health and performance in a selected number of smallholder farms around Dushanbe and 2) identify management factors and issues with possible effects on the reproductive performance of these dairy cows. To perform this study a questionnaire and a clinical evaluation form was used. The questionnaire was designed to highlight the occurrence of factors, relevant to the area, that are known to affect reproduction in dairy cows. The clinical evaluation consisted of a reproductive and general anamnesis, a general observation of 6 parameters including Body Condition Scores (BCS), examination of the udder and milk, vaginal inspection and rectal palpation. If needed cow-side milk-progesterone test was also performed.

Both design and performance of the study were made in close cooperation with the relevant authorities in Tajikistan and the results will hopefully help in deciding if measures need to be taken within this field in Tajikistan as well as guidance in which actions would be of importance in such case.

LITERATURE REVIEW

Tajikistan

Figure 1. *Map of Tajikistan and neighbouring countries. Geology.com (2008).*

Located in Central Asia the Republic of Tajikistan covers a land area of 14,255,000 Ha (FAO, 2012), equalling 1/3 of the size of Sweden (Landguiden, 2016, Nationsencyclopedia, 2017) but containing almost the same amount of population with its 8.5 million inhabitants (World Bank, 2016). Being landlocked with more than half of the country surface above 3000 metres, the climate offers large variations in temperature with averages ranging from -20 °C to 30 °C depending on height, location and season (Countrystudies, 1996).

Tajikistan is the most financially challenged country of the former Soviet Union. Post-independence, declared in 1991, followed a devastating civil war from 1992-1997 leaving a disrupted country in need for foreign aid and new political stability (FAO, 2010). In combination with natural disasters it resulted in a widespread poverty, especially in rural areas (FAO, 2010). The cities also experienced a deep socio-economic crisis as a consequence of the war and Tajikistan faced a 7% de-urbanization and a major emigration, including a majority of well-educated inhabitants as well as the Russian-speaking population (Center of Economic Research, 2013, NE, 2015). The remittances home by emigrants have long constituted a substantial part of Tajikistan's GDP (Landguiden, 2016) but are now on a decline as the economy and social structure of Tajikistan is recovering and developing. As of July 1st, 2015, Tajikistan is no longer regarded a low-income country but instead a lower-middle income country, meaning gross national income (GNI) is above 1,045$ but less than 4,125$ per capita

(World Bank, 2015). Counted in 2000, 79.9 % of the population were ethnically Tadjik, 15.3% Uzbek, 1.1% Russian, 1.1% Kirgiz and the rest smaller minority groups (NE, 2015). Tajikistan has since 2000 managed to markedly reduce monetary poverty (World Bank, 2016). However, 31% of the population is still living below poverty line, stated as <1.90$/day by the World Bank, and important development factors such as education, health care, sanitation and heating remain inaccessible to large quantities of the population (NE, 2015, World Bank, 2016). Main obstacles for business development include lack of infrastructure, unreliable energy supplies and a weak rule of law (World Bank, 2016). Also, restraining Tajik development is a widely spread corruption, partly due to Tajikistan being an important transit-country for narcotics (NE, 2015).

Agriculture and dairy production in Tajikistan

With a majority of the country covered in mountains (Landguiden, 2016) only 5-6% of Tajikistan is actually arable land (FAO, 2010). Even so, half of the population depends on agriculture as a livelihood (FAO 2016). The agricultural sector of Tajikistan has a low productivity but in spite of this agriculture remains a key sector for the economy constituting 26% of the GDP (NE, 2015). With 70% of the population living in rural areas where most farming and animal production is held, an argument can be made that agricultural development can contribute to poverty reduction (FAO 2016). Since 2012 the government has put a reform programme in place to strengthen the country's agricultural sector; "Agrarian Reform Programme of the Republic of Tajikistan" and financial support is given from the European Union with implementation aid from FAO (FAO 2016).

Figure 2. *Dairy cows in a smallholder farm in Hisor District, Tajikistan. Photo by author.*

Despite the little arable land, larger areas can be, and are being, used as pasture. Thus keeping livestock plays a central role of the agrarian production of Tajikistan (NE, 2015). An estimation was made that there were around 1.1 million dairy cows in total in Tajikistan on January 1 st 2016 (Sattorov, 2016). Since independence from the Soviet Union there has been a shift from large state and collective farming towards private animal holding (NE, 2015) and today more than 95% of the animals are held in private households under smallholder conditions (Sattorov, 2016). 854,737 tons of milk was produced in total in 2014, with the Khatlon region being the largest milk production region but the Direct Rule District (DRD) region having the most advanced dairy farms. 95% of raw milk is produced in the private sector. Average milk yield in households is 3 L/day, or 780 L/lactation (Sattorov, 2016). Only around 1 % of the milk is then processed. Mainly milk and local dairy products such as "chakka" are produced under smallholder conditions, with the main goal of self-sufficiency. Surplus milk is, if possible, sold to neighbours or in the centres of districts and towns. It can also be collected for a lower price and brought by middlemen to bigger markets or processors at a price of 1.5-2 somoni[1]/L milk or 8-10 somoni/kg "chakka" (Sattorov, 2016).

There are several identified possible constraints of higher productivity in the cows held under smallholder conditions in Tajikistan. Limited knowledge of a proper and balanced feeding and water regime is one speculated cause. Other possible factors are lack of ventilation (heat stress), unsatisfying animal welfare, insufficient hygiene, use of a local breed with low productive potential and not using necessary veterinary prophylaxis for infectious diseases. Also there are issues from concomitant steps in the value chain such as an insecure collection of the dairy products leading to insecurities in the value of producing more, not knowing if it will surely be collected (Sattorov, 2016).

A study of reproductive performance and factors affecting it in dairy cows has, to the author's knowledge, not been made in Tajikistan. However, there have been studies on prevalence's of specific infectious diseases known to affect reproduction. *Brucella spp*. has been proven seropositive in 4.1% of the cows on a herd level and 2% of the cows on an individual level (Lindahl *et al*., 2014). Another study showed bovine viral diarrhoea virus (BVDV) had a seroprevalence of 77 % and *Neospora caninum* 21% in dairy farms in peri-urban areas of Dushanbe (Lindahl, 2008). Since these studies WHO (World Health Organisation) and the government of Tajikistan have developed a national guideline for a strengthened surveillance of brucellosis in humans and livestock in the county which was approved by the Ministry of Health and Social Protection of Population on August 2015 (WHO, 2015). Systematic surveillance of other infectious reproductive diseases has, however, to the author's knowledge not been initiated or previously conducted in the country.

[1]Local currency in Tajikistan, 1 TJS equals 0,127 USD 2017-01-06 (Valutaomvandlare, 2017)

Dairy production and reproductive performance under smallholder conditions

Keeping animals under smallholder conditions differs in many ways from large-scale and high-producing dairy farms. One animal does not have only one purpose but may be held for several different reasons in addition to giving milk. Also, the owner might not solely have the animals as main occupation. Constraints met under smallholder conditions might therefor differ from constraints met in larger scale productions, as might the means to overcome these constraints.

General challenges to attain a sustainable development for food safety and security under smallholder conditions are discussed in a report on the subject by the Swedish FAO committee (Magnusson, 2016). Exemplified in this report is the poor access of many smallholders to markets, which inhibits the development of a higher production and, as the requirements of governmental- or international markets on the products are too high for these producers it also excludes them from such higher value markets. Consequently this exclusion contributes to a lack of engagement to participate in commercial activities that could be positive for capacity building to increase productivity. Other issues mentioned is the lack of access to land constraining the will to invest in the farms, large yield-gaps in comparison to high-income countries, price volatility and exposure to climatic events and animal- and plant diseases (Magnusson, 2016).

Depending on location and season there might be more or less contribution of environmental heat stress on the animals. Heat stress severely impairs dairy cow performance and reproduction irrespective of production system if temperatures and humidity are high enough, but breeds in warm climates have adapted to this effect in several ways. Breeds that have shown such adaptations are Zebu or Sanga breeds (Berman, 2011), both non-existing in Tajikistan. However temperatures are well above 30°C in parts of Tajikistan during several months making this an assumable factor contributing to production losses, and under smallholder conditions more extensive methods than shade or possibly use of water to evade heat may be uncommon or inaccessible.

In a study similar to the conducted study, a reproductive study under rural smallholder conditions in a country with widespread poverty (India), results showed several key challenges in factors affecting reproductive performance (Ghuman & Singh, 2010). For example those responsible for oestrous detection were not aware of the primary signs of oestrous but rather relied on signs that are regarded supplementary, something that can contribute to poor oestrous detection and animals bred at the wrong time. They also acknowledged the fact that recordkeeping was disorganised and that there was lack of enough heat stress relief. (Ghuman & Singh, 2010) Another study looking at smallholders in a low-income country also identified poor heat detection and lack of record keeping as two of the most important husbandry factors affecting reproductive performance. In addition nutritional deficits and diseases were also added to the list of factors contributing to poor reproductive performance in this study (Chatikobo., *et al* 2009).

Not having systemic fertility records was, in the study by Ghuman and Singh (2010), regarded as a major constraint for smallholder dairy development. Similarly other literature agrees that recordkeeping is uncommon in low-income countries (Flamant, 1998). Flamant (1998)

discusses the subject and states that the value and benefits of the records are questioned in comparison to the effort of keeping them, especially when having only one or two animals. Instead, owners and caretakers commonly rely on memory, which is often proven wrong (Flamant, 1998). In addition there are positive effects on a national level for dairy production development if smallholders keep records (Flamant, 1998).

Regarding oestrous expression not only the factor of limited knowledge may contribute to poor detection. It is known that the level of oestrous expression is largely increased by having more than one cow present (Brun-Lafleur *et al*., 2013), something not always manageable in the smallholder scenario.

Another issue is the impact of the owner's economy. Managing to afford all necessary supplies for optimal production performance or veterinary care is not always possible. Concerning reproduction many cannot afford to cull only for fertility reasons and keep rebreeding animals for long periods of time hoping to eventually get a calf. Obviously this is contradictory since unproductive animals are then consuming from already scarce resources (Mukasa-Mugerwa, 1989).

Figure 3. *Dairy cows in a smallholder farm in Vahdat District, Tajikistan. Photo by author.*

Key reproductive figures under optimal performance

Within the reproductive field there are key figures to be sought after to manage a profitable production. Basic reproductive traits of importance include; age at first calving, calving interval (including days open and gestation length), calving rate, age at first service, number of service per conception as well as non-returning and returning rate of service (Dinka, 2012).

On average the female cow reaches puberty between 7-18 months (Noakes, 2009) but some breeds have been reported to reach puberty as late as 40 months (Mukasa-Mugerwa, 1989). Factors affecting time of puberty include breed, season, nutrition, growing rate, body weight (Peters & Ball, 2004), temperature, age and disease (Mukasa-Mugerwa, 1989) - but the heritability of time of puberty is low (Mukasa-Mugerwa, 1989). The aim of age at first calf under Scandinavian production conditions is 24-25 months (Växa Sverige, 2015). In tropical conditions the average age at first calf of *Bos Taurus* and *Bos Taurus* x *Bos Indicus* crosses is instead 34 months (Mukasa-Mugerwa, 1989). Of course there is an economic gain of lowering the age of first calf, but caution should be taken not to be too drastic in this matter since results are reported that getting heifers in calf too soon can reduce mammary gland development and result in poor fertility in the first lactation (Sheldon *et al*., 2006).

Calving interval is divided into the three subperiods; gestation length, postpartum anoestrous and service period. The latter two are sometimes referred to together as “days open”. Counting with a gestation length of 280 days, days open should not exceed 80-85 days if the commonly sought after calving interval of 365 days is to be achieved (Peters & Ball, 2004). Passing 365 days of calving interval is followed by substantial economic losses (Kafi & Zibaei, 2007, Kossaibati & Esslemont, 1997).

Number of services per conception is dependent on what breeding system is used; being higher under uncontrolled natural breeding and lower when organised mating or artificial insemination is used. Number of services per conception values >2 are regarded poor (Mukasa-Mugerwa, 1989). Calving rate is the percentage of inseminated animals that finally give birth to a calf. A similar rate is pregnancy rate, number of inseminated animals resulting in pregnancy. Under good management calving- and pregnancy rate can, and should, range around 60-70% (Mukasa-Mugerwa, 1989, Peters & Ball 2004), with interference if <50% (Barrett & Parkinsson, 2009), but under smallholder conditions in tropical countries this number can be as low as 20% (Mukasa-Mugerwa, 1989). Other similar rates used to estimate and evaluate fertility is the “return”/“non-return rate”. Non-return rate is the number of cows, calculated at a certain chosen time after insemination such as after 21/60/90/120/145/200 days that did not come back into heat and are therefor expected to be pregnant. At 30-60 days the non-return rate is frequently around 80% in large-scale, efficient production systems, which is usually around 20% better than the true calving rate (Barrett & Parkinsson, 2009).

Reproductive inefficiency is combined with substantial economic losses. The exact amount of loss differs from year to year and in different production systems, but an example for the UK prices of 1995 states that each day one cow exceeds a 360 day calving interval costs 3£. In a similar manner, each extra service above an average of 1.8 services/conception is equivalent with an extra 20£/service, and each extra culling for reproductive reasons above a herd level

culling of 5.3% means loosing 770£. If oestrous is missed, for example by not observing it, it will add 12.6 £/case and every case of vulvar discharge costs 161.6 £ counting both direct and indirect economic losses (Kossaibati & Esslemont, 1997).

The healthy dairy cow reproductive cycle

As mentioned above the female cow normally reaches sexual maturity between 7-18 months (Noakes, 2009) even if some breeds reportedly reached puberty as late as 40 months (Mukasa-Mugerwa, 1989). After puberty, cows are polyestrous animals with a repeated oestrous cycle throughout the whole year unless 1) the cow becomes pregnant, 2) is within 3-6 weeks post calving, 3) is in high milk yield or 4) attains any of a number of pathological conditions (Noakes, 2009). One cycle is defined as the days between two cases of oestrous, normally being 21 days in the adult cow (Noakes, 2009). One cycle has four phases: proestrous (days 18-20), oestrous (day 0), metoestrous (days 1-4) and dioestrous (days 5-18) (Peters & Ball, 2004). However, the division between the individual behavioural phases are indistinct with this categorisation in cows and the cycle is often described with a luteal phase and a follicular phase instead – follicular phase corresponding with proestrous and oestrous and luteal phase corresponding with metoestrous and dioestrous. Actual oestrous with the typical behaviour varies from 6-30 hours, being on average 7 hours (Peters & Ball, 2004).

The oestrous cycle is regulated by a fine interplay of different hormones and organs. The exact mechanisms of this regulation are well described in reproductive literature since decades and beyond the scope of this background. Examples for further reading on this subject include relevant chapters in “Veterinary Reproduction and Obstetrics” by D E Noakes et al., or “Reproduction in Cattle” by Peters and Ball. In short, depending on which phase of the oestrous cycle the cow is in, the hormonal levels, behavioural expression and appearance of the reproductive tract will vary in a certain manner – something useful in the dairy reproduction management and in the evaluation of reproductive health.

