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# Brucellosis in small ruminants – an investigation of knowledge, attitude and practices in peri-urban farming around the region of Dushanbe, Tajikistan

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Brucellosis in small ruminants – an investigation of knowledge, attitude and practices in peri-urban farming around the region of Dushanbe, Tajikistan

Brucellos hos små idisslare – en kunskaps-, inställnings- och tillämpningsstudie (KAP-studie) i periurbana områden omkring Dushanbe, Tadzjikistan

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## **SUMMARY**

Landlocked Tajikistan is situated in Central Asia and is not only the smallest republic of Central Asia, but it is also one of the most mountainous with some of Central Asia's highest peaks. Tajikistan is currently and historically the most financially disadvantaged country within Soviet Union/Russian territories.

Agriculture is the main occupation for more than half of the country's population. Unfortunately, however, only 7% of Tajikistan is arable land and the agriculture productivity is low. Approximately 80% of the households in Tajikistan own livestock, most commonly sheep or goats and smaller numbers of cattle. Hence, livestock is an integral component of Tajik agriculture and a vital part of the livelihood of the people. Concurrent with the country's independence from the Soviet Union, there was a serious degeneration in disease control programs and the productivity of livestock in Tajikistan remains low due to poor reproduction rates and uncontrolled breeding, poor utilization of grazing land and high mortalities in livestock owing to diseases.

Brucellosis is a zoonosis, and is therefore naturally transmitted between humans and other vertebrates. With the continuous and inevitable interaction of mankind and animals, the existence of brucellosis – that is endemic in Tajikistan – provides a genuine hazard to both human and livestock health; this is seen mainly in urban and peri-urban areas where humans and animals live closer together.

The main reservoirs for human cases of brucellosis are small ruminants, and because of the absence of a pragmatic method to protect humans from such infected animals, the goal must therefore be to control the disease in the small ruminant population.

The aims of current study were to investigate the knowledge, attitude and practices regarding brucellosis among smallholders and to identify possible risk factors. When interpreting the results, it is clear that there is a widespread lack of adequate knowledge among the participating smallholders, followed by the attitude and practices acted upon this fallible awareness. A better education of farmers is needed so they can protect themselves from the exposure as well as reduce the risk of facilitating the transmission and spread of brucellosis.



## **SAMMANFATTNING**

Det kustlösa och bergiga - en del av Centralasiens högsta bergstoppar återfinns här - Tadzjikistan är ett av de minsta länderna i Centralasien. Av länderna i forna Sovjet är Tadzjikistan, både idag och historiskt sett, det finansiellt svagaste landet.

Mer än hälften av landets invånare arbetar med jordbruk. Dock är endast 7% av Tadzjikistans yta jordbruksbar mark och produktiviteten inom lantbruket är låg. Cirka 80% av hushållen äger boskap, framförallt getter och får samt ett mindre antal nötkreatur. Djurhållning är ett integrerat element i det dagliga livet och utgör en väsentlig del i människors dagliga levebröd. Samtidigt som landet blev självständigt från Sovjet försämrades kontrollprogram för sjukdomar kraftigt och avkastningen från boskap i Tadzjikistan är än idag låg på grund av låga reproduktionstal i kombination med okontrollerad uppfödning, bristfälligt brukande av betesmark och hög mortalitet hos boskapen på grund av sjukdomar.

Brucellos är en zoonos och kan därför smitta naturligt mellan djur och människor. Då det förekommer en fortlöpande och oundviklig interaktion mellan dessa två grupper utgör brucellos – som är endemisk i Tadzjikistan – en beaktansvärd fara för både människor och djur; särskilt i urbana och peri-urbana områden där djur och människor lever tätare in på varandra.

Den främsta reservoaren för humana fall av brucellos är små idisslare och då det saknas en fungerande, pragmatisk metod för att skydda människor från dylika smittförande djur måste det primära målet istället vara att kontrollera – och minimera – sjukdomen i får- och getpopulationerna.

Studiens syfte var att undersöka kunskapen, inställningarna och vanorna avseende brucellos hos småbrukare och därefter identifiera möjliga riskfaktorer. Resultaten visar att det förekommer stora kunskapsluckor hos de deltagande tadjjikerna, därtill beklagansvärda inställningar och vanor på grund av denna fallerande kunskap. Det krävs därför bättre utbildning av dessa människor för att på så sätt ge dem verktyg för att kunna skydda sig själva från exponering av smitta, likväl för att minska risken att brucellos sprids mellan djuren.





## **ABBREVIATIONS**

<b>cELISA</b>	Competitive ELISA
<b>ELISA</b>	Enzyme Linked Immuno-sorbent Assay
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>iELISA</b>	Indirect ELISA
<b>KAP</b>	Knowledge Attitude and Practice
<b>NBCP</b>	National Brucellosis Control Programme
<b>OIE</b>	World Organization for Animal Health
<b>SLU</b>	Swedish University of Agriculture Sciences
<b>TAU</b>	Tajik Agriculture University
<b>WHO</b>	World Health Organization

.



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## BACKGROUND

### Tajikistan

Tajikistan is situated in Central Asia and borders Afghanistan in the south, Uzbekistan in the west, Kyrgyzstan in the north and China in the east. The country's official language is Tajik Persian, with a population of approximately 7.7 million. Approximately 80% of the inhabitants are Tajiks, 15% Uzbeks and the remaining 5% consists of various other nationalities, including Russians and Kyrgyzs (Central Intelligence Agency (CIA), 2012). At 14300 sq km, landlocked Tajikistan is not only the smallest republic of Central Asia, but it is also one of the most mountainous with some of Central Asia's highest peaks, including Ismoil Somoni Peak at 7495 m. More than half of the country lies 3000m or more above sea level (The Swedish Institute of International Affairs (UI), 2012).



Picture 1. Map of Tajikistan ([www.geology.com](http://www.geology.com), 2007).

Tajikistan is currently and historically the most financially disadvantaged country within Soviet Union/Russian territories. The country has had a Russian presence since the 19th century, becoming a separate constitutional republic in 1929 within the Russian empire and then later in the Soviet Union; following its collapse and reformation. Tajikistan declared its independence in 1991. After this split a civil war broke out from 1992 until 1997 (Swedish National Encyclopedia (NE), 2012) that proved to be devastating to Tajikistan. This conflict meant great suffering for the country that saw war time policies that included ethnic cleansing (UI, 2012).

The GPD per capita is \$879 (UI, 2012) and approximately half of the population lives under the poverty line (CIA, 2012). The health system in Tajikistan is weak, and large parts of the population have little opportunity to get adequate health care (NE, 2012).

The primary official sources of income for Tajikistan are aluminum production, cotton growing (UI, 2012) and remittances from migrant workers – a million Tajiks work abroad, mostly in Russia, sending back money supporting Tajik families equivalent to 47% of the country's official GDP, making Tajikistan the most remittance-dependent country in the world (The World Bank, 2012).