Factors influencing dairy cow reproduction

There are numerous factors reported to affect reproduction performance by influencing one, or several, aspects of the oestrous cycle, fertilization or implantation process, gestation or parturition. It is a complex interplay between biology and environment and in reality all factors contribute to the state of the reproductive performance. For the sake of structure the factors described below are categorised into mainly being animal-related or environmental-/management related, with the goal of this section being to offer an overview of the factors affecting reproduction that are relevant to this study. Nonetheless, for comprehensive information on each respective factor further reading is advised.

Animal-related constraints of reproductive performance – Systemic affection

The body functions as a whole unit and is a fine and complex cooperation between several, different organ systems. The reproductive tract is no exception and is dependent on the health of the rest of the body, and several conditions affecting other organ systems have been shown

to have a negative impact on reproductive performance. Below in table 1 are examples of such conditions and examples of their reported effect on reproduction.

Table 1. *Examples of systemic and non-infectious conditions and their effect on reproduction*

Condition	*Reported reproductive effect*
BCS-variations	
Low BCS and high milk yield post-partum	>10 days longer to conceive (López-Gatius *et al*., 2003)
Low BCS at calving	10% decrease in pregnancy rate (López-Gatius *et al*., 2003)
Large loss of BCS early post-partum	30 days longer to express first post-partum oestrous (Butler, 2003)
High BCS before calving	Decreased appetite postpartum generating a negative energy balance with multiple effects, for example delayed ovulation. (Butler, 2003)
Lameness	14 days longer calving to conception interval (Collick *et al*., 1989)
Stress	Reduction of GnRH-release compromising the magnitude of LH-surge (Dobson *et al*., 2007)

In addition to the examples stated in the table above, infectious diseases can affect reproduction. For example, mastitis has been associated with a delayed resumption of ovarian activity postpartum, premature luteolysis and a prolonged follicular phase in cyclic cows (Huszenicza *et al*., 2005). There are also several general infectious diseases that have direct or indirect effects on cattle reproductive performance. The ways these infectious diseases affect reproduction are diverse but the main mechanisms are 1) interfering with sperm survival- or transport reducing fertilisation rates 2) direct effects upon the embryo, foetus or placenta (i.e. embryonic deaths or abortions) or 3) indirect effects upon embryo survival (i.e. effects on uterine function) (Parkinson, 2009). Primary bacterial agents reported to cause infertility or subfertility are: *Campylobacter fetus* (mainly *subsp. venerealis*), *Brucella* spp (mainly *B.abortus*), *Mycobacterium bovis*, *Leptospira* spp, *Salmonella* spp. (mainly *S. Dublin*), *Listeria monocytogenes*, *Histophilus somni*, *Bacillus licheniformis* and *Chlamydophila abortus*- and *pecorum*. In addition several other bacterial pathogens are implicated in reproductive disease but may be opportunistic (i.e. *Mycoplasma* and *Ureaplasma*) or contaminants of reproductive organs after a systemic infection (i.e. *Arcanobacterium pyogenes*, *Aeromonas* spp, *Fusobacterium neccrophorum*, *Escherichia coli*, *Streptococcus* spp). Protozoal agents exemplified in literature as affecting reproduction include; *Tritrichomonas fetus*, *Neospora caninum* and *Sarcocystis* spp. Bovine viral diarrhoea virus and bovine herpesvirus 1 are important viral agents of infectious reproductive diseases. There are also fungal agents causing for example abortions, and the most common fungal agent causing such problems is *Aspergillus* spp (Parkinson, 2009).

Animal-related constraints of reproductive performance – Direct effects on the reproductive system

As one might consider logical, it is shown that disorders within the reproductive tract has consequences for the reproductive performance. Peri-parturient problems such as dystocia, retained foetal membranes, ketosis, hypocalcemia and metritis all predispose cows to subsequent sub-fertility (Giuliodori *et al*., 2013, Sheldon *et al*., 2006). Since this study aims at evaluating cows that are >20 days post-partum conditions that are peri-parturient and early post-partum are not discussed further. Described below are clinical disorders in the reproductive organs affecting reproductive performance. Noteworthy is that references and studies describing these conditions in the following paragraphs are all based on research in high-income countries with large-scale, high-yielding dairy production. Differences in comparison to low-income and smallholder production systems such as in Tajikistan may therefor be evident, or even expected, and interpretations should be cautious.

Endometritis

A concern stretching throughout the post-partum period is endometritis - one of the major risk factors for delayed ovulation and prolonged luteal phases in high-yielding dairy cows (Opsomer *et al*., 2000). Endometritis is a superficial inflammation of the endometrium, associated with the persistence of pathogenic bacteria in the uterus >3 weeks postpartum. Endometritis causes infertility at the time of infection and subfertility after the disease is no longer evident. Conception rate is about 20% lower for cows with endometritis, 3% more animals are culled for failure to conceive and the median calving to conception interval is 30 days longer (Sheldon *et al*., 2006). Clinical endometritis is characterised by the presence of purulent or mucopurulent discharge in the vagina (Barlund *et al*., 2008), and occurrence of this in combination with rectal palpation is still the most used method for diagnosis (Barlund *et al*., 2006). In a study conducted by LeBlanc *et al*, (2002), findings for evaluation of endometritis included; prevalence and character of vaginal discharge, cervical diameter, location of uterus, symmetry of the horns, size of horns, thickness of uterine wall and dominant palpable ovarian structure. Incidence numbers varies in different literatures, probably as an effect of different definitions and diagnostic methods.

Pyometra

If pus is accumulated in the uterus, for example as a sequel to a chronic endometritis or foetal death with subsequent infection, the uterus can develop a pyometra. This is usually associated with a persistent corpus luteum since the endometrium is inflamed and unable to release PGF-2α and thereby not able to cause luteolysis. The cervix is commonly distended. The condition is sometimes persisting undetected for a long time since the cow may be thought to be pregnant - prolonging days open. The uterine horns become distended; the degree of distension depending on the accumulation of pus. The illness is not usually accompanied with systemic disease (Peters and Ball, 2004).

Cervicitis

A high degree of cervicitis, with or without concurrent endometritis, has also been shown to influence reproduction negatively in the sense of lower conception rates (Hartmann *et al*., 2016).

Ovarian cysts and follicle structures larger than ovulatory follicles

Occurring in 6-19% of lactating dairy cows in the U.S. (Silvia *et al*., 2002, Wiltbank *et al.*, 2002), follicles can develop beyond normal ovulatory size (15-18mm) without ovulating – becoming cystic. Other than size, some definitions, especially in older literature, include a low progesterone (Wiltbank *et al*., 2002) and persistence of the structure for at least 10 days. Newer studies with repeated ultrasonography show other dynamics (Gilbert, 2016) and a proposed, updated definition includes a persistence of more than 6 days combined with a disturbance in normal ovarian function (Silvia *et al*., 2002). Sometimes cyst-like structures become partially luteinized (Gilbert, 2016, Peter *et a*l., 2009). These have a thicker wall, but at palpation luteal cysts are not easily distinguishable from follicular (Wiltbank *et al*., 2002). Luteinisation is correlated with production of progesterone and functionally follicular and lutein cysts are separated due to levels of progesterone (Silvia *et a*l., 2002, Wiltbank *et al*., 2002). There can be several cystic structures occurring at the same time (Gilbert, 2016). The pathogenesis of cystic ovaries is not completely understood but it seems to be a result of a lack of ovulatory LH-surge (Gilbert, 2016, Wiltbank *et al*., 2002). Cysts have been shown to cost 137 dollars in reduced production and veterinary expenses in the U.S. and add 22-64 days open (Silvia *et al*., 2002).

Anoestrous; types, causes and contributing factors

A crucial event for an efficient dairy cow production is a functional cyclicity and a prompt return of this post-partum. The number of days open, as mentioned earlier in this thesis, is ideally <85 days to achieve an economically optimal calving interval. Becoming pregnant within this period requires an utmost cooperation between; a normal uterine involution; the endocrine function of the hypothalamus, pituitary and ovaries for an efficient resumption of cyclicity; ability of expression and detection of oestrous and finally a successful conception (Peter *et al*., 2009). Approximately 20% of dairy cows fail this cooperation and have neither ovulated nor displayed oestrous before the start of the aimed breeding period (Walsh *et a*l., 2007) and 29.6% of Swedish dairy cows showed atypical progesterone profiles in an evaluation of post-partum return to cyclicity (Petersson *et al.*, 2006) – in other words, prolonged post-partum anoestrous and non-return to cyclicity has a significant occurrence in dairy productions of high-income countries. There are four different categories of anoestrous, all described in the table 2 below.

Table 2. *Types of anoestrous in cattle and pathophysiological traits of the different types. (Peter et al., 2009, Wiltbank et al., 2002)*

Type of anoestrous	*Pathophysiological traits*
I	Growth of follicles to emergence without deviation and establishment of a dominant follicle
II	Growth and deviation but the follicles undergo atresia or regression
III	Growth, deviation and establishment of a dominant follicle but failure to ovulate
IV	Prolonged luteal phase due to lack of luteal regression

Type I is quite uncommon in high-yielding production systems and is associated with bilateral small ovaries at rectal palpation (Wiltbank *et a*l., 2002), caused by severe undernutrition (Jolly *et al*., 1995, Wiltbank *et al*., 2002). Type II is similar to type I at palpation but is much more common. It occurs normally in prepubertal heifers and early post-partum but can also be associated with prolonged anoestrous periods due to moderate or pronounced nutritional deficits, occurrence of suckling or diseases (Wiltbank *et a*l., 2002). Type III is generally associated with structures larger than ovulatory follicles that may develop into ovarian cysts (Peter *et al*., 2009), a condition already discussed. Type IV is caused by a lack of luteolysis due to insignificant or non-existing PGF-2_{α} release from the endometrium. This is for example seen when there is a uterine infection (Wiltbank *et al*., 2002), which has also been discussed in previous paragraphs.

Mentioned above are several reasons of prolonged anoestrous-periods: undernutrition of different degrees, suckling, ovarian cysts and lack of luteolysis. In addition an increased feed intake can also lead to anovulation (Walsh *et al*., 2007). In a study finding 29.6% atypical progesterone profiles in the post-partum period of Swedish cows other factors are included as possible reasons for delayed ovarian activity; first parity in comparison to later parity cows, tied-up housing in comparison to loose-housing, season of calving (winter being at higher risk), longer dry-period, lameness, large bodyweight loss in early lactation, previous reproductive abnormalities in earlier lactations, and genetic factors (Petersson *et al*., 2006). In the study by Petersson *et al* (2006), atypical profiles of ovarian resumption include; delayed resumption of cyclicity, cessation of cyclicity or prolonged luteal phase post-partum. Finally, heat stress has also been shown to directly affect the follicular development and indirectly affect anestrous by influencing energy balance (Rensis & Scaramuzzi, 2003).

Failure of conception and loss of pregnancy

The birth of a calf is dependent on the body's ability to conceive and maintain the pregnancy. Factors reported to affect conception rates resemble factors discussed in combination with other reproductive disorders and include; parity, milk production, heat stress, diet and energy balance (Chebel *et al*., 2004). If conception takes place the next issue is to maintain the pregnancy. Incidence of pregnancy loss ranges from 0.4%-10.6 % in a U.S. study (Forar *et al*., 1995) but from 8.7%-16.1% in a Polish study (Gehrke & Zbylut, 2011). In any case, pregnancy loss is

stated as one of the major sources of decreased fertility (Lee & Kim, 2007). Adult cows are more affected than heifers and the first trimester is more affected than the latter two. Regarding causes, the main role is played by infectious reasons, followed by the equally important environmental, maternal and genetic factors (Gehrke & Zbylut, 2011). Other reported causative factors of pregnancy loss include heat stress, cow parity, the bull used, milk production, progesterone serum levels after conception, twin pregnancy, season and clinical disease (i.e. mastitis) (Lee & Kim, 2007, McDougall *et al*., 2005).

Environment- and management factors affecting reproduction

Nutrition

Nutrition is vital to life. For reproductive performance nutritional status is of utmost importance. Energy requirements increase rapidly as milk production is initiated after calving, often resulting in a negative energy balance (NEB) in the cow. The energy output of milk-production and bodily functions is then larger than the energy consumed in the food, something also true in conditions when feeding resources are scarce and not sufficient for the needs of a cow. Inadequate energy intake triggers mobilisation of energy from body tissues (Sheldon *et al*., 2006) and can in turn affect reproduction since cows in NEB may choose to prioritize nutrients away from the reproductive tract and into biologically more relevant areas at the moment (Leroy *et al*., 2008). Nutritional deficits have been shown to affect different stages of follicular growth and maturation and delaying ovulation (Butler, 2003, Leroy *et al*., 2008) as well as being a causative factor for anoestrous (Jolly *et al*., 1995). A negative energy balance also reduces serum progesterone levels, reduces fertility (Butler, 2003) and influences the likelihood of conception (Sheldon *et al.*, 2006).

The use of body condition scoring, BCS, is a helpful and simple way to evaluate the nutritional status of cows. Both a BCS that is too high and one that is too low at calving have a negative impact on reproductive performance measures (Sheldon *et al*., 2006). For example, cows with a BCS that is high at calving have been reported to have a lowered appetite post-partum generating a substantial weight loss and NEB in the post-partum period, leading reduced conception rates at subsequent insemination (Butler, 2003). A cow that instead has a low BCS has little adipose tissue to use as an energy source, often resulting in a NEB, especially post-partum (Sheldon *et al*., 2006). Cows with BCS 3 are most likely to become pregnant (Loeffler *et al*., 1999). It is important to make sure to always have cows in an appropriate BCS, with extra attention paid around calving. Also, a good mineral balance to prevent peri- and post-parturiant conditions is essential in the nutritional care for optimal reproductive performance (Sheldon *et al*., 2006).

Heat stress

Lactating dairy cows have a thermo-neutral zone ranging from around 5-20°C. Beyond 20°C regulating body functions, such as skin evaporation or increased respiratory rates, start. When the cow can no longer regulate the temperature enough to cool herself by bodily functions she will enter heat stress (Kadzere *et al*., 2002). In addition to ambient temperature, humidity is a co-factor contributing to heat stress (Chaiyabutr *et al*., 2008). Entering heat stress has detrimental effects on the productive performance (e.g. milk production, feed intake, metabolic

rate) (Kadzere *et al*., 2002) but is also implicated in poor reproductive performance and generates low breeding efficiency (Kadzere *et al.*, 2002), and severely reduces fertility in cows (Dobson *et al*., 2007). The pregnancy rate can decrease to as low as 10% if the environmental temperature is 33°C (Hansen & Arechiga, 1999). Oestrous expression is reduced, both by a reduced oestradiol-secretion (Rensis & Scaramuzzi, 2003) and by the physical lethargy appearing with higher temperatures (Kadzere *et al*., 2002). Higher incidences of anoestrous and silent ovulations are seen together with heat stress (Rensis & Scaramuzzi, 2003), follicular development and oocyte quality is affected (Dobson *et al*., 2007, Rensis & Scaramuzzi, 2003) and in addition sperm quality and early embryonic development is also affected (Kadzere *et al*., 2002). There are also consequences on fertility after the temperature has normalized again (Dobson *et al*., 2007, Rensis and Scaramuzzi, 2003). Except scientific studies the effects of heat stress become clearly evident when cows with high genetic potential are imported to tropical environments fail to reach their theoretical productive potential (Kadzere *et al*., 2002).

To prevent heat stress in warm climates, consideration of management cooling might be advisory. Examples of such that have been proven beneficial preventing or reducing heat stress include offering shade (West, 2003), cooling air-flow or sprinkling water (Igono *et al*., 1992, Seath & Miller, 1948, Turner *et al*., 1992) or using an evaporative cooling system (Chaiyabutr *et al*., 2008).

Water supply

In high temperatures, causing body regulatory mechanisms such as evaporation and higher respiratory rates, water losses increase. Needed water intake is consequently higher to maintain these mechanisms and avoid dehydration (Sjaastad *et al*., 2010). In addition, as the main substance of milk, adequate water supply is essential for milk production (Sjaastad *et al*., 2010) and restricting water intake in lactating cows has resulted in a significantly decreased milk yield and dry matter intake. (Little *et al*., 1976) As a reference, a high-producing dairy cow in their thermo-neutral zone needs to drink 23 L water/day in the dry period and 84 L of water/day in lactation (calculated on a milk-yield of 35L milk/day) to balance the water losses (Sjaastad *et al*., 2010).

Detection of oestrous

Oestrous detection at a correct time is essential for an optimal calving-conception interval, which in turn is the main influence of the total calving interval (Peters & Ball, 2004). Not managing to observe oestrous is according to Mottram (2016) the most important factor preventing higher conception rates. For the use of artificial insemination to be of success a correct and efficient oestrous detection is vital (Kafi & Zibaei, 2007). One could argue the same would apply in all methods where man is responsible for deciding the time of service. To improve accuracy of finding the cows in heat multiple technology devices have been developed and evaluated. In the 1990's tri-axial accelometers in collars became easily available and economically reasonable and have since become widely used in developed large-scale dairy cow management (Mottram, 2016), but visual observation is still the most popular and recommended method if conducted often enough (Kafi & Zibaei, 2007). For visual observation to give result, knowledge of the commonly displayed and secure signs of oestrous is important,

but lack of this knowledge can be evident in some countries and communities. For example in Indian smallholder farms incorrect detection of oestrous was identified as a key challenge (Ghuman & Singh, 2010). Below, in table 3 are the signs of oestrous commonly stated in reproductive literature.

Table 3. *Methods of oestrous detection in cows in reviewed literature (Noakes, 2009., Nordéus et al 2012., Peter & Ball, 2004., Roelofs et al., 2005)*

Signs of oestrous
Primary signs
Standing to be mounted
Lordosis
Supplementary signs
Behavioural
Mounting other animals
Indirect signs of mounting activity; dirt on rump/flanks, ruffled or absent hair on tail-head, saliva on flanks
Aggressiveness
Bellowing
Restlessness
Flehmen lip curl; either by cow in oestrous or by the one interested in her
Licking/sniffing the perineum
Reduction in time spent eating and ruminating
Physiological
Vaginal discharge; Clear, elastic mucus secreted from the vagina, “oestrous discharge”. This might be the main sign in tied-up cows not managing to show other behavioural signs. However the timing of discharge can be misleading by 2 days from actual oestrous even if the clear secretion is usually quite reliable. In pro-oestrous a thicker and greyish discharge can be seen and in metoestrous a sangious, bright red vulvar secretion is sometimes evident.
Swollen vulvar lips and reddish vaginal mucous membrane
Slight rise of body temperature
Reduced milk yield

Detection of pregnancy and finding empty animals

To minimize days open and keeping an efficient calving interval managing an early diagnosis of pregnancy is crucial. Identifying non-pregnant animals early is important since treatment or re-breeding might be needed (Balhara *et al*., 2013). There are several methods to achieve a pregnancy diagnosis; for example transrectal palpation, ultrasonography, and serum measurement of Pregnancy Specific Protein B – with transrectal palpation being the most widely used. The sensitivity of these three methods of pregnancy diagnosis is described below

in table 4. To early identify empty animals in milk, progesterone tests can be used, at expected heat-dates after service, to find the non-pregnant animals with a low progesterone level (Sheldon *et al*., 2006). In large parts of the world different external signs are also used as a method for detecting pregnancy. Examples of such signs include; lack of heat-signs, increase of abdominal width, movement when palpating the abdomen externally, udder- or milk-yield changes or different behavioural patterns. However, these signs are neither solely reliable nor efficient in achieving an early diagnosis (Noakes & Taverne, 2009). For further information on these as well as other possible methods of pregnancy diagnosis see precise literature regarding this matter. Fact is that an early and correct diagnosis of pregnancy is a basic criterion for a high reproductive performance (Balhara *et al*., 2013, Romano *et al*., 2006).

Table 4. *Sensitivity (%) of a few different methods for detecting pregnancy in cows. Data from Sheldon et al (2006)*

Method of pregnancy diagnosis	Days after service					
	21-24	25-28	29-31	32-35	37-50	>50
Bovine pregnancy specific protein B in plasma		75	92	98	98	98
Ultrasonography		83	90	96	98	98
Transrectal palpation					95	98

Stable environment

There is a direct effect on fertility and reproductive performance depending on how the cows are held and the stable environment. For instance, the interval between calving to first cyclicity and luteal activity is reported 7.5 days longer for cows in tie-stalls in comparison to loose-housing systems. (Petersson *et al*., 2006) In addition it is important to make sure that the environment allows a satisfactory expression of oestrous - something compromised by, for example, slippery floors (Vailes & Britt, 1990). Also, the indirect influence of the built environment on reproduction should be considered, for example settings that could cause lameness (Collick *et al*., 1989).

Hygiene and biosecurity

Prevention is a cornerstone in health programmes (European Commission, 2007). Increasing numbers of animals in limited space puts pressure on hygiene and biosecurity to maintain healthy animals. Setting up and applying a policy regarding hygiene and biosecurity is advised for prevention of disease being introduced and/or spread within the herd (Sheldon *et al*., 2006).

Regular visits by a veterinarian for inspection of the farm and animal examinations including reproductive examinations is also advised as a foundation for a health-programme on a herd level (Sheldon *et al*., 2006).

Record-keeping

One of the major factors contributing to successful dairy cow management is record-keeping. It is a pre-requisite for the development of an efficient and economically rewarding animal production and has been used for a long time in high-income countries where large-scale production is dominant (Flamant, 1998). In these countries recording organisations have proven that record-keeping indeed enables farmers to increase productivity, improve the genetic development and enhance the quality of their products (Flamant 1998). Routinely used record-keeping contains valuable information that is crucial for productive- and reproductive evaluation. Thereby records are an important tool for deciding improving measurements – both for the individual farmer and, if aggregated, on a national level (Chagunda *et a*l., 2006). The ability to keep a record and collect data effectively depends on animal identification. For this, animal identification needs to be both clear and accurate. Reproductive basic data recommended for collection are calving date, dates of insemination, confirmation of pregnancy and information concerning culled animals. In case of action taken on an individual animal, examination findings, diagnosis and treatment should be recorded. These data should not only be collected but also evaluated frequently so needed measurements can be excised in time (Sheldon *et al*., 2006).

What does this background mean in relation to the current field-study?

Dairy cow production under smallholder conditions in low-income countries differs in many ways from the efficient, high-yielding production of high-income countries. Economic, educational, social and environmental conditions are not the same and this is reflected in the animal care and production. The situation in Tajikistan resembles other low-income countries, and within the reproductive field of smallholder farmers in similar countries previous studies have shown several factors to have a negative impact on reproductive performance; limited knowledge (e.g. in oestrous detection), heat stress, nutritional deficits, lack of record-keeping, general- and reproductive diseases and in-efficient culling. All of the above and their connection to reproductive performance have been reviewed above, and in addition other factors, relevant to this study, known to have a direct or in-direct affect on reproduction have been described; stable-type, hygiene- and biosecurity, oestrous- and pregnancy detection, water-supply and cooling aids. The combination of the local conditions in Tajikistan, circumstances of smallholders in other countries, the natural cycle of the cow, key reference figures of highly efficient production systems and the reviewed factors known to affect productive and reproductive performance is the foundation of this study. By using this knowledge in the design of the questions and examinations in the current study, the assessment of reproductive performance and factors possibly affecting it in dairy cows of Tajikistan is hopefully secured.

MATERIAL AND METHODS

Study area

The subjects of study were small-scale dairy farms in the area around the capital of Dushanbe. Within the Direct Rule District (DRD) region 5 districts were visited in different directions from the capital; Shahrinav, Hisor, Rudaki, Varsob and Vahdat. The chosen area has a high density of small-scale dairy farming kept in a way representative for a larger area of the country. (Sattorov, N., Ministry of Agriculture Tajikistan, personal communication. 2016-09-13)

Figure 5. *Map of districts surrounding the capital of Dushanbe (red marking). Life.ansor.info (2017).*

Sample selection

The aim was to collect material from as many small-scale dairy farms and cows as possible during an 8-week sample-collection period. The number of smallholder farms included was therefor not set beforehand. At the end of sampling 70 farms had been included and 88 individual cows examined in the study. The inclusion criterion for a farm was to contain ≤20 dairy cows. The inclusion criteria for individual animals were to be female, post-pubertal cows with a history of ≥1 calf and ≥20 days postpartum. The 5 districts visited were selected to be representative of Tajik agriculture and time-efficient for collecting data.

In each district a number of villages were chosen and within these villages as many farms and individual cows as possible were included. Random selection was applied on all levels within a district when including villages, farms and individual animals. To achieve random selection the names, for example of the different villages in a district, were written on small pieces of paper and then samples to be included in the study were drawn from the collection of paper pieces. When this method was not applicable another suitable method was used depending on the circumstances, for example, “every other animal from the left” if cows were in a tied-up stall. The exact numbers of villages/farms/animals included within each district differ depending on logistic limitations such as time, darkness, road availability, local guidance and the presence of cows and approval of study by the farmers. In addition, communal grazing was

often used in Tajikistan, where all livestock of a village was brought to and from the pasture at the same time. At pasture the animals were not guarded by their owner but by a shepherd. In such case, possible animal-holders to evaluate were limited since both owner and its matched animal(s) were needed for the study. Below is a table showing the distribution of farms in the visited districts (table 5.)

Table 5. *Distribution of the number and percentage of farms visited in each district within the DRD-region*

Design and implementation of method

District	Number	Percent
Hisor	17	24.3
Rudaki	14	20.0
Shahrinav	17	24.3
Vahdat	9	12.9
Varsob	13	18.6
N	70	

The study consisted of one questionnaire with questions regarding farm data and factors that could potentially influence reproductive performance (see attachment 1) and one clinical evaluation form with anamnesis and clinical data regarding the individual animal included (see attachment 2).

In each farm, previous to starting any questions or examinations, the owner or main caretaker was entitled anonymity and that participation was voluntary, then informed about the aim of the study and the examinations about to be conducted. An interpreter translated all information, questions and answers during the interviews and examinations. Every question was asked in an open manner not revealing any of the possible alternatives in the questionnaire and only after the answer was translated the interviewer chose the alternative suitable. When questions regarding veterinary care were asked the accompanying local veterinarian (accompanying to support the logistics of the study) was not allowed to be present.

The interview was sub-sectioned into six main categories: farm-data, animal-data, farm management, consultation of animal care, reproductive health management and environmental factors. Farm data included number of cows, information regarding the main caretaker of the animals (i.e. gender, education level, experience) and main purpose and goal of the production. The animal data covered breed, method of animal identification, average calving interval, age at first calf, total number of calves/year, weaning age and milk yield. Entering the section of management, questions aimed at farm management such as record keeping, milking equipment (i.e. by hand or automatic) and routines of hygiene and biosecurity. Consultation of animal care included questions regarding the use, purpose and frequency of veterinary care and disease testing. The category of reproductive health aimed to distinguish information of routines important for reproductive performance such as breeding method, routines and knowledge of heat control and detection of pregnancy. Last, regarding environmental factors, were a

collection of questions concerning stable type, feeding regime, water supply and method(s) to minimize heat stress. These were all based on the routine used at the time of the study (September-October). If farmers used pasture the answer of stable type refers to the stable-type used when the cows were not in pasture.

Figure 6. *Performing interviews in the field assessing the reproductive management. Pictures taken in two of the included 70 farms: left picture in Varsob district and right picture in Shahrinav district, Tajikistan. Visible next to the interviewer in both pictures is the interpreter used throughout the study. Authorisation of participation given by persons included. Photos by author.*

The clinical evaluation consisted of one anamnestic part with individual cow-data and one examination part with general observation parameters, udder examination including milk sample, external vaginal examination and rectal palpation of the reproductive organs. When needed in the reproductive evaluation a milk-progesterone test was performed.

Anamnesis included time since calving, time since insemination/breeding, lactation number, age, milk yield, breed and known illness. It was conducted the same way as the interview with open questions asked and then the questioner, not the caretaker, filled in the suitable category in the form. If supposed days open proved >90 days from the stated information it was also asked why the period between calving and breeding was prolonged and if any measures were taken (i.e. veterinary examination or treatment) because of this.

General observation started with body condition scoring by comparing the animal to an objective 5-point BCS-chart. BCS was followed by scoring of the general state of health, cleanliness, signs of lameness, injuries and rumen distension (table 6).

Table 6. *Included in the clinical evaluation of 88 smallholder dairy cows in Tajikistan was a section with a general observation assessing 5 different parameters. Each parameter was described by a number of classifications to enable a suitable category for any given cow observed. The method of classification for each parameter is described below*

Parameter	*Method of classification*
General health	1) No remark 2) Reduced: Evident signs of illness (i.e. reduced alertness) or several indicators of affected health at the same time (i.e. Low BCS, diarrhoea and dull fur combined)
Cleanliness	1) Clean or having slight faecal splashes on the udder, hind or flanks 2) >3 areas of >10 cm in diameter with dry faecal contamination 3) Faecal contamination covering > 1/3 of hind body and udder
Injuries	1) None or a total area of wound or signs of inflammation covering less than the size of a palm 2) Total area of wound or inflammation is a maximum size of two palms 3) Total area of wound or inflammation exceeds two palms or a single wound or inflammation is larger than one palm
Signs of lameness	1) No 2) Yes After observation of weight loading on all four limbs of the animal.
Rumen distension	1) Filled and with a slight bend outwards from the original body curve 2) Filled 3) Not filled and a clear triangle space is seen

Udder examination included observation and palpation of the udder and all four teats for signs of inflammation or lesions. Signs of inflammation included the teat being red, sore, swollen or warm at examination. A milk sample was always collected if possible for ocular and olfactory examination in search for signs of modification. Answers were categorised as either “yes” or “no”.