### **Agriculture in Tajikistan**

Agriculture contributes to approximately 20 percentage of Tajikistan's official GDP (CIA, 2012) and it is the main occupation for more than half of the country's population. Unfortunately, however, only 7% of Tajikistan is arable land and thus the agriculture productivity is low and the lack of appropriate technology is prominent (UI, 2012). Due to this, approximately 60% of the country's food is imported. In contrast to other low income countries, the rural population, at approximately 75%, is increasing rather than decreasing (Ahuja *et al*, 2009).

After the country's independence from the Soviet Union in 1991 livestock ownership shifted to smallholder private ownership (>90%) from the state-owned collectives (Ward *et al*, 2012). Concurrent with this change, there was a serious degeneration in disease control programs and the productivity of livestock in Tajikistan is yet low due to poor reproduction rates and uncontrolled breeding, poor utilization of grazing land and high mortalities in livestock owing to diseases (Ward *et al*, 2012).

Approximately 80% of the households in Tajikistan own livestock, most commonly sheep or goats and smaller numbers of cattle (Jackson *et al*, 2007). Hence, livestock is an integral component of Tajik agriculture and is a vital part of the livelihood of the people. The livestock population has steadily increased during the last years, small ruminants in particular. In 2007, small ruminants made up 58% of the total numbers of farm animals in Tajikistan (Ahuja *et al*, 2009).

The animals of a village are generally grazed collectively as a unit during winter (picture 2), but participate in annual migrations to high altitude pastures were they are mixed with other

animals during summer (Jackson *et al*, 2007). This transhumance is regarded as a promoting factor for the spread of diseases, just as the mixing of animals at markets and the custom to keep animals in close space during winter since this facilitates transmission of infections (Food and Agriculture Organization (FAO), 2010).



*Picture 2. Animals of a village grazed collectively as a unit. Private photo.*

## **Brucellosis**

Brucellosis is a zoonosis, and is therefore naturally transmitted between humans and other vertebrates. With the continuous and inevitable interaction of mankind and animals, the existence of brucellosis provides a genuine hazard to both human and livestock health, mainly in urban and peri-urban areas where humans and animals live closer together (Corbel *et al*, 2006).

Brucellosis is one of the most widespread zoonoses in the world (Corbel *et al*, 2006) and caused by the small gram-negative aerobic or microaerophilic *Brucella* spp. The bacteria are non-motile, non-spore-forming, rod-shaped to coccoid and encapsulated in cells. They are facultative intracellular pathogens, hence more difficult to treat with antibiotics, with a preference for reproductive organs and mononuclear phagocytes, which they can multiply within. Despite its parasitic ability, the bacteria can survive for some time in the environment: nearly a year in animal dung, more than 50 days on a wall during winter but less than a day

during summer. Lysol or formalin or similar disinfectants kills *Brucella* quickly (Epiwebb, 2012), and the bacteria die off when acidity drops below pH 3.5 – 4. Pasteurization of milk products or proper meat preparation will have the same effect (FAO, 2010).

There are six recognized species (and multitude biotypes) of the bacteria, which show strong host preference, although five of these six species can cross-infect other animal hosts. Four of these six species can cause disease in humans: *B melitensis* is the most pathogenic one, following *B suis*, *B abortus* and *B canis*. *Brucella ovis* and *B neotomae* - is of lesser significance concerning human disease. It is probable that strains associated with marine animals, i.e. other *Brucella* species dissimilar from the six mentioned, can infect humans (Corbel *et al* 2006). The agent mainly responsible for brucellosis in small ruminants is *B melitensis* and it is also the primary cause of human brucellosis (Blasco & Molina-Flores, 2011).

*B melitensis* infection occurs geographically in the Mediterranean region, Africa, some parts of Asia and South America (Epiwebb, 2012). These areas, where brucellosis is prevalent, include many of the low-income countries in the developing world. Nevertheless these countries contain more than 70 per cent of the susceptible world livestock (Corbel *et al* 2006) making the disease important worldwide. Brucellosis in small ruminants has long been neglected, when compared to bovine brucellosis. Reasons for this are, for instance, that small ruminants generally are a low-income business and their affected owners represent inhabitants of the world's marginal rural areas. The current main reservoirs for human cases of brucellosis are small ruminants, and because of the absence of a operational, pragmatic method to protect humans from such infected animals, the goal must therefore be to control the disease in the small ruminant population (Blasco & Molina-Flores, 2011). Also, by controlling the disease in the small ruminant population one can reduce it in cattle as well (Ahuja *et al*, 2009). According to WHO, brucellosis in humans can only be eliminated if it is controlled in the animal reservoir. Furthermore, a WHO report mentions the difficulties in this since the test-and-slaughter-programmes, which were applied in many higher income countries, are neither acceptable nor affordable in poor countries (WHO, 2006). In order to justify such programmes the herd prevalence must be very low, adequate facilities and resources must be available and an accurate legal framework must be in place. In addition, the farmers must fully co-operate and accept the slaughter policies regarding infected animals (FAO, 2010). This is unfortunately not a common setting in low income countries. The alternative in these countries would be a mass-vaccination of livestock. According to WHOS's report, the health sector often considers this method as too expensive in relation to the increase of human benefits, whilst the veterinary sector in turn believes it too costly for a chronic disease with a low mortality rate (WHO, 2006).

Blasco and Molina-Flores (2011) draw the conclusion that there is a great prospect globally, considering the available diagnostic and prophylactic tools, of fighting *B melitensis* infection effectively. They also point out what is necessary in order to do so successfully: an improved quality of national veterinary services and organizations involved.

## **Brucellosis in livestock**

### *Clinical signs*

Brucellosis causes significant economic losses due to abortions, reduced fertility and lowered milk production in livestock (WHO, 2006). The abortions often occur during late pregnancy, frequently followed by retained placentas. The infection also can cause testicular infections in males leading to orchitis and epididymitis. Notably, fever is not a clinical sign in animals (Epiwebb, 2012).

Goats are generally more susceptible to *B melitensis* than sheep, and once infected the disease is often more severe and protracted than in sheep (Quinn et al, 2002). Infected goats may eventually be afflicted with mastitis, arthritis and bursitis. *B melitensis* and *B abortus* are more associated with abortions in sheep than *B ovis* is (Lewerin Sternberg, 2011).

Noticeably, animal placental tissue, unlike human placental tissue, contains the agent erythritol. This polyhydric alcohol, acting as a growth factor for brucellae, promotes infection in placenta and foetus followed by abortion and is also found in mammary glands and epididymis (Quinn *et al*, 2002).

### *Transmission*

Transmission of *B. melitensis* between animals occurs mainly by environmental contamination after abortions or by direct contact, but sexual transmission is also important one route of infection, probably more so in small ruminants than in cattle (Corbel *et al*, 2006). Animal owners are also more prone to commingle small ruminants from different herds, than they would do with cattle, which promotes the transmission of the disease. Dogs can acquire infection with *Brucella* species, including *B melitensis*, by ingesting aborted foetuses and/or placental material and thereafter infect humans and domestic livestock (Corbel *et al*, 2006).