The gynaecological examination began with evaluating the external genitalia. Special attention was made to the vulvar lips (regarding swelling, colour and appearance), vaginal mucus membrane and occurrence of any kind of vaginal discharge to detect cyclic changes or disease characteristics. Vaginal discharge was categorised, as “None”, “Oestrous”, “Metoestrous” or “Mucopurulent” and the mucous membrane was “Pink”, “Pale”, “Red” or showing “Signs of vaginitis or vestibulitis”. To be classified as “oestrous-discharge” it needed to be clear and with high viscosity, for “metoestrous” it needed to be sangious and a muco-purulent discharge was, as the name inclines, purulent with changes of colour, odour and/or texture.

After external inspection *transrectal palpation* of the uterus and ovaries was performed for evaluation of the genital tract. The goal of this examination was to determine the status of the uterus and ovaries. The uterus and ovaries were given 4 categories respectively. Uterine categories were “Dioestrous”, “Oestrous”, “Pregnant” or “Endometritis/pyometra” and ovarian categories were “Cyclic”, “Anoestrous”, “Ovarian cyst” or “Pregnant”.

Figure 7. *Rectal palpation performed in pasture in 1 of the 88 included cows in the study. Rectal palpation was a part of the clinical evaluation assessing reproductive health in smallholder dairy cows in Tajikistan. Photo taken in the Rudaki District, 1 of 5 included districts. Photo by author.*

Palpation and subsequent classifications were based on instructions of palpatory traits found in the scientific literature and in the next few paragraphs the palpatory traits used in this study are summarized.

The uterus was considered in dioestrous if, at palpation, it was placed within the pelvis or just over the pelvic edge combined with having a low-moderate tonus and absence of signs of pregnancy or pathology. If instead classified as being in oestrous the uterus was contracted, with a high palpatory tonus, and had consistent other clinical findings indicative of oestrous. The uterus was expected to be fully involuted at palpation when examined cows were >35 days post calving. In cows examined >20 but <35 days post-calving the possibly unfinished involution-process was taken into consideration at evaluation. The cervix did not have its own category but was included in the uterine evaluation, regarded as normal being 6-13 cm long and 2-4 cm broad. The classification of endometritis/pyometra was made upon the presence of several of the following findings; broadened cervical diameter, abnormal location of uterus, asymmetry of the horns, enlarged size of the horns and/or a thickened uterine wall. Other signs, such as a consistent anamnesis or vaginal discharge, as well as if a CL was evident at ovarian palpation, were also considered in addition to the uterine findings for this classification.

For determining pregnancy rectal palpation was used in this study. The method was chosen based on being reliable and convenient. Presented in table 7 are the signs used to achieve a diagnosis of pregnancy and timeframe of gestation in this study.

Table 7. *Palpatory traits used in this study at rectal palpation for diagnosing pregnancy in cows at different gestation lengths*

Time of pregnancy (months)	*Palpatory traits used for diagnosis*
0-1,5	Corpus Luteum (CL) on one of the ovaries (prerequisite for pregnancy but not a positive diagnosis)
1,5-3	Asymmetrical uterine horns, thin wall, fluctuation and a CL. The CL is commonly ipsilateral to the pregnant bigger horn.
3-4	Signs of the uterus mentioned above are clearer, uterine size enlarges and is now usually on the pelvic edge or hanging over it and rückstoss can be felt.
4-5	Uterus not entirely palpable, placentomas, small foetal parts within the foetal liquid and unilateral fremitus.
5-6	Large uterus sometimes in the bottom of the abdomen and therefor sometimes not palpable. Broad cervix tensed over the pelvic edge. Fremitus. Pathological conditions as pyo-/mucometra can have a similar appearance as this pregnancy-stage and are sometimes hard to distinguish.
>7	Clear foetal parts are once again palpable, now larger and sometimes combined with movement. Bilateral fremitus and large placentomas are other signs.

Classification of the ovaries depended on occurrence and type of dominant structures palpated. To be classified as “cyclic”, palpation of a CL or a high progesterone level in the milk were pre-requisites. Also, no concurrent findings were present indicating pregnancy or pathology. If there was an old CL or no CL at all at palpation but signs of oestrous were evident in the reproductive tract the ovaries were also classified as “cyclic”. A concurrent follicle of ovulatory size was considered supportive, but not a certain, sign of oestrous. If an ovarian structure had a palpatory feel of a follicle and was >25 mm in diameter it was classified as an ovarian cyst if anamnesis was in accordance and described a disrupted cyclicity. In this study only one examination of each animal was performed, excluding the possibility of using persistence of the structure as a criterion. If no dominant structures were palpated in either ovary and the uterus had a palpatory feel of dioestrous the animal was suspected as being in “anoestrous”. However, before this classification was determined a progesterone test was always applied. The classification of anoestrous in this study thereby refers to anoestrous type I and II in the classification system used by Peter et al (2009) previously in this thesis. If the uterus showed signs of pregnancy the ovaries were classified as “pregnant”. In the event of it being too early to determine pregnancy at palpation, in other words if the cow was mated <2 months ago, the ovaries were classified as cyclic as long as a CL was present and signs of pathology were not.

In any uncertainties regarding palpatory findings in the ovaries a milk-progesterone test was conducted. The test used in the study is called P4 Rapid Progesterone Heat Detection, produced by Ridgeway Science in the UK, and is an in-milk progesterone detection test easily used in the field. It does not quantify the progesterone level but distinguishes if progesterone levels are

high or low. After fore milking, a small volume of milk was collected and placed in the test tube. The milk was then mixed within the tube and the test strip was placed in the milk sample and after 5 minutes two lines appeared on the test strip; control line and test line. Appearance of the control line was a pre-requisite for the test to be used in the study since it showed that the test had functioned properly. If both lines appeared they were compared to each other in accordance to the instructions from the producer; a lighter test line in comparison to the control line meant progesterone levels were high, an equal or darker test line indicated that progesterone levels were low. In this study the test was used as a diagnostic help, always in combination with anamnesis and clinical findings from the other examinations including the rectal palpation, never as a sole diagnostic method.

In addition to anamnesis and clinical examination the environmental temperature where the cows were held was measured at each farm.

Ethical approval

All treatment of animals in this study was conducted in accordance to the ethical standards of the Ministry of Agriculture in Tajikistan and the Tajik Agrarian University. All handling of animals was approved of the chief of State of Veterinary Service and the Veterinary chief in each district before carried out. Previous to starting the questioning and examinations the owner or main caretaker was guaranteed anonymity and informed that participation was voluntary, as well as informed about the aim of the study and the examinations that were to be conducted.

Statistical analysis and handling of results

Raw data was entered in Microsoft Excel and statistical analyses were performed in Minitab Express Version 1.5.0. (Coventry, UK) and SAS version 9.4 (Cary, NC, USA). Charts and tables were constructed in Microsoft Excel.

In addition to descriptive statistics, associations were analysed between cyclicity and BCS, cyclicity and breed, pregnancy and BCS and pregnancy and breed. For associations all variables were screened in univariable logistic regression.

From the descriptive raw data two separate “days open” were calculated for each examined cow; 1) “days open according to anamnesis”, based on the anamnestic statements of calving date and insemination/mating date and 2) “days open according to examination” which was calculated from the stated calving date and the subsequent examination findings. These two were then compared to evaluate accordance.

To further evaluate reproductive performance all cows categorised as cyclic in the clinical examination data were subdivided into two groups depending on the stated calving date: cyclic with <90 days post-partum or cyclic with >90 days postpartum.

RESULTS

Descriptive data - Interview

Basic farm data

The mean number of cattle was 5.7 animals (range 1-23) and of cows 2.4 cows/farm (range 1-19). 40 % of the farmers were happy with their herd-size and wanted to exist in the same size but 58.6 % wanted to expand the production. 1.4% instead aimed at a contraction. All farmers used the production primarily for self-sufficiency, 15.7% answered that they also regularly sold the products at the market. 37.1% used their animals and their products as an economic reassurance selling only when in need of money. 38.6% always sold the bull calves.

A majority of the households owned only the local mixed breed, some had improved local breeds (pure breed mated with a local mixed breed) and a few had pure breeds or combinations of the above (figure 8). Holstein and Swiss brown were the stated pure breeds.

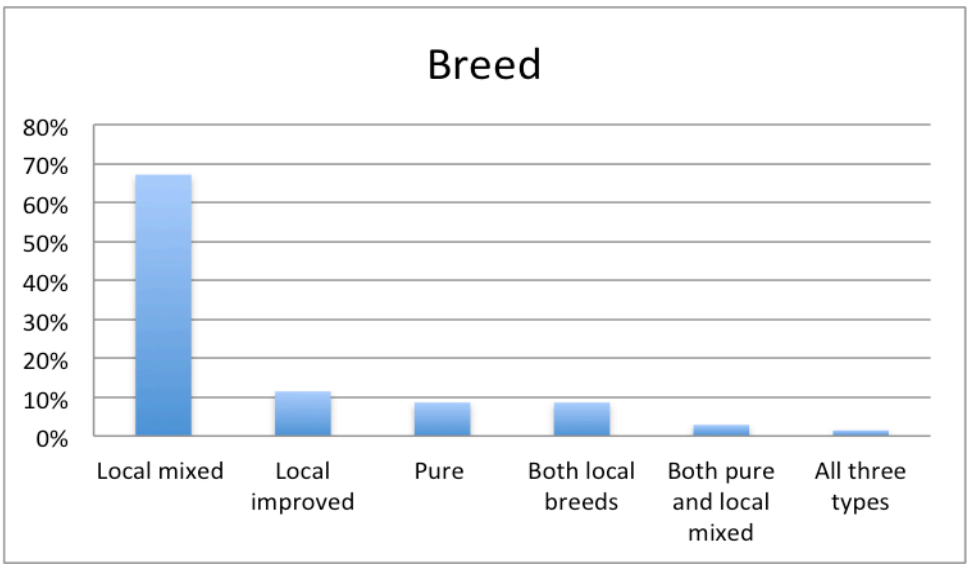

Figure 8. *Percentage of breeds kept in the included 70 farms. The farms were distributed between five districts surrounding Dushanbe, Tajikistan. A local improved breed is when the local mixed breed is mixed with a pure breed. Holstein and Swiss brown where the pure breeds stated by the farmers.*

When asked on a herd-level about the average milk-yield/cow a majority answered that the amount was less than 5 L of milk/day and almost ¼ answered less than 2 L/day (figure 9). In addition 24.3% got <5 L of milk/day in total with all owned cows, 27.1% managed to milk between 5-10 L in a day and 30 % got >10 L.

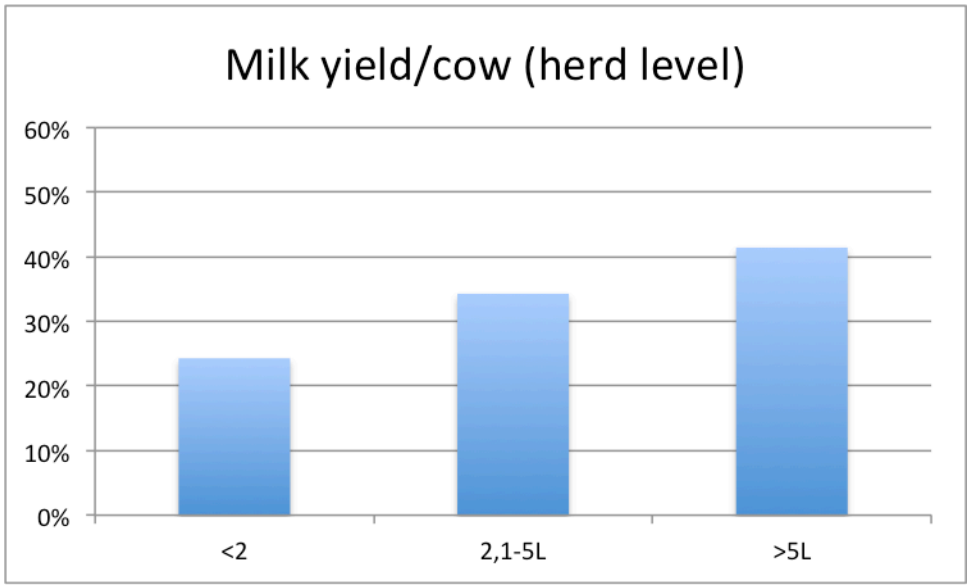

Figure 9. *Percentage of cows giving a certain milk yield per day, based on farmers statements of a herd level average of milk yield per cow in 70 different farms in 5 different districts in Tajikistan.*

Below follows a table showing the distribution of answers about the main caretaker(s) of the animals (table 8). Commonly the owner, or the owner in combination with family members or friends, took care of the animals. In a majority of the farms both men and women were involved in animal care and in about 1/3 of the farms women had the main responsibility. The years of experience in animal care was usually >10 years.

Table 8. *Summarized percentages of the interview-answers regarding the main animal caretaker(s) in the 70 smallholder dairy farms in Tajikistan.*

Information regarding main animal caretaker(s)	**Percent**
Role	
Owner	35.7%
Family member or friends	18.6%
Staff	2.9%
Owner and family members or friends	40.0%
Family member or friends and staff	1.4%
All three of the above	1.4%
Experience	
0-2 years	2.9%
2-10 years	20.0%
>10 years	77.1%
Gender(s)	
Male	15.7%
Female	32.9%
Shared	51.4%

Regarding identification of the cows more than half did not have any identification nor did they use signalement, just over a third of the care-takers had names on their animals, whereas a few used number tags or combinations of the above (figure 10).

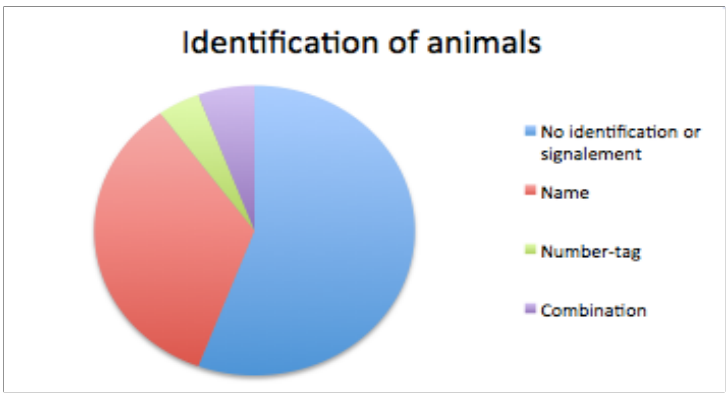

Figure 10. *The methods of identification and their frequency used as stated by the farmers in the 70 smallholder farms in Tajikistan.*

61.4% of the farmers stated that the calving interval was <13 months, 15.7% answered 13-18 months, 4.3% said >18 months and 18.6% said they did not know. Below is a diagram showing the distribution of how old the cows were when having their first calf according to the interviewee, with a large proportion being 3 years or more (figure 11).