*B. melitensis* and *B. ovis* can be found mainly in small ruminants, but *B. melitensis* can also establish itself in other species, notably cattle, which is particularly dangerous to affected humans since these animals excrete large numbers of bacteria, both through great volumes of milk and through abortions. Nevertheless, cattle infection is most often caused by *B. abortus* (Corbel *et al*, 2006).

In livestock, there is a greater susceptibility to brucellosis in sexually mature animals; although it is possible for young animals to be latently infected and these animals may eventually become a source of infection when mature (Corbel *et al*, 2006).

## **Brucellosis in humans**

Brucellosis, popularly called Malta fever, undulant fever or Bang's disease, to mention merely a few of many names, is listed by the World Health Organization as a neglected zoonosis (WHO, 2006). It has multiple routes of infection, and humans acquire brucellosis primarily due to indirect or direct contact with infected animals, or their products such as milk or meat. Laboratory workers are also at risk. Infection may occur via cuts in the skin, via



inhalation or via mucous membranes. Human to human transmission, such as mother to child or sexual contact, is possible but rare. People of both sexes and of all ages are affected. Human brucellosis normally presents itself in clusters of clinical cases and most cases are caused by *B. melitensis*. In endemic countries, such as Tajikistan, *B. melitensis* first and foremost infect humans either via unpasteurised milk products or by exposure to infected placental material, aborted foetuses or infected animals, which after abortion can shed a vast amount of bacteria (Ahuja *et al*, 2009). The use of dried dung as fuel and isolation in houses may also promote infection in households (Corbel *et al*, 2006).

Brucellosis is an occupational disease; farmers, veterinarians, inseminators etc are at higher risk of contracting it. There is an even stronger association with poverty; poor people live closer to their animals, are more likely to consume unpasteurized milk products and meat from infected animals, and are less prone to protect themselves when dealing with foetal fluids and vaginal discharges after abortion or full-term parturition. Furthermore, as with other conditions; poor people, especially in rural areas, are less likely to get proper diagnosis and treatment, and since brucellosis is a zoonosis it is a double burden – i.e. it affects both people and their animals - in poor households (WHO, 2006).

The clinical picture is not specific and diagnosis needs support from laboratory tests. Human brucellosis manifests itself as an acute or sub-acute illness, its first stage characterized by intermittent or remittent fever accompanied by ague, malaise, anorexia, sweating, muscle pain and prostration. Without proper and prompt treatment, the acute phase might develop into a chronic incapacitating one marked by persistent localized infection, such as osteoarticular complications, or the more non-specific “chronic fatigue syndrome” (Corbel *et al*, 2006). Even though the mortality is very low in humans, this disabling, chronic feature of the disease is of particular distress in rural communities lacking adequate health care and where physical fitness for work is essential (Jackson *et al*, 2007). In tropical countries human brucellosis may be misdiagnosed as drug-resistant malaria (WHO, 2006) and it is under-detected, hence under-reported in most parts of the world (Corbel *et al*, 2006).

### ***Brucellosis in Tajikistan***

According to Jackson *et al* (2007), the brucellosis situation in Tajikistan was relatively well managed during Soviet time with the help from state controlled test-and-slaughter programmes as well as some vaccination. Authorities used a variety of vaccines – Strain 19, Strain 82 and Rev 1 – in domestic ruminants from the 50s up until independence in 1991 (Ward *et al*, 2012). Nevertheless, following independence 1991 Tajikistan became a politically and economically fragile state (CIA, 2012) and disease programs suffered major setbacks (Jackson *et al*, 2007). This was followed, during the late 1990s, by recognition of Tajik public health authorities that the situation regarding brucellosis in human was out of hand. Sheep and goats belonging to state farms, consisting of approximately 10% of the country’s small ruminant population, were vaccinated with Rev 1 up through 1999 (Ward *et al*, 2012).

In 2004, a pilot National Brucellosis Control Programme (NBCP) started in Tajikistan in co-operating with FAO. This pilot included eight well-vaccinated neighbouring districts and the programme was one year later extended to ten more - partly-vaccinated - districts. In this specially designed bi-annual national programme, i.e. every spring and autumn, vaccinations were carried out in the eight pilot districts, while the ten partly vaccinated districts were given a more irregular treatment. The vaccine used was Rev 1<sup>1</sup> *Brucella melitensis* - applied conjunctivally - and from 2010 the costs were shared with livestock owners in order to make the NBCP more financially sustainable?. In addition to vaccination of livestock, activities such as pre- and postknowledge, attitude and practice studies, information and instructions to both animal owners and primary care physicians along with improvement of diagnostic techniques in clinical laboratories took place within this national programme (Ward *et al*, 2012).

Before the pilot NBCP, Jackson *et al* (2007) conducted a study of baseline seroprevalence of brucellosis in 2003 which presented a prevalence of 5.5% in goats, 5.8% in sheep, and 2.1% in cattle. Furthermore, the study found 69.2% of the villages and 14.4% of the households to have at least one seropositive animal.

In 2009 another study (Ward *et al*, 2012) was performed to evaluate the efficiency and value of the NBCP. Four years after the start of the NBCP the seroprevalence in small ruminants was in the well-vaccinated pilot districts reduced to 20% of the 2003 levels (from 8.9% to 1.8%) and to 60% in the partly vaccinated districts (from 4.9% to 3.0%). Household prevalence was reduced from 25.1 to 7.5% in the well-vaccinated districts and from 13% to 10.9% in the partly-vaccinated dittos. Moreover, there was no significant change of prevalence in non-vaccinated districts during this time period. Ward *et al* (2012) are interpreting these overall results as a large, true reduction of prevalence, hence a reduced risk for households contracting brucellosis in these areas included in the pilot.

Considering the current circumstances in Tajikistan, with smallholder agriculture - instead of state owned collectives - and an endemic setting; mass vaccination ought to be considered as the main intervention (FAO, 2010). The reduced seroprevalence since 2003 in the pilot well-vaccinated districts indicates that this is possible, but may be costly (Ward *et al*, 2012). With extensive Rev 1 vaccine programmes, the infection in small ruminants can be reduced to a low and stable level. Providing that veterinary services and economic resources are up to standard, eradication is possible in a later stage, after a combined test-and-slaughter and vaccination phase. Vaccination recommended not cease until a period of 8-12 years of zero prevalence has passed, and the risk of transmission from affected neighbouring areas is negligible (FAO, 2010).