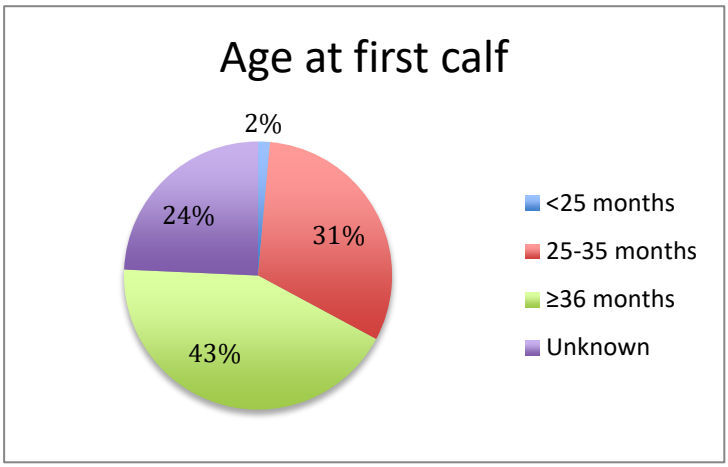

Figure 11. *Average age for cows to have their first calf. Stated on a herd-level by the farmers in the 70 smallholder farms in Tajikistan.*

60% of the farmers produced 1-3 calves each year and 15.7% produced less than one calf/year. 10% had 3-6 calves, 5.7% >6 calves and 8.6% did not know the number of calves/year.

In the bar chart below the statements of weaning routines are visualised, showing that a majority weaned their calves >3 months post-partum or used natural weaning (figure 12).

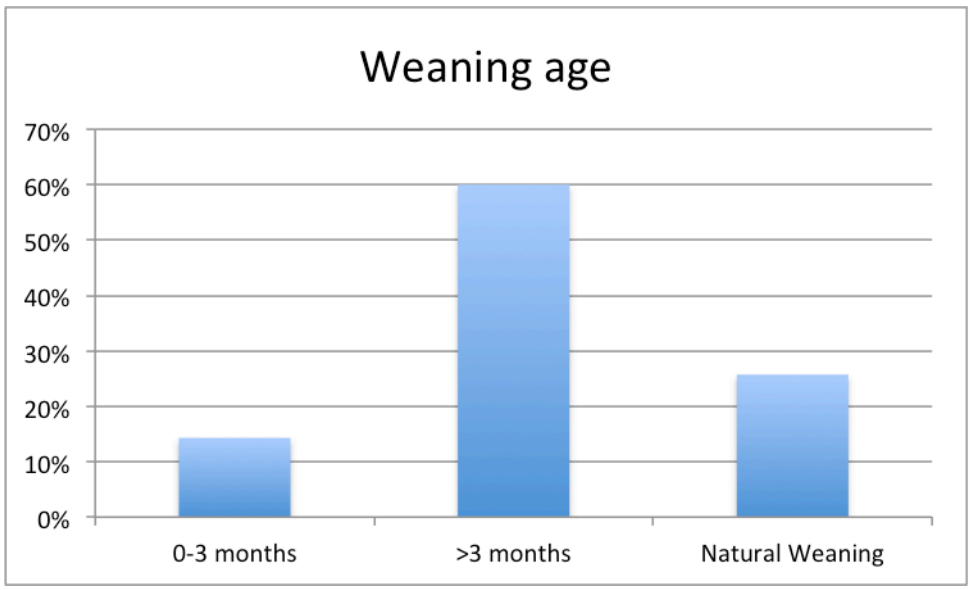

Figure 12. *Distribution of the farmer statements of average weaning age, answered on a herd-level, in the 70 smallholder farms in Tajikistan.*

General management

As shown below a clear majority of the farmers did not keep written records on the animals (figure 13).

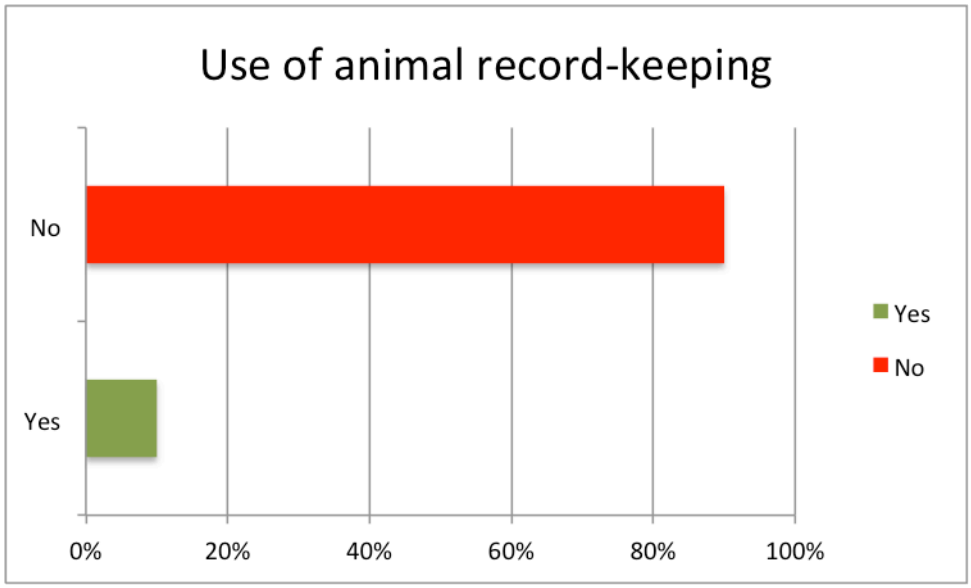

Figure 13. *Statements of farmers in the 70 farms, answering whether or not they kept written records of their animals.*

Out of the 8 farmers that did keep records, no farmer recorded solely animal health, 1 kept data on just reproductive measures such as calving/insemination date, 3 wrote down data regarding production/economy, 3 kept data on a combination of the above including reproduction and 1 kept data on a combination of the above but not any reproductive measures.

All farmers milked by hand.

When asked about routines of hygiene and biosecurity a majority answered that they did not have any specific routines or that they had a verbal agreement of the routines among the people taking care of the animals. One farm applied a written policy. Regarding hygiene routines it was slightly more common to not have any routines than to have verbal agreements whereas with biosecurity there was a higher prevalence of having verbal agreements in comparison to no structured routines (figure 14).

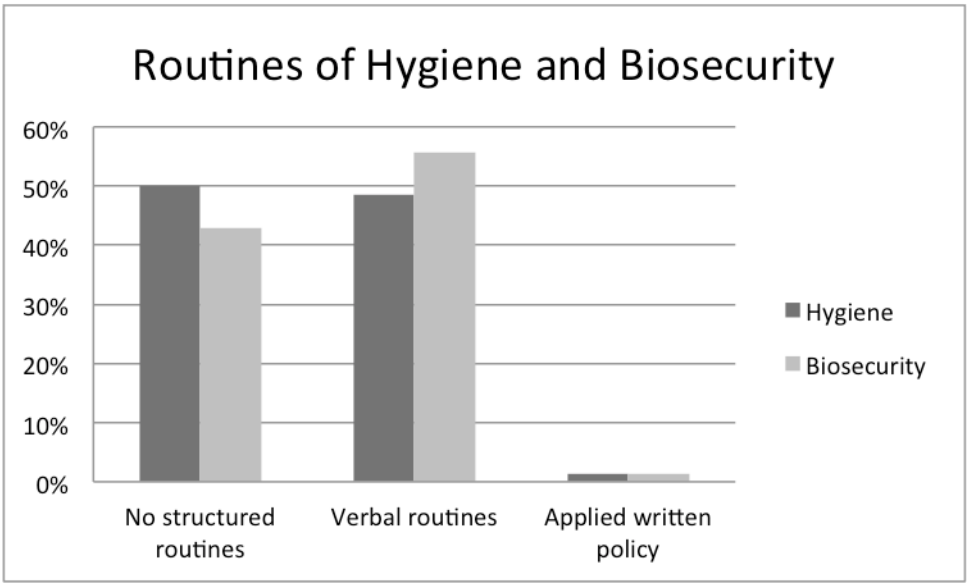

Figure 14. *To see if hygiene and biosecurity were taken into consideration by the farmers in their animal care, questions were asked if they had any routines in these areas, and if so, if they were verbal agreements or written policies. Above the farmers statements of their routines on hygiene and biosecurity are compared. Statements collected from 70 smallholder dairy farms in Tajikistan.*

Almost all of the farmers did use veterinary consultation for their animals and in 79.7% of the veterinary visits the main purpose was preventative care such as vaccinations or check-ups of the health status of the animals. The frequency of visits, however, varied among farms (figure 15) with a majority visiting yearly.

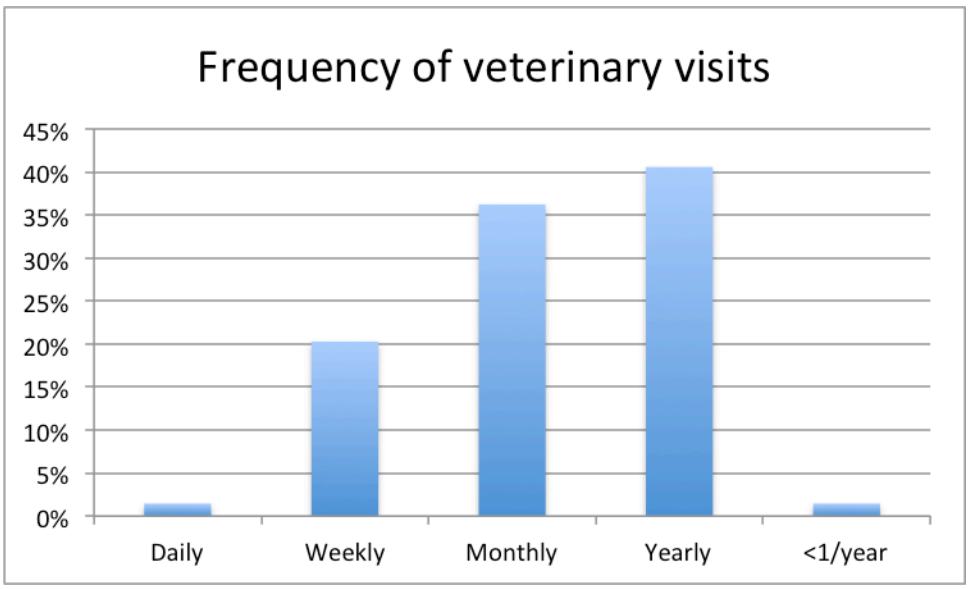

Figure 15. *Average frequency of veterinary visits at the 70 farms, as stated by the farmers. Each category includes the number of visits until approaching the next category. Yearly visits mean up to 11 visits/year, if 12, they are instead categorized as monthly, and so on.*

Regarding use of consultation on animal care except by veterinarians 1 farm used a zootechnicians help and none used paraveterinarians, AI-technicians or animal scientists, 1 used advice from another, educated person (medical doctor) and 3 used the help from other, laymen such as neighbours or relatives.

67.1% of the farmers screened healthy animals for infectious diseases with blood sample taken by a veterinarian, but which disease they tested for and the frequency of testing varied. 85.1 % stated they did such testing regularly, with intervals varying from farm to farm but ranging from every other week to once a year. 6.4% tested when needed (i.e. if there was en epidemic going) and 8.5% did not know the frequency. Reported diseases that were screened include: piroplasmosis, brucellosis, foot and mouth disease, bovine viral diarrhoea, anthrax, leptospirosis, black leg and tuberculosis.

Reproductive management

Below is a visualised distribution of the different breeding methods used in the study-area of Tajikistan (figure 16), with a majority using organised natural service.

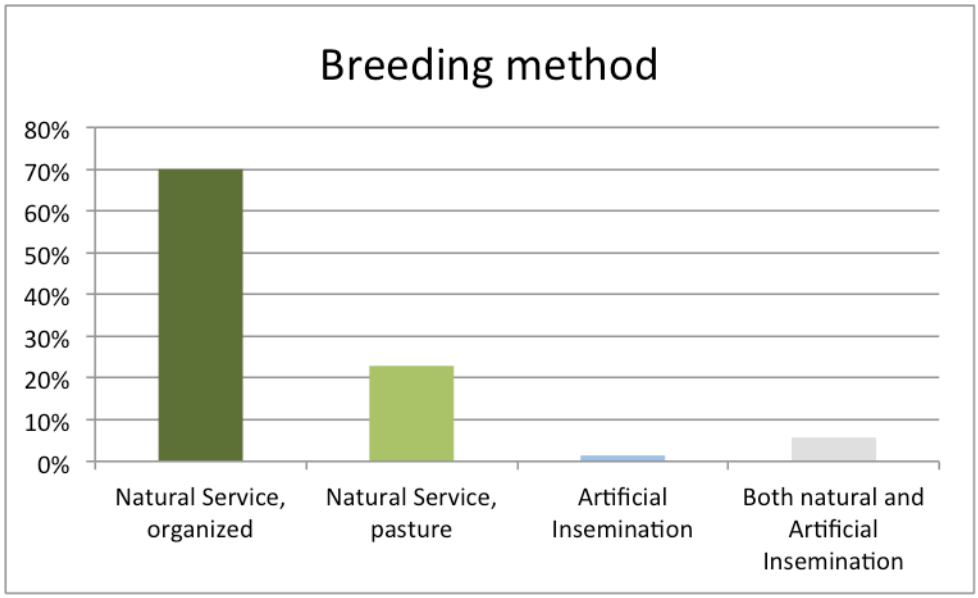

Figure 16. *Breeding methods and their frequency, used at the 70 farms, as stated by the farmers. Organized natural service means the animal caretaker is in charge of when service takes place, whereas natural service in pasture means a bull is always together with the cows in the pasture and service is not controlled by the caretaker.*

In total 87% had routines of oestrous detection. Stated signs used for detection are summarized in order of frequency used in the table below (table 9).

Table 9. *Frequency of each sign used for oestrous detection rated by prevalence as stated by the farmers in the 70 smallholder farms in Tajikistan. Each farmer listed all the different heat signs used, with several answers possible. Therefor the sum of percentages will not add up to 100%*

Sign of oestrous	*Frequency used*
Bellowing	75.9%
Mounting other animals/people	51.7%
Vaginal discharge/vulvar appearance	32.8%
Restlessness	27.6%
Loss of appetite	13.8%
Standing when mounted	10.3%
Lower Milk Yield	6.9%
Flehmen	1.7%
Smelling the perineum	1.7%
Chin-resting	1.7%
Frequent Urination	1.7%
Lordosis	0

93.1% relied on three or less oestrous signs for detection. In 68.3% of the cases the owner was the one responsible for detection, in 26.7% it was a family member or friend and in 5% it was staff. This distinction showed that the person responsible for oestrous detection was not necessarily the same person as the main caretaker, for example a woman could be the owner and main caretaker but her husband was in charge of oestrous detection, or a daughter was the main caretaker but her father the owner and person responsible for detecting oestrous. In 69 % of the farms the caretaker looked every day for signs of oestrous, in 22.4% the caretaker looked for signs of oestrous only when oestrous was expected and in 8.6% had other answers such as “not so often” or “once a week”. 82.8 % had no specific time of day for detecting oestrous, 5.2 % looked only in the morning, 1.7% midday, 6.9% in the evening and 3.4% in morning and evening.