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<sup>1</sup> Full-strength ( $1 \times 10^8$ ) quality-assured Rev 1 *Brucella melitensis* live attenuated vaccine (BRUCEVAC, Jordan Bio-Industries Center (JOVAC); CZV REV 1 CZ Veterinaria (Ward *et al*, 2012)

## Introduction to study

In order to gain control over the brucellosis situation in endemic countries, it is important to collect data and information about livestock owners' everyday practices as well as their awareness and understanding of brucellosis, including fundamental information such as local customs and animal trading patterns. Considering livestock owners' awareness about the zoonosis' multiple routes of transmission, together with reducing the prevalence in their animals, are the most efficient ways to reduce the prevalence of human brucellosis cases (FAO, 2010). Small ruminants constitute more than half of Tajikistan's total number of farm animals (Ahuja *et al*, 2009) and their owner's practices are therefore important to survey. It is this study's aim to implement an integrative approach regarding research on brucellosis in Tajikistan; i.e. by approaching it both from a human and a veterinary health point of view. Hopefully this study can contribute to facilitate and draw attention to the often mentioned but seldom acted upon collaborative effort of multiple disciplines in order to deal with the brucellosis situation in endemic countries (Jackson *et al*, 2007).



Picture 3. A seroprevalence study took place concurrently with the KAP-study. Private photo.

To the author's knowledge, no comparable KAP-study has previously taken place in Tajikistan. Two surveys (Ward *et al*, 2012; Jackson *et al*, 2007) - as mentioned above - have

investigated the seroprevalence of brucellosis in small ruminants of Tajikistan, but the geographical areas have not been the same as the topical areas evaluated in this study.

### **Objectives of the study**

1. To investigate the knowledge, attitudes and practices of brucellosis among small ruminates owners in the peri-urban area of Dushanbe.
2. To identify risk factors for brucellosis from the KAP-study by comparing the results to relevant literature.

## **MATERIAL & METHODS**

### **Study population and study area**

This study took place during five weeks in the autumn of 2012 in the peri-urban areas of Dushanbe, Tajikistan. It was undertaken jointly by the author and Ms Isabel Ljung, with important help from the Tajik Agriculture University (TAU), located in Dushanbe. The interview procedures took place concurrently with a seroprevalence study (picture 3), presented by Ljung (2013), whose study included the same 97 animal owners that participated in the KAP study.

The study was conducted in villages situated around Dushanbe, the capital of Tajikistan. No fixed numbers of interviewees or animals (for the seroprevalence study) were set before the start of the study; the plan was instead to conduct as many interviews as possible within the given time frame of five weeks. This time frame was chosen as the field team, during their ten weeks in Tajikistan, also had to conduct the laboratory work regarding the collected blood samples.

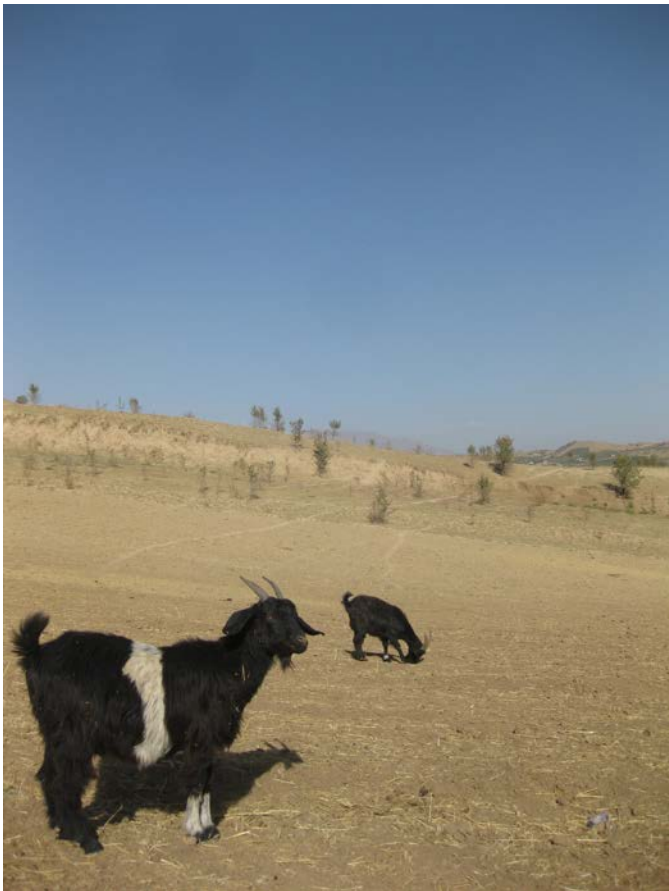


*Picture 4. Sheep of the local fat-tailed Gissar breed. Private photo.*

The smallholders' livestock were, during the time frame of the field study, kept indoors during night-time and grazed collectively with other animals from the village during daytime. Often cattle, sheep, goats as well as dogs and donkeys were mixed at the pastures. All sheep included in the study were of the local fat-tailed Gissar-breed and all goats were also of local breed (picture 4 and 5).

The villages were situated in the four districts that are surrounding the city: Gissar, Rudaki, Vahad and Varzob; and 5-6 villages in every district were visited by the field team. The villages were partially selected randomly and partially by convenience, so that there was an even spread through the city within an approximate radar of 30 km. The current households were selected purely randomly, firsthand, after arrival to the villages. They were all smallholdings, i.e. no state farms were included. An even distribution of households around the city was prioritized in front of collecting numerous interviews within one small geographical area, as it was considered important to avoid bias through misguided sample population. Location coordinates were collected using hand-held global position system (GPS) unit at every village.

In the seroprevalence study that took place concurrently with this KAP-study 908 sheep and goats were considered positive after analyzed with both i-ELISA and c-ELISA, with an overall prevalence of 9.5% (Ljung, 2013).



*Picture 5. Goats of a local breed. Private photo.*



## Study design and data collection

A questionnaire, developed by Lindahl *et al* (2013) with slight modification for small ruminants, consisted of approximately 60 questions, of which 44 were used and interpreted in this study. The parts of the KAP-questionnaire that are interpreted in this study are included as an appendix. The questionnaire was designed to assess the knowledge, attitudes, and practices (KAP) of livestock owners regarding brucellosis in small ruminants. Some questions were open questions which were designed to initiate an accessible discussion, while others were more of a straight forward character, i.e. close questions. Then the questionnaire was translated into Russian and the person in the family responsible for handling the sheep and goats was interviewed orally. All the interviews were conducted by the author with the help from a translator, who spoke Tajik, Russian or Uzbek depending on the farmer's native language.

## Statistical analysis

The data were entered in Excel (Microsoft) and analysed on household level by using descriptive statistics in SAS version 9.2 (Cary NC, USA). Charts were constructed in Word (Microsoft) and in Excel.

## RESULTS

A total of 97 households, in 22 villages, were interviewed. The distribution of households, within the four districts, was as follows: 27 in Varzob, 21 in Rudaki, 23 in Gissar and 26 in Vahdat. Numbers of animals belonging to the households are stated in table 1.

*Table 1. Distribution of owners in relation to their stated quantity of owned sheep, goats or cattle, divided into ranges. \*NB all 97 interviewees owned at least one small ruminant*

Total number of either sheep, goats or cattle owned by each of the 97 households	Interviewees owning sheep N (%)	Interviewees owning goat N (%)	Interviewees owning cattle N (%)
0*	34 (35)	10 (10)	8 (8)
1-2	2 (2)	3 (3)	15 (15)
3-5	16 (16)	19 (20)	41 (42)
6-9	11 (11)	30 (31)	26 (27)
10-20	27 (28)	26 (27)	6 (6)
21-40	5 (5)	8 (8)	0 (0)
41-100	2 (2)	1 (1)	1 (1)
Total:	97 (100)	97 (100)	97 (100)

The percentage distribution of family members mainly responsible for taking care of the small ruminants and assisting, when needed, in lambing and/or calving are shown in figure 1 and 2.

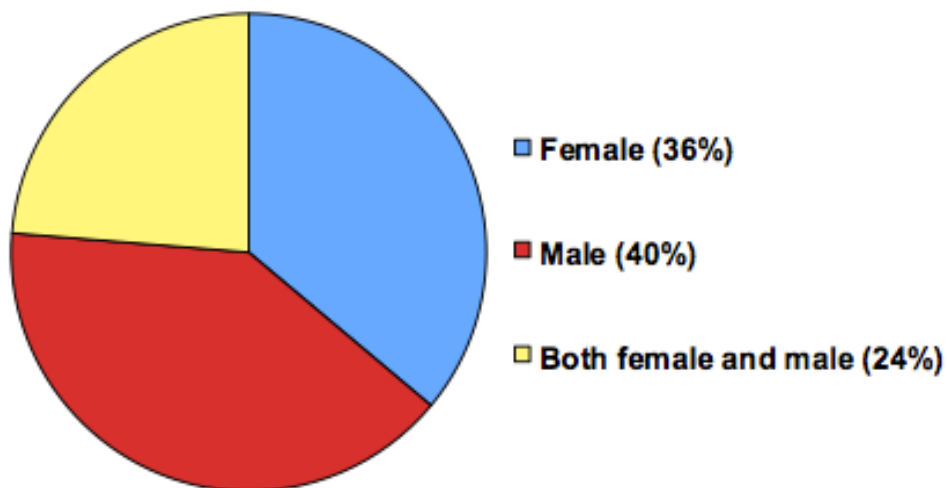


Figure 1. Person(s) in household mainly responsible for taking care of the sheep and the goats.

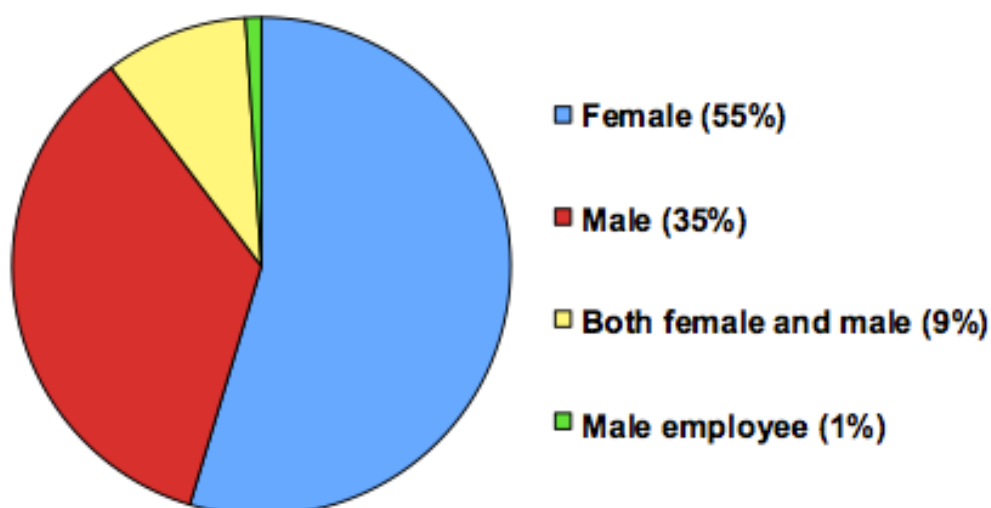


Figure 2. Person(s) in household assisting during lambing and/or calving.

### Stated knowledge of brucellosis

The interviewees were asked if they “had heard of a disease named brucellosis”; 55 (57%) of the owners answered positively, including the seven veterinarians that were among the interviewees. Most of these 55 owners also believed they knew somewhat about brucellosis. Their stated source of information about the disease is shown in figure 3. The more detailed questions concerning brucellosis were only discussed with these 55 owners.

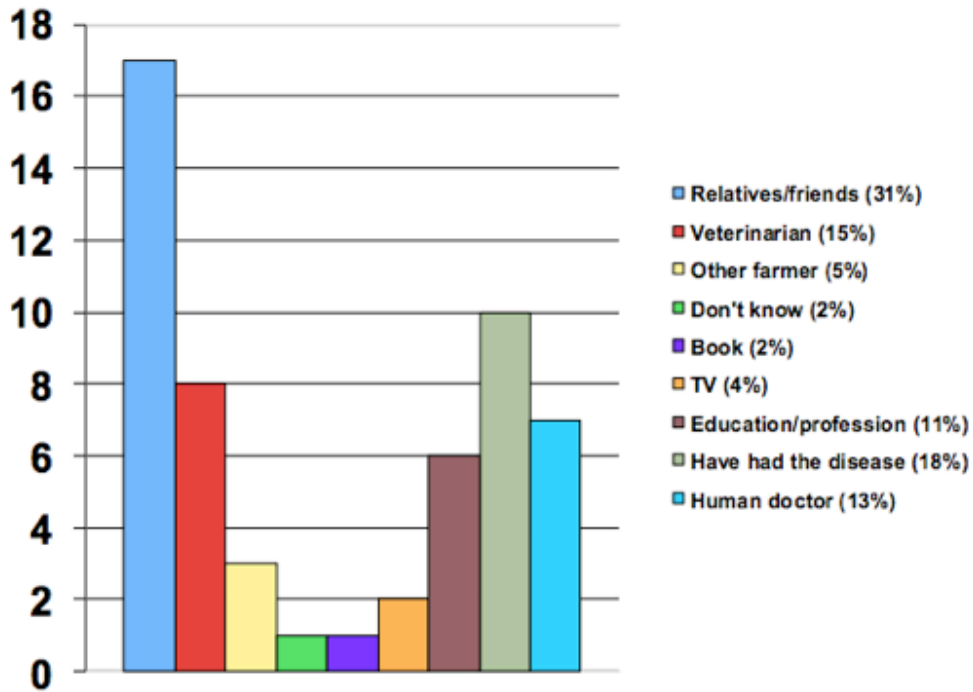


Figure 3. The interviewees' stated source of information regarding brucellosis.