Below is a table showing descriptive data on questions regarding detection of pregnancy (table 10). A majority of the farms did not use any verification of pregnancy and if verification was used it was equally common to use an untrained layman as using a veterinarian to perform the verification. Untrained laymen mainly relied on external signs or alternative methods, not rectal palpation or ultrasonography, for detecting pregnancy.

Table 10. *The interview contained a section with questions aiming at reproductive management. Verification of pregnancy was regarded a vital part for optimized reproductive performance and several questions were asked regarding the routines of this subject. Below is a table summarizing the answers as stated by the farmers at the 70 smallholder farms in Tajikistan. The first question is a prevalence of all 70 farms, whereas the rest are follow-up questions with prevalence's of the 17 farms that used verification of pregnancy*

	Percent
Verification of pregnancy is always performed	
No	75.7%
Yes	24.3%
If yes, when?	
<3 months	23.5%
3 months	35.3%
>3 months	35.3%
No specific time	5.9%
Who performs the verification?	
Veterinarian	47.0%
Other trained person	5.9%
Untrained (i.e. owner)	47.1%
Method	
Rectal palpation	41.2%
External Signs	29.4%
Other (i.e. human pregnancy test)	23.5%
Ultrasonography	5.9%

Environment

A majority of the cows were held in a tied-up stable when/if not in pasture (figure 17).

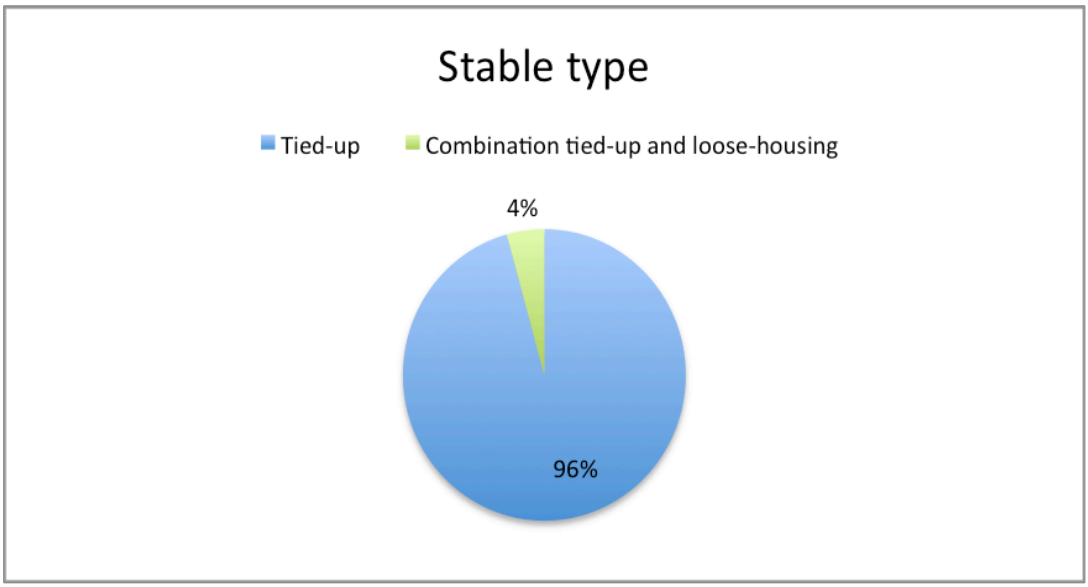

Figure 17. *Summary of stable types used as stated by the farmers in the 70 farms. If the farmers partially used pasture for the cows the answer was based on the stable type used when the cows were not in pasture.*

At the time of study the season for using pasture was still ongoing. 87.1% of the animals were fed more than once a day according to the farmers, either by pasture combined with additional feeding in the morning and/or evening or by being fed several times per day in the stable (if farmers did not use pasture). 12.9% had free access during the day in the pasture but were not fed anything else. None of the animals were only fed once a day without usage of pasture.

The kind of feed and the percentage of use of the different kinds are displayed in the figure below (figure 18). The dominant feed used was forage combined with concentrate.

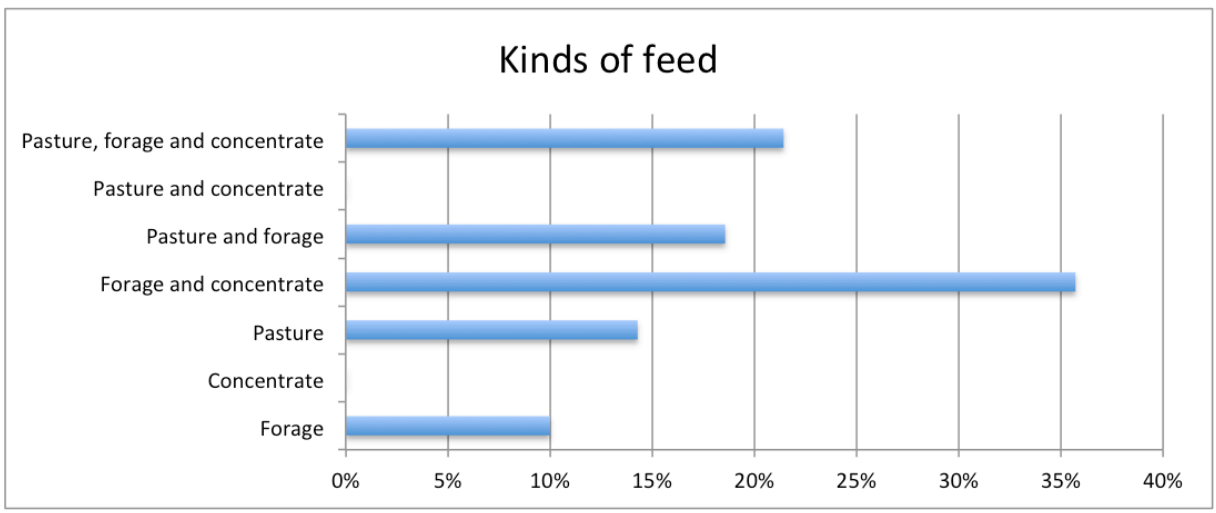

Figure 18. *The farmers were asked of their feeding regime for their animals; frequency and type of feed used. In this figure the different types of feed and their prevalence in the 70 farms, as stated by the farmers, are displayed.*

Regarding water 17.5 % gave the animals water once a day, 78.9% gave them water more than once a day and 3.5% had free access of water. If not in free access, water was given by bucket. In 65.7% of the visits water was not seen accessible for the animals.

High temperature evasion was mainly achieved by offering shade and sometimes it was combined with washing the animal. The distribution between methods is shown below (figure 19).

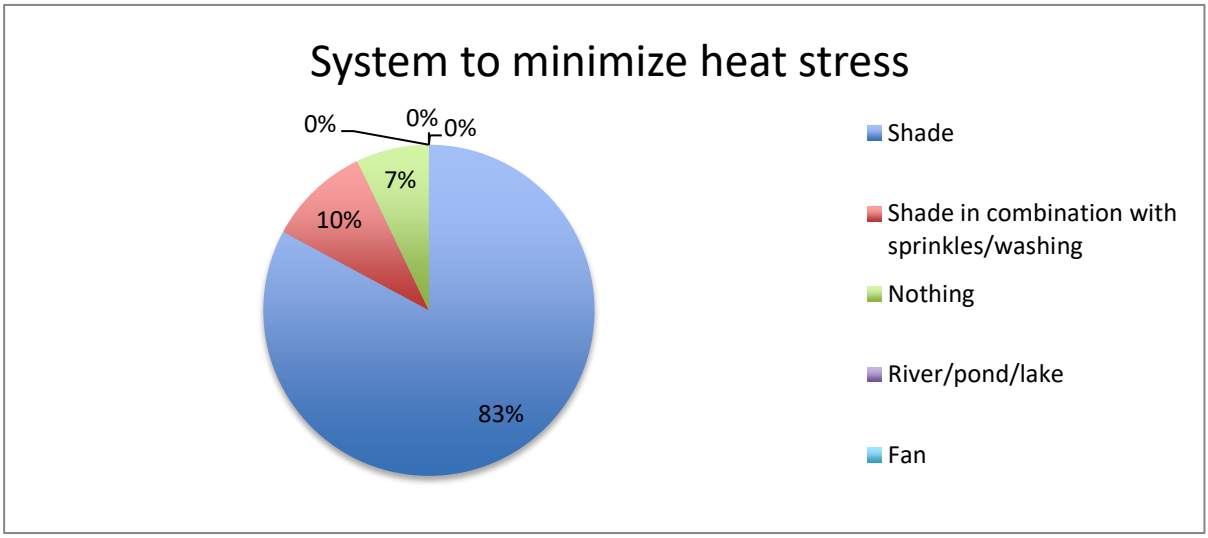

Figure 19. *Methods used for heat evasion as stated by the farmers in 70 smallholder farms investigated in Tajikistan.*

Environmental temperatures where the cows were held measured above 20°C in 87.5% of the farms and the rest of the temperatures, 12.5%, ranged between 10°C -20°C.

Descriptive data – Clinical evaluation

Anamnesis

The results of the anamnesis is primarily used for analyses combined with other data for each cow, for example to achieve days open or compare anamnestic statements with examination findings (see results further down) and not as prevalence. The use of information on time since calving and insemination, beyond prevalence, are thus displayed in other charts further down. The table below summarizes the answers of the anamnestic questions on each individual cow (table 11). Milk yield and breed have previously been described on a herd-level average. However, the answers of breed and milk yield on an individual level correspond with the answers of the herd level, with the mixed local breed and production of less than 5L of milk/day dominating. The oldest cow according to the caretakers' statement participating in this study was 16 years old and the youngest was 2.5 years. The majority of the cows were between 3 and 10 years, and almost 1/3 were of unknown age. Most cows were in their early lactations but around 1/5 of the cows were >5 lactations. No cow had a history of >10 lactations. Showing last in the table the vast majority did not have any known illnesses.

Table 11. *Summarized distribution of the anamnestic statements in the clinical evaluation of the 88 included cows. The cows were distributed on 70 smallholder farms in five districts in Tajikistan*

Anamnesis question	*Percent*
Days after calving	
20-90 days	17.0%
3-6 months	31.8%
6-12 months	42.1%
>12 months	5.7%
Unknown	3.4%
Time since insemination/mounting	
<2 months	15.9%
≥2 months	47.7%
Not inseminated/mounted	19.3%
Unknown	17.1%
Lactation number	
1-2	42.1%
3-≤5	31.8%
>5-10	17.1%
>10	0%
Unknown	9.1%
Age (years)	
2-≤3	2.3%
>3-≤5	26.1%
>5-10	35.2%
>10	6.8%
Unknown	29.6%
Milk yield/day (L)	
<5	50%
5-15	47.7%
>5	2.3%
Breed	
Pure	10.2%
Local improved	18.2%
Local mixed	71.6%
Known illness	
No	92.1%
Yes	7.9%

For 40 cows the farmers stated anamnestic days open that were >90 days. Table 12 shows the distribution of the responses to why this period was prolonged. None of the farmers had taken any measures because of the prolonged days open.

Table 12. *Farmers who stated days open that exceeded 90 days in the anamnesis of a cow were asked for the reason of prolonged days open. In 40 cows the farmers stated >90 days open in the anamnesis and below is a table showing the distribution of reasons given, sorted by frequency of occurrence.*

Reason stated by the farmers as cause for prolonged anamnestic days open	*%*
No signs of oestrous	37.5
Mated but did not become pregnant	15
Unknown reason	15
Old age	7.5
Thin cow/scarce feeding resources	7.5
Showed signs of oestrous but owner did not mate the cow	7.5
Taken for mating but cow did not allow mating	5
Abortion	2.5
Suckling	2.5

General Clinical Observation

Below in table 12 the data seen when generally observing the individual cows is summarized. Main findings include half of the animals being <3 in BCS. Otherwise there were generally few pathological or abnormal findings. No injuries or signs of lameness were seen in the cows included in the study.

Table 12. *Within the clinical evaluation there was a section with a general observation of six parameters on each cow. Below the prevalence of each finding is shown within the four parameters with occurring abnormalities. The two parameters lameness and injuries are excluded since they did not occur at examination in the included cows. 88 individual cows were included in the study, distributed in 70 smallholder farms in Tajikistan. For further explanation of the different categories see material and methods, table 6*

Parameter examined	*Percent*
Body Condition Score	
1	29.6%
2	37.5%
3	29.6%
4	3.4%
5	0%
General state of health	
Without remark	95.5%
Reduced	4.5%
Cleanliness	
1	67.8%
2	24.1%
3	8.1%
Rumen distension	
Filled and with a slight bend outwards from the original body curve	8.1%
Filled	72.4%
Not filled and a clear triangle space is seen	19.5%

Udder examination

Below is a table summarizing the data of findings in the examinations of the udders and the milk (table 13). There were few pathological or abnormal findings even if milk modification and teat lesions did occur, as well as one case of probable mastitis.

Table 13. *Summarized results of udder- and milk examination findings. The udder was palpated for signs of inflammation and lesions and then a milk sample was collected for visual or olfactory modification. 88 cows from 70 smallholder farms in Tajikistan were included in the study. The udder was examined in 86 of the 88 cows - two cows were excluded due to safety reasons. Of these milk was possible to collect and examine from 75 cows*

Parameter examined	*Percent*
Signs of inflammation[1]	
No	98.8%
Yes	1.2%
Milk modification	
No	92%
Yes	8%
Teat lesions	
No	94.2%
Yes	5.8%

[1]Signs of inflammation include redness, swelling, soreness or raised temperature in the area

Examination of the reproductive tract

Vulvar mucous membranes and vaginal discharge

93 % of the animals showed no vaginal discharge and 82.6% had a pink mucous membrane. 4.7% had a discharge with appearance of an oestrous-discharge. 10.4% of the mucous membranes were regarded pale and 1.2% reddish. Clearly abnormal findings were rare and are shown in figure 20.