Of the owners with stated awareness of brucellosis, 36 (65%) knew that all animals could be infected with brucellosis, and all 55 knew that brucellosis could infect humans too. Their stated knowledge about how humans can be infected is presented in figure 4

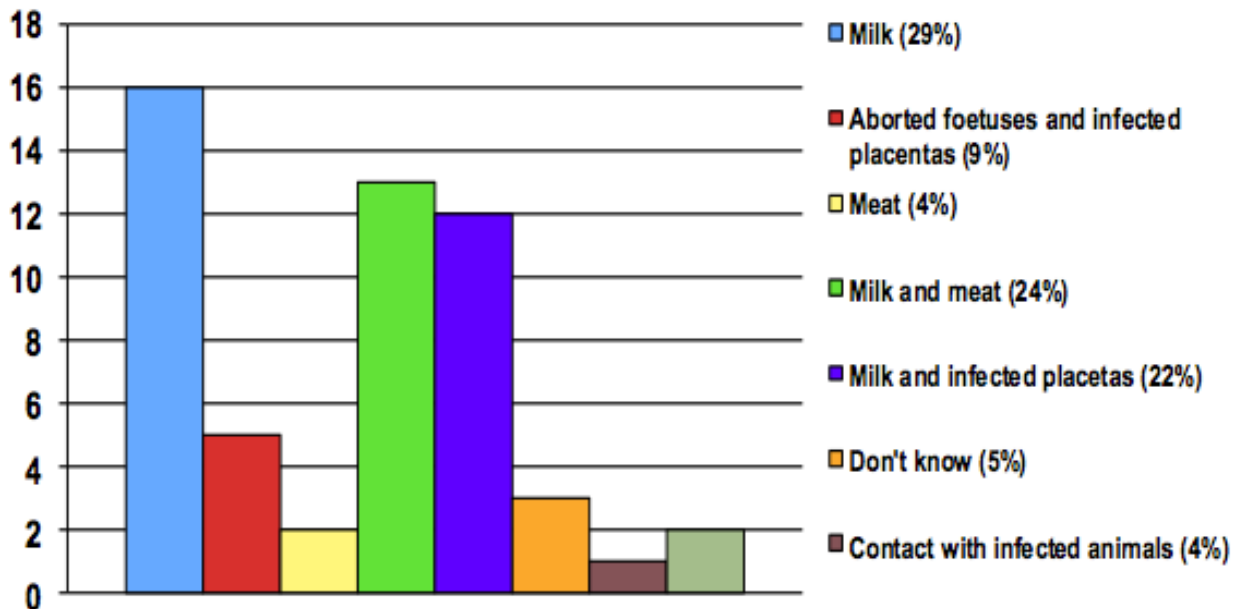


Figure 4. The interviewees' answer regarding how humans can be infected with brucellosis.



Six owners (11%) mentioned abortion as a symptom in animals, and 24 (44%) mentioned fever as part of the clinical picture in humans. The name of brucellosis in Tajik means, roughly translated, “joint ache” (Sattorov, personal message, 2012), 46 (84%) owners mentioned joint ache and/or problems with limbs as a symptom in humans.

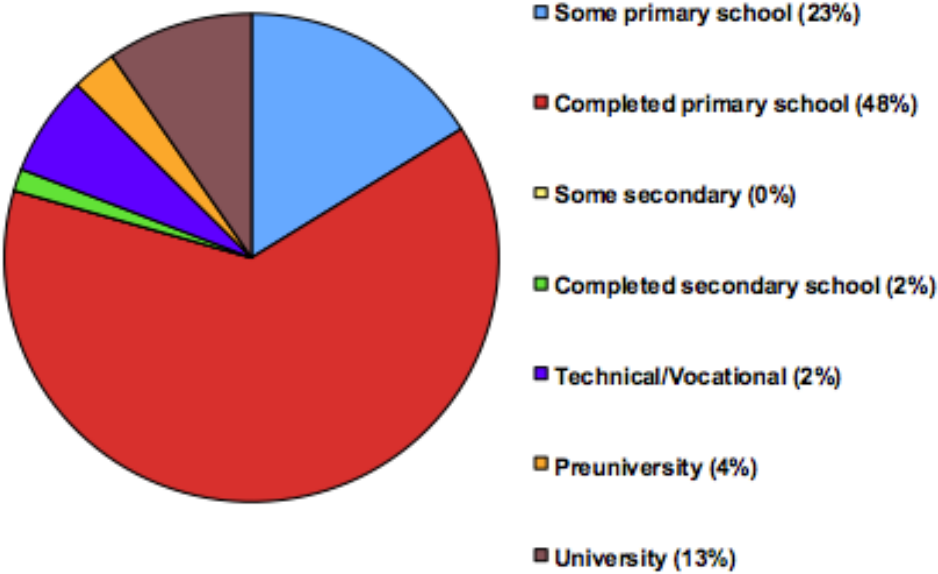


Figure 5. Last grade of formal education completed.

Seventy-nine (82%) of the owners wanted more information about the disease; a majority of those wished to receive this information in writing, preferably in Tajik.

The interviewees' stated last grade of formal education is shown in figure 5.

### Owner's stated attitudes and practice regarding brucellosis

The 97 interviewees' stated behaviour regarding buying and selling livestock is shown in figure 6.

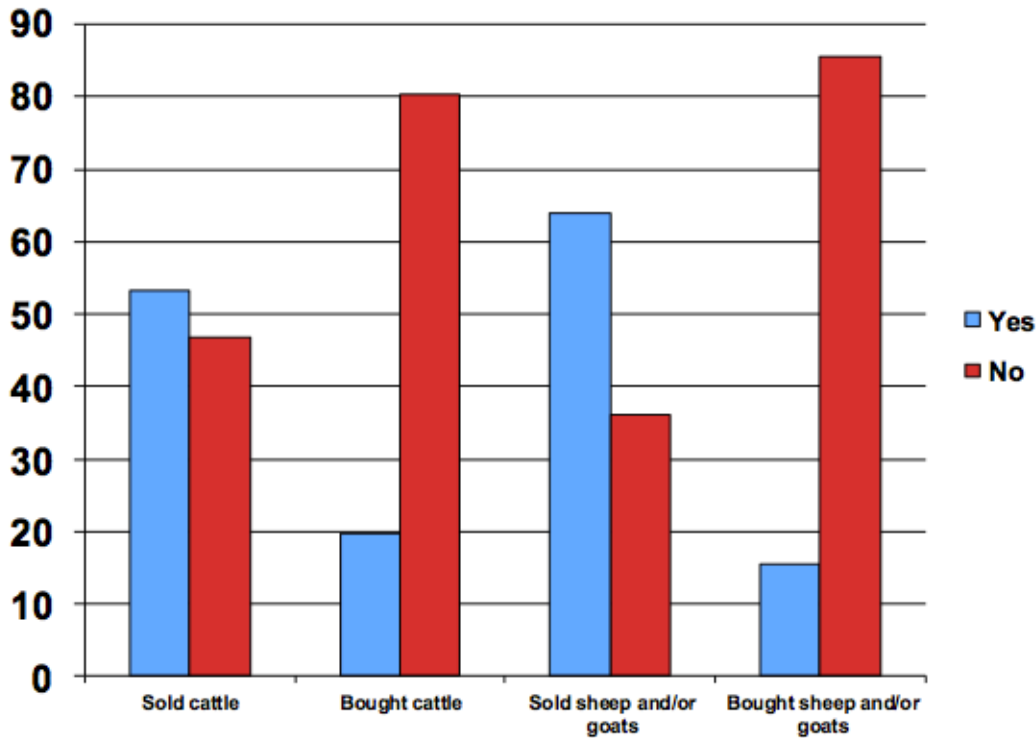


Figure 6. Stated behaviour regarding buying or selling livestock during the last twelve months (answers in percentage).

Regarding drinking unpasteurized milk, 18 (18%) interviewees declared they drank the milk fresh, 23 (24%) that they ate Smetana made out of fresh milk but boiled the milk for drinking and 56 (58%) correspondingly boiled the milk before drinking it and/or made Smetana out of it. Thirty (31%) consumed milk from sheep or goats on a regular basis, whether or not this milk was boiled before consumption was not asked.

When asked if they had had any abortions in livestock lately, 53 owners stated that at least one of their animals had aborted during the last year, further information is found in figure 7.

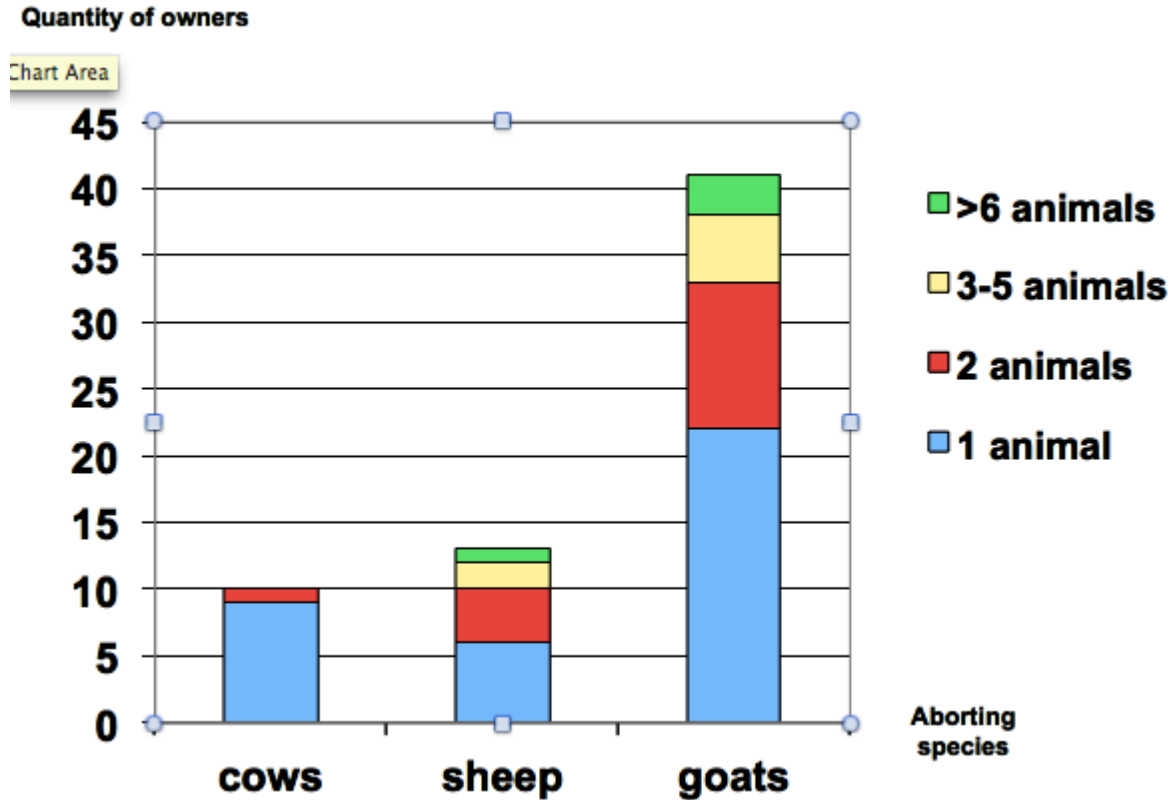


Figure 7. Total number of abortions during the last twelve months.  $n = 53$ , i.e. 55% households altogether, grouped into ranges regarding how many animals of each species that aborted.

Furthermore, 73 (75%) stated that they buried aborted foetuses, 13 (13%) that they gave the material to the dogs and 10 (10%) that they burned it. When asked about protective actions if encountered aborted materials, 58 (60%) stated that they protected themselves from the material through the use of gloves or tools.

## DISCUSSION

### Knowledge of brucellosis

A majority of the owner's stated that they had somewhat knowledge of the disease. However, their knowledge was rather fallible when it came to the clinical picture: very few mentioned abortion in animals (these very few added other random symptoms such as "fever", "lying down" and "joint aches" as well to their answers). One possible explanation to this might be that in a hyperendemic setting, animals may only show subclinical signs such as reduced fertility and lowered milk production and not dramatic abortion storms (Holt *et al*, 2011).

Although, Holt *et al* (2011) draw the conclusion from their study in Egypt that the interviewees' high level of awareness of the disease; e.g. the knowledge of clinical signs or transmission pathways, is consistent with an endemic situation. This, however, is not consistent with the findings in current study; the demonstrated lack of knowledge in the

interviewees was striking. One also ought to bear in mind that high levels of awareness not necessarily go hand in hand with accurate behaviour and practices, as perception of a risk is influenced by many factors, e.g. life experience and culture (FAO, 2010).

In 2009, a study – with a questionnaire included - was carried out in Tajikistan (FAO, 2010). According to the results, 88% of owners had knowledge of brucellosis, 60% knew about symptoms in humans and 28% about ditto in cattle. Hence, somewhat different results compared to the results of current study; as the stated knowledge here was rather fallible regarding clinical signs since. For example, only 44% mentioned fever as part of the clinical picture in humans, and only 11% mentioned abortions as a symptom in animals.

Furthermore, in the current study less than half of those stating knowledge about brucellosis knew that fever was a symptom in humans. Many participants held that fever was something normal one had every now and then, and that it does not have an infectious origin. This is unfortunate, since fever is often the first sign of human brucellosis, meaning that in order to receive quick adequate health care - hence avoiding a chronic incapacitating state of disease - they ought to seek help earlier than when they begin to suffer from chronic joint aches. At this point, the disease is much more difficult to treat (WHO, 2006).