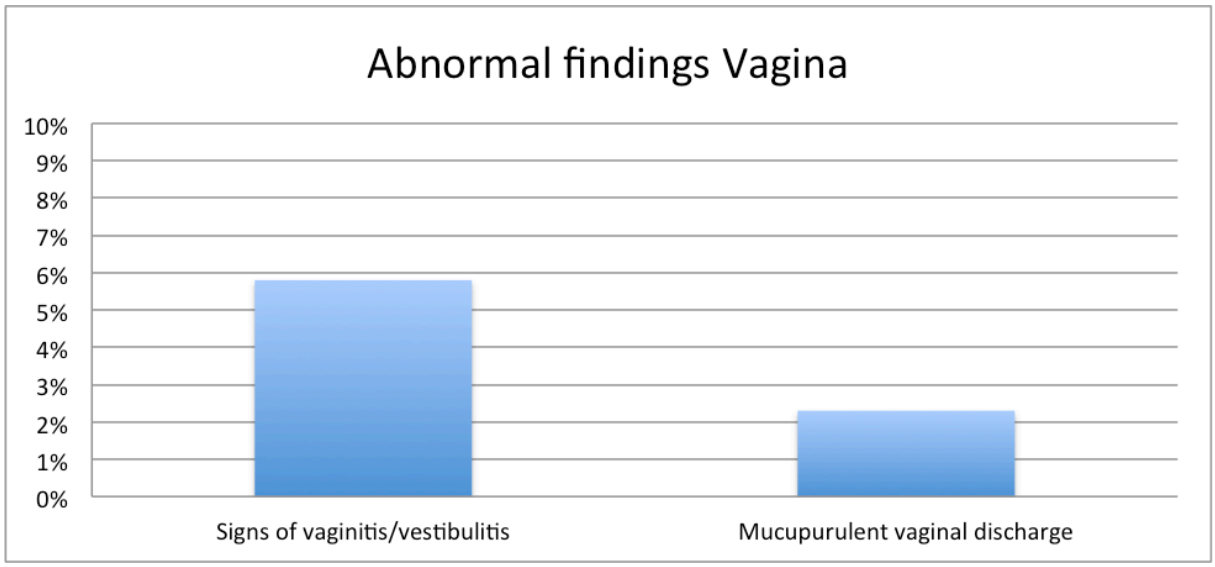

Figure 20. *Prevalence of abnormal vaginal findings in the 88 examined cows from 70 smallholder farms in Tajikistan.*

Rectal palpation – uterine and ovarian findings

One owner did not allow rectal palpation after the questionnaire, anamnesis and general examinations, excluding 2 cows from palpatory findings. The prevalence of the four categories of uterine findings at palpation are visualised in the figure below (figure 21). Few palpations with pathological findings were made. The prevalence's of examined cows categorised as dioestrous and pregnant were similar.

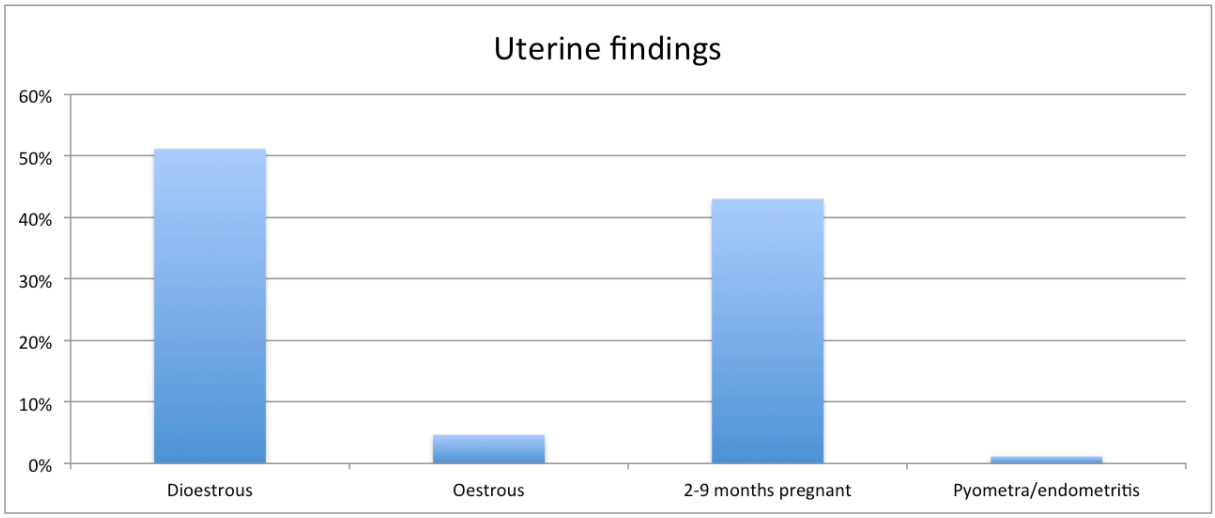

Figure 21. *Four categories were used when classifying findings of uterine palpation in the 86 examined cows in 70 smallholder farms in Tajikistan. The four categories together with their respective prevalence in the examined cows are displayed above. Of the initial 88 cows included in the clinical evaluation two cows are excluded in these results since the owner did not allow rectal palpation. For further description on the different classifications, see material and methods.*

The prevalence of the categories of ovarian findings at palpation are visualised in the figure below (figure 22), with the category of "cyclic" split up into those being cyclic <90 and >90 days postpartum. Almost 1/3 of the cows were cyclic, non-pregnant and >90 days postpartum. Also, there was an 18% prevalence of anoestrous. In addition, table 14 shows the distribution of the cyclic cows relative to parturition.

Table 14. *Distribution of cyclic cows relative to time since parturition. 32 of the 88 cows examined were categorized as cyclic. The examined cows were distributed in 70 smallholder farms in Tajikistan*

Time after calving	*Cyclic cows*
20-90 days	7
3-6 months	12
6-12 months	11
>12 months	2
Unknown	0
	32

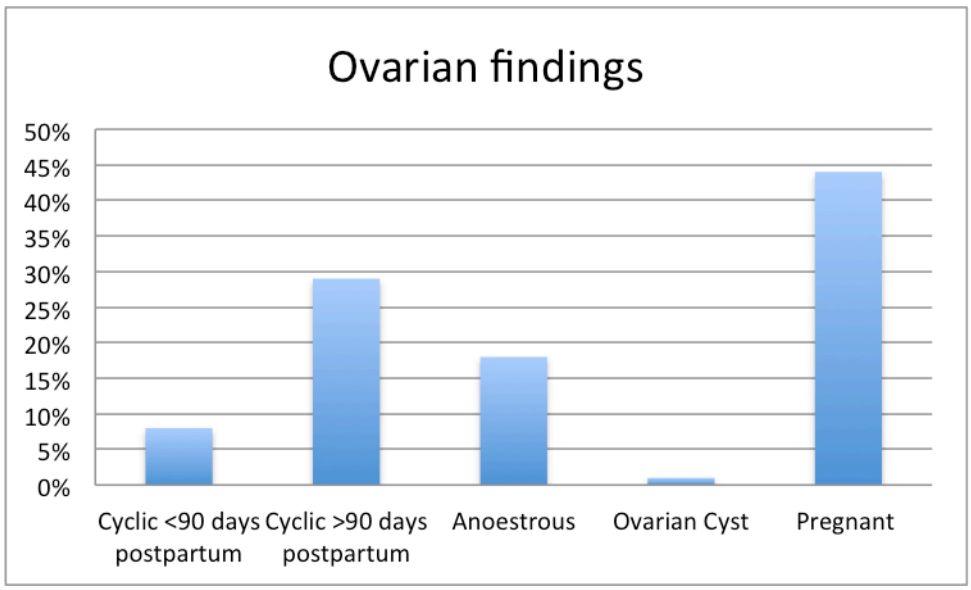

Figure 22. *Four categories were used to describe palpatory findings in the ovaries; cyclic, anoestrous, ovarian cyst or pregnant. The category "cyclic" has, post-examinations, been split up into two categories to better visualize the results - cows that are cyclic with >90 days passed since calving and <90 days passed since calving. The category "pregnant" is based on the palpatory findings in the uterus. The prevalence of the respective categories are visualized above, based on the palpatory findings in the 86 examined cows. Of the initial 88 cows included in the clinical evaluation two were excluded since the owner did not allow rectal palpation. The cows were distributed in 70 smallholder farms in Tajikistan.*

Descriptive data – Other results

Comparison between the days open according to anamnesis and days open calculated from the last calving date after rectal palpation showed poor accordance with each other (table 15).

Table 15. *Correspondence of days open stated at anamnesis with days open calculated from the calving date after rectal palpation. Cells marked green are the number of cows where anamnestic statement and palpatory diagnosis were in accordance with each other. The two cows not examined rectally of the 88 included cows are categorized as unknown in days open (palpation). Examined cows were distributed in 70 smallholder farms in Tajikistan*

	Days open (palpation)				
Days open (anamnesis)	20-60 days	60-90 days	>90 days	Unknown	Total
20-60 days	9	0	13	5	27
60-90 days	0	2	2	2	6
>90 days	0	2	33	1	36
Unknown	4	1	9	5	19
Total	13	5	57	13	88

Based on this data 44% of the anamnestic information regarding days open was not in accordance with what was latter found at palpation. However, even if anamnesis stated >90 days open and palpation stated >90 days open (which was the case in 33 of the cows, see table

15) they did not necessarily correspond with each other. For example, if anamnesis stated 120 days open and latter examination proved that days open was in fact 180 days, both would categorise as >90 days open in table 15. In other words, there were cases where anamnesis and examination did not correspond even if both are categorised as >90 days in table 15. When these cases, differing within the category of >90 days, are also considered the total percentage of anamnestic and palpatory information not corresponding is 52%.

Associations

Analysing pregnancy compared to the different BCS (table 16) showed that cows with BCS 3 in the study were significantly ($p<0.009$) more likely to be pregnant than the cows with BCS 1. Other associations analysed were not significant (pregnancy and breed, cyclicity and BCS and cyclicity and breed).

Table 16. *Relationship between different Body Condition Scores (BCS) and pregnancy at an individual level (n=86) using univariable logistic regression. Abbreviation NS=not significant result.*

Variable	Category	P	OR (95% CI)
BCS		0.06[a]	
	1	1	Reference
	2	NS	
	3	0.009	5.0 (1.5-16.8)
	4	NS	

[a]Liklihood ratio test

DISCUSSION

Results showed several challenges in both reproductive management and performance of the dairy cows in the studied area in Tajikistan. Even if there were few overt signs of clinical disease there was a reduced performance with certain inefficient performance figures and a serious mismatch regarding anamnestic statements and subsequent clinical findings. In the clinical examination the dominating abnormal conditions include low BCS and cows in anoestrous. Interview answers revealed numerous management shortcomings possibly contributing to the reduced performance and abnormal clinical conditions, with inadequacies in key events for an optimized reproduction and production.

In addition to the challenges and results discussed below, contributing socio-economic factors need consideration in the future handling of improvement implementation. It is positive that literacy levels have been recently proven high in Tajikistan (Lindahl *et al*., 2016, UNICEF, 2013), even if general education is still not accessible to the whole population (NE, 2015). Unfortunately, even if general education is attained it does not automatically translate into good husbandry, thus specialised education within the dairy production field might also be needed for improvement to be realistic. In addition, with 31% of the population living below the poverty line (<1.90 $/day) the possibly limited smallholder economy might restrain some of the management factors affecting reproductive performance, even if the farmer would want to perform them. In spite of this there is hope for a positive development since many management improvements can be done without large monetary investments for the farmers (e.g. keeping records, organising the heat-detection, using pregnancy verification). If reproductive performance, and thereby also the production, would be improved there are several socioeconomic gains. Most obvious is a raised income with the possible, positive, following chain effects of such a change. Another socio-economic incitement is that since women were a part of the daily caretaking of the animals in 84% of the farms, an increased importance of the animal production might just mean an increased importance of tasks traditionally performed by women, which could potentially strengthen their position in Tajikistan.

Main challenges related to reproductive performance

When analysing the state of the reproductive performance in the studied cows three main challenges were seen; prolonged days open, anoestrous and abnormal BCS. Few obvious diseases were seen (reproductive or general that could affect the reproductive tract), something that may be connected to the high prevalence of regular veterinary visits and check-ups on the animals. Subclinical diseases with possible effect on reproduction could however still be evident. Nonetheless, the mentioned challenges are of vital importance for an improved and optimized production and reproduction, and are further discussed below.

Empty cows >90 days post-partum – prolonged days open

There was a high percentage of non-pregnant cows with a clinically healthy and cyclic reproductive tract that had passed >90 days since calving. This is equivalent to inefficiency in the production with an inevitably prolonged calving interval as a consequence. With half of the anamnestic statements not being equivalent to what was latter found at rectal palpation there

were many cases of expected pregnancies that were in fact empty – adding on to an inefficiency since not only were the cows not pregnant but the farmer did not know of it. As a comparison, large-scale dairy production in high-income countries set the limit for an efficient and economically rewarding production to a maximum of 85 days of calving to conception interval (Peters & Ball, 2004) with recommended interference of cows exceeding this limit. However, in this study none of the farmers who stated that their cow was beyond 90 days open had interfered and taken any measures to find out why the days open were that long. This is problematic from a production point of view, if the reason for the prolonged period would be pathologic and needs treatment to be resolved or by the simple loss of time and consequently also money.

There are several possible explanations for these results, including the management challenges that are further discussed below. For example, if not verifying pregnancy the farmer might think the cow is pregnant when in fact she is empty. Suboptimal oestrous detection, like a farmer not using primary or adequate signs for detection or cows not fully expressing the behavioural oestrous signs for any reason could also contribute to cows not getting pregnant efficiently. Another reason that could partially be responsible for these results is the possibly undetected cases of subclinical endometritis, resembling the cyclic reproductive tract if ultrasonography or repeated examinations are not performed. Finally, socio-economic factors such as lack of knowledge of key figures and optimal management within the field and/or an economy that is too scarce to perform all needed measures are not to be forgotten when interpreting these results.

Anoestrous

Of clinical conditions in the reproductive tract anoestrous was of dominance. A majority of the cows diagnosed with anoestrous had passed the recommended 85-day limit since last calving and were therefor already contributing to a prolonged calving interval in the production. Together with the cyclic cows with prolonged days open the cows with anoestrous increase the total number of cows with prolonged days open, adding on to the apparent inefficiency.

In accordance with anoestrous being the dominant clinical condition the most common reason given by the farmers for prolonged days open was “no showed signs of oestrous” (table 12), which itself is a possible indication of a cow in anoestrous. In search for explanations of the incidence of anoestrous several of the previously reported causes or factors contributing to anoestrous or delayed cyclicity were found in a substantial percentage of the cows in this study; low BCS (Jolly *et al*., 1995, Wiltbank *et al*., 2002), suckling (Oxenreider, 1968., Wiltbank *et al*., 2002) and being tied-up (Petersson *et al*., 2006). Possibly there could also be genetic factors in the local breed, similarly to those existing in tropical breeds (Mukasa-Mugerwa, 1989). Interestingly, there was no significant association between cows in anoestrous and their BCS in this study.

Low Body Condition Scores

BCS is indicative of the nutritional status of the cow and cows of BCS 3 are most likely to become pregnant (Loeffler *et al*., 1999). In this study, however, more than half of the cows were of a BCS <3 and 1/3 were of BCS 1. Nutritional deficits are known to have several serious

detrimental effects on reproductive performance, for example delaying ovulation (Butler, 2003, Leroy *et al*., 2008), being causative for anoestrous (Butler, 2003) and reducing the likelihood of conception (Sheldon *et al*., 2006). In other words, even if no association was found in this study between anoestrous and BCS previous literature states otherwise. Also, our results show a significantly higher likelihood of cows with BCS 3 to be pregnant than cows with BCS 1, aligning with previously described linkage between nutrition and likelihood of conception. With this in mind one could argue that nutritional deficit may contribute to the reproductive constraint in Tajikistan.