Their knowledge about animal-human transmission was more adequate, which of course is very positive.

### **Risk factors regarding attitudes and practices**

Since brucellosis has a multiple route of transmission (Quinn *et al*, 2002), there are many risk factors for spreading the disease within the animal population, as well as from animals to humans.

In this study, more than 90% of the smallholders owned at least one cattle together with their sheep and/or goats. Further research, such as collecting blood and/or milk samples from the cattle and identification of the *Brucella* species, is needed in order to investigate whether the cattle in the same household as the ones with infected small ruminants are infected with *B melitensis*. As mentioned earlier, *B melitensis* is a particular hazard when it establishes itself in cattle since these animals can shed large numbers of bacteria, both through milk and through abortions or infected births (FAO, 2010). Additionally, more research in the peri-urban area of Dushanbe including collecting blood samples from owner's and characterize, if any, human antibodies, would provide more information whether or not humans are infected and - if so - by which *Brucella* species.

As seen in figure 6, the owners subjected to this study are involved in a fair level of trading, especially through local markets where many animals are mingled. Buying and selling animals is a great hazard as it facilitates transmission between new animals (Jackson *et al*, 2007). A similar concern is the mixed pastures.

More than half of the households had had at least one abortion during the last twelve months. In the study from 2009 (FAO, 2010) sheep and goat owners in Tajikistan reported an abortion rate of ten per cent, and cattle owners reported three per cent correspondingly. Hence, these two studies differ greatly. The author cannot present any good explanation to this. Yet, it was a common scenario while interviewing that the question was asked and a negative answer followed. Then, when the owners were asked again – e.g. with a different formulation – they answered yes. Another common scenario was that the interviewees answered differently - when asked again - when a local authority, e.g. the local veterinarian, was not listening. The author did so consistently as it was very common that the interviewees changed their answer regarding this particular question.

According to the reported results as many as 85% of the owners burned or buried aborted materials. In spite of these results, the author doubted this since abortions can for example occur during grazing where the owners are not nearby. A similar concern regards to the participants willingness to seek veterinary assistance, whether the animals were vaccinated or not and against which diseases. These answers might be unreliable since the interviewees often gave the impression of trying to please the interviewer and the sometimes accompanying local vet, instead of answering truly.

The author observed during the field work that the practice of living close to one's animals is a common feature in Tajikistan, especially during winter, an aspect worth noticing since there are multiple routes of infection to humans (FAO, 2010). The author also noticed that it is a widespread practice in Tajikistan to collect dung for fuel during winter, important to bear in mind in view of the fact that the bacteria can survive in dung for a long time; hence dried dung can import infection to households (Corbel *et al*, 2006)

As seen in figure 5, almost half of the interviewees consume fresh – i.e. not boiled - milk and/or Smetana<sup>2</sup>. This is a serious matter, since consumption of infected milk products is the greatest hazard of contracting brucellosis (Corbel *et al*, 2006). A surprisingly high number, since an earlier study (Jackson *et al*, 2007) states that “scalding of milk is a common practice in Tajikistan”.

Additionally, according to the owner's statements, 40% do not protect themselves properly when dealing with aborted fetuses and/or placentas. There is a risk that the number is even higher, since, as mentioned above, they often gave the impression of trying to please instead of answering truly. This is also a severe issue, as there is a risk of infection by skin contamination if one is not protected properly when dealing with infected aborted materials (Corbel *et al*, 2006).

To sum up, many owners seem to be aware of the risk of contracting the disease through milk, but there seems to be less understanding regarding hazards such as infected placental materials and contaminated Smetana.

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2 Whether or not the milk was from cattle and/or small ruminants was not asked.

Finally, the aims of the study were to investigate the knowledge, attitude and practices regarding brucellosis among smallholders and to identify risk factors from this. It is clear that there is great lack of adequate knowledge among the participating smallholders, following the attitude and practices acted upon this fallible awareness. It is the author's true belief that more education of farmers is needed so they can protect themselves from the exposure as well as reduce the risk of facilitating the transmission and spread of brucellosis.

### **Notable reflections**

None of the 11 interviewees that had had brucellosis in the family had neither received proper medical care nor information from the doctor concerning how and where they could have contracted the disease. Five of these 11 families had been informed that they could have been contaminated from infected milk or meat, but none of the 11 families knew about the risk of contracting the disease from infected placenta-material.

Interestingly, only two of the interviewed owners had heard of the national control programme. The FAO supported NBCP is regarded as an example of a successful control strategy (Ward *et al*, 2012). This difference between farmers and authorities might be yet another indication that information concerning animal and human health issues does not reach out to smallholders.

Whether the households owned a dog or not was not asked when conducting the study. However the author noted that the custom of having dogs running around the smallholding was very common, worth mentioning since dogs can acquire infection with other *Brucella* species by ingesting aborted fetuses and/or placental material and thereafter infect humans and domestic livestock (Corbel *et al*, 2006).

Another question that ought to have been included in the study was whether or not the owners isolated animals if case of an abortion. However, none of the interviewed owners mentioned that they isolate animals if they abort. This matter should have been asked during the interviews, as isolation is an important prophylactic measure since animals can shed vast amount of bacteria in their vaginal discharges weeks after abortions (FAO, 2010).

### **CONCLUSIONS**

Given the commonly observed high seroprevalence (Jackson *et al* 2007; Ljung, 2013), and the stated, as well as noted, practices of smallholders there is a high risk of exposure of *Brucella* spp. for the people of Tajikistan, both through the consumption of infected milk products<sup>3</sup> as well as through farmer's practices. In order to protect human health, what must be achieved is control over the disease situation in the animal reservoir.

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<sup>3</sup> It is more common in Tajikistan to use milk from cattle than milk from small ruminants. It was not specifically asked in this study from which species the milk they used (and did or did not boil) came from. Current study is mainly about *B melitensis* in small ruminants. However, as mentioned earlier, cattle can be infected with *B melitensis* as well and then shed large amount of bacteria. Hence, it is therefore a risk factor to drink unpasteurized cattle milk if the cattle have co-mingled with small ruminants that are shedding *B melitensis*.

Unfortunately, as the results from this KAP-study show, the knowledge among animal farmers in Tajikistan about brucellosis is very inadequate. It is necessary with more education, both when it comes to how to avoid the disease and how to recognize it. The results also demonstrate that it is important, in order to successfully battle this endemic disease, to survey local customs, beliefs and traditions since this obviously can contribute to disease transmission.

Hence, further research is needed on the subject; a greater geographical area - including more animals tested and more owners interviewed - is necessary for providing results and facts on the eve of a presumable continued and improved national control programme.

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smallholders, followed by the attitude and practices acted upon this fallible awareness. A better education of farmers is needed so they can protect themselves from the exposure as well as reduce the risk of facilitating the transmission and spread of brucellosis.

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