Somewhat surprising, in controversy to the low BCS found in the clinical examination a majority of the farmers stated to give a feed of both forage and concentrate and fed the animals several times/day (figure 18), although the amounts or quality were not controlled. In addition to amount and quality, the fact that the study was conducted in the end of the dry-season may contribute to low BCS in the cows where pasture was used as part of the feed. Also, there might be a bias between statements and reality. Since further nutritional evaluation or questioning was not included in this study the possible conclusions regarding nutrition are limited, but such a study might be of interest, particularly with the results found in BCS not being in accordance with the stated animal feed.

Main challenges related to management factors

Several key events of dairy cow reproductive management showed results that raise serious concerns of possibly having negative effects on the reproductive performance of the cows in Tajikistan. Below the most crucial factors that could be contributing to the performance constraints seen in this study are discussed.

Lack of proper pregnancy verification

A vast majority did not use any verification of pregnancy, regarded as a basic criterion for a high reproductive performance (Balhara *et a*l., 2013, Romano et al., 2006). This is in contrary to the results of a similar study conducted in India, also evaluating reproductive performance and management of dairy cows in smallholder farms, which showed almost all farmers verified the pregnancies there (Ghuman & Singh, 2010). As a probable consequence of not verifying pregnancy in Tajikistan there was a serious mismatch between anamnestic statements from the farmer and what was latter found in clinical examination of the same cow, with more than half of the statements proven to be wrong after rectal palpation. If pregnancy verification were always performed this number would likely be much lower since non-pregnant animals could be detected and re-bred or treated and pregnant animals could be classified in an accurate gestation length.

Of the minority that did verify pregnancy in Tajikistan, only a small proportion did this before three months of gestation and it was just as common to use untrained laymen as veterinarians for the verifications – arguably factors that would affect the accuracy and efficiency of the verification. The percentage of veterinarians performing the verification matches the percentage of reliable methods used; rectal palpation or ultrasonography. Within the farmers not using such reliable methods, external signs were most frequently used for detection of pregnancy. However

other methods were also stated, such as regular use of human pregnancy tests. If no pregnancy verification was applied the owner commonly relied on lack of returning heat signs post-service. Exemplifying these unreliable methods that occurred in the study inevitably raises the question of socio-economic factors like education and costs. Even if rectal palpation is reliable and not an expensive method per se, using a veterinary professional is more expensive than for example looking at external signs. In addition, if one has limited or no education in the area the reasons of why it would be important to prioritise verification and a reliable, early method of such might not be obvious.

Using unreliable methods or no verification at all can lead to an inefficient production with unnecessary days open and missed opportunities for rebreeding or treatment (Balhara *et al*., 2013). In deed unnecessary days open was one of the major performance constraints in Tajikistan and the lack of pregnancy verification may be an important causative factor of this challenge.

Figure 24. *A son of a farmer included the study. Maybe he will be part of a future improvement in pregnancy verification in Tajikistan with this natural skill with the rectal glove. Photo by author.*

Suboptimal oestrous detection

Knowledge of oestrous detection signs and routines concerning oestrous detection has previously been acknowledged as a major constraint in reproductive performance in the smallholder scenario (Chatikobo *et al*., 2009, Ghuman & Singh, 2010). In accordance, the smallholders in Tajikistan mainly relied on supplementary signs when determining heat; bellowing, mounting other animals or people and vaginal discharge being the top three mentioned signs. The signs recognized as primary were in minority; standing to be mounted used in 1 of 10 cows and lordosis not mentioned by any farmer. The vast majority used less than three signs and most farmers did not have any specific time of day when trying to detect oestrous. Also, even if 69% stated they looked for oestrous every day in their animals, the

answers gave the impression of being a passive finding when noticed more than an active choice to detect.

Factors contributing to these results may be that almost all cows were held tied up when not in the pasture, and many were tied up in the pasture too, limiting the regular expression of oestrous signs, with emphasis on limiting the primary sign of standing to be mounted – widely used in higher yielding productions. For example, Peters and Ball (2004), mention that vaginal discharge may be the main sign seen in tied up cows. On the other hand it was still relatively common at the visited season for the cows in Tajikistan to be in common pasture during the day, opening the possibility of oestrous sign display. At pasture the main person responsible for oestrous detection was usually not present though, limiting the security for this person in detecting oestrous since they instead needed to rely on the guarding shepherd to notice and report such behaviours.

If unreliable or few signs are used this might lead to breeding efforts being made at the wrong time, and missed signs of oestrous or missed communication of such may lead to missed breeding opportunities. In elongation rebreeding could be a necessary consequence, which is both timely and economically inefficient.

Late weaning

In high-yielding dairy farms, for example in Europe and North America, it is common to separate the calf from its mother within 24 hours after birth and artificially rear the calf (Flower & Weary, 2001, Stěhulová *et al*., 2008). Of course, separating the calf from the cow and hand rearing it means the whole milk yield from the cow can be kept and used by the farmer. Regarding reproductive performance suckling and presence of the calf is a known constraint on reproductive performance delaying resumption of cyclicity post-partum (Oxenreider, 1968). Early weaning is also accompanied with less severe behavioural effects of separation in comparisons to later manual separation (Flower & Weary, 2001, Stěhulová *et al*., 2008).

In Tajikistan a majority of farmers had either no routines of weaning (using natural weaning by the mother), or weaned the calves after >3 months. Even if weaning was used, the calf was often kept tied up just beside its mother unless it was sold. Except that milking was done by hand in all the farms more detailed questions were not asked regarding milking routines. However, observations were made that cows were milked for owner consummation during the same time period that the calf was still suckling its mother. Even if there have been reports on positive effects (improved udder health, increased milk yield, influenced milk composition and decreased abnormal suckling) of such “restricted suckling” with combinations on suckling and milking the cow in tropical mixed breeds (Fröberg *et al*., 2007), the effects on reproductive performance remains a challenge when using such weaning management.

Lack of record-keeping

In similar studies as the one conducted, the lack of organised record-keeping has been speculated to be of major importance in failure to achieve efficient reproductive performance (Chatikobo *et al.*, 2009, Ghuman & Singh, 2010). In the smallholder scenario relying on

memory is commonly occurring, which in retrospect is often proven wrong (Flamant, 1998). Similarly, in the current study 90% did not keep any records of their animals, something that has a likely contribution to the substantial mismatch seen when comparing anamnestic statements with subsequent clinical findings in this study. Within the mismatch there were cows thought to be pregnant that proved to be empty, cows thought to be empty that proved to be pregnant and there were cows that were thought to be of a certain gestation length that at examination appeared to be of a different gestation length. In addition, the interview revealed a majority of the farmers stated a calving interval of 1 calf/year but after examination only 15% fulfilled the limit of days open for a calving interval of 1 year to be possible. This is indicating that without keeping written records it is uncertain if memory serves you right, possibly positively distorting the actual performance data and in turn complicating improvement implementations. To make something better, initial data is needed to aim measure aids optimally as well as for later comparison in evaluation of the actions taken.

Lack of heat evasion and insufficient water supply

Shade was the predominantly reported technique to evade heat in the statements. However, during the study animals were observed frequently being tied-up in the sun without access to shade, with mid-day temperatures in the visited season of 30°C-40°C, well beyond the thermo-neutral zone of dairy cows (Kadzere *et a*l., 2002). In addition, most animals did not have free access to water but were given water by bucket, commonly 1-3 times/day. Heat stress is known to have a variety of serious negative effects on reproductive performance, both in cyclic and pregnant individuals (Hansen & Arechiga, 1999, Kadzere *et al*., 2002, Rensis & Scaramuzzi, 2003), and both heat stress (Kadzere *et al*., 2002) and restricted water supply (Little *et al*., 1976) markedly lower milk yield and production performance. In Tajikistan, even if more advanced heat evasion methods might be hard to achieve, cool water from the mountains is not a scarce resource and improvement of water supply for drinking and cooling the animals should be possible. This would increase basic animal welfare and productive- and reproductive performance.

Breed

No association was seen between breed and pregnancy or with breed and cyclicity. This is interesting since there seemed to be a growing interest of using pure breeds or mixing pure breeds with the local mixed breed (producing the improved local) to improve production. During the study the question was raised weather there is evidence of such effect or if knowledge of proper management and husbandry is of greater importance. Also, the proof of the heritage of the stated pure breeds could be questioned since any evidence seemed rarely applied at purchase of the animals. Further investigation would be needed to determine conclusions regarding effects of the genetic material on the reproductive and productive performance of dairy cows in Tajikistan.

Limitations of study

Logistic limitations affected the number of farms and animals included in the study during the 8 weeks and to some extent the initial random selection. The use of interpretation when

interviewing is always concurrent with a caution for misinterpretations in the study material. Also, when performing the milk progesterone test the result was not always clear and was sometimes interpreted differently depending on the person reading it. Another limitation was that all examinations could only be performed once, sometimes affecting the security in a diagnosis – for example that of a structure classifying as an ovarian cysts or if a cow with low progesterone is in fact in anoestrous when not being able to do another progesterone test in 10 days. In the cows categorised as cyclic there was an additional diagnostic limitation of possible endometritis cases that were undetected at palpation but might have been detectable with access to an ultrasonography apparatus. Finally the experience level of the author performing the rectal palpation is a possible bias. However, the diagnostic limitations were known beforehand and considered in all cases.

Figure 25. *A broad perspective of beautiful Tajikistan, man and animal side by side, both heading towards a goal. Could this be a metaphor for the final words of this thesis? Photo by author.*

CONCLUSIONS

The aims of this study was to 1) assess the reproductive performance and health of cows in a selected smallholder farms around Dushanbe and 2) identify factors and issues with possible effect on the reproductive performance of these dairy cows.

Reproductive performance was reduced with the most prominent challenge being a high proportion of clinically healthy, cyclic cows with prolonged days open post-partum leading to a subsequently prolonged calving interval. The general health of the cows was good with few overt signs of clinical disease that could affect reproductive performance. However, a majority of the cows had an abnormally low BCS and the cows with BCS 1 were significantly ($p<0.009$) less likely to be pregnant that cows with BCS 3. Within the reproductive tract anoestrous was the clinical condition of dominance, contributing to an even higher number of cows with prolonged days open. The prolonged days open and consequently prolonged calving interval, seen both with the cyclic, non-pregnant cows and the cows in anoestrous raises concerns regarding the reproductive efficiency in smallholder cows in Tajikistan. The low BCS observed indicates nutritional deficits, a possible cause of poor reproductive performance.

Several factors and issues were found with possible contribution to these performance and health results. Lack of proper pregnancy verification and record-keeping combined with a suboptimal heat detection and late weaning routines are discussed as probable contributors, all regarded as key elements for an optimised and efficient dairy reproduction. In addition, the unsatisfactory heat evasion in the hot season (that prevailed during the study) and socio-economic factors such as income and education are mentioned as additive factors of consideration.

In conclusion, a problematic reproductive inefficiency seems to be evident in the investigated cows in Tajikistan, leaving room for improvement - both in the poor performance figures as well as the management factors that may contribute to their existence. These shortcomings lead to direct production losses for the farmer, but also to an inefficient use of natural resources. Improvement may therefor have a positive effect on socio-economic factors and quality of life of the individual farmers, but is also a step for an improved environmental sustainability of the production. The means to attain such an improvement need detailed implementation plans with local consideration as well as further investigation of the challenges and factors showed in this study, even if these results contain important clues as to where one might start.

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Date Questionnaire nr:

Attachment 1

Management questionnaire

Number of cows in total:
Number of cows with ≥ 1 calf:

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	• Commercial • Self-sufficiency • Other	*Please write purpose; meat/milk, selling animals in market, keeping them as bank, for transportation* Yes = 1 No =2
The goal for the dairy herd size	1. Keep existing 2. Expansion 3. Contraction	

Date Questionnaire nr:

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	1. <1 2. 1-3 3. 3-6 4. >6; 5. Unknown	
Milk yield/day at the moment Total/household in L	1. <5 2. 5,1-10 3. >10 4. Unknown	
Milk yield/day at the moment Average/cow in L	1. <2 2. 2,1-5 3. >5 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	
Routines of biosecurity	1. No structured routines 2. Verbal routines 3. Applied written policy	

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	Yes = 1 No = 2
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 • Arching • Bellowing • Mounting other animals • Flehmen • Smell other cows vagina • Chin-resting • Frequent urination • Vaginal discharge/vulvar swelling • Restless • Other;	Yes = 1 No =2
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 (e.g. pasture) 4. Free access (eg pasture) and feeding once a day 5. Free access (e.g. 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	

Date Questionnaire nr:

Attachment 2

Clinical evaluation form

Cow ID (number, name or description):
Farm location/Farm and district name:

Anamnesis based on oral and displayed records

Time after calving	1. 20-90 days	2. 3-6 months	3. 6-12 month	4. >12 months	5. Unknown
Time after insemination/mounting	1. <2 months	2. ≥ 2 months	3. Not insem/mounted	4. Unknown	
If >3 months **in between insemination/mounting and calving;** ***Why prolonged period***		**Days in between insemination/mounting and calving**			
Measures taken					
Person handling measures					
Lactation number	1. 1-2	2. 3-5	3. 5-10	4. >10	5. Unknown
Age	1. 2-3	2. 3-5	3. 5-10	4. >10	5. Unknown
Milk yield/day	1. <5 l	2. 5-15 l	3. >15 l		
Breed	1. Pure, Specify:	2. Improved local	3. Local Mixed		
Known illness	1. No	2. Yes			
If yes; which?					

Date Questionnaire nr:

Temperature where the cow is held 1. <+10° 2. +10°-20° 3. >+20°

Body Condition Score (BCS)

1 2 3 4 5

General clinical examination

General state of health	1. Without remark		2. Reduced
Cleanliness	1	2	3
Signs of lameness	1. No		2. Yes
Injuries (e.g. major skin wounds)	1	2	3
Rumen distension	1	2	3

Udder examination

Cardinal signs of inflammation	1. No	2. Yes
Ocular milk modification	1. No	2. Yes
Olfactory milk modification	1. No	2. Yes
Teat lesions	1. No	2. Yes

Date Questionnaire nr:

Gynecological examination

Vaginal discharge	1. None	2. Oestrous	3. Metoestrous	4. Mucopurulent
Vaginal mucous membrane	1. Pink	2. Pale	3. Red	4. Signs of vaginitis/vestibulitis
Uterus	1.Dioestrus	2. Oestrous	3. 2-9 months Pregnant	4. Pyometra /Endometritis
Ovaries	1. Cyclic	2. Anestrus	3. Ovarian cyst	4. Pregnant

☐ Progesterone test in milk: 1. High 2. Low

Summary: