Animal welfare assessment of dual-purpose cattle in Mexico – with focus on health and behaviour

Bedömning av djurvälfärd hos nötkreatur i kombinerad mjölk- och köttproduktion i Mexiko – med fokus på hälsa och beteende

Linnea Edstam

Uppsala 2016

Agronomprogrammet husdjur

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Linnea Edstam

Studentarbete, Uppsala 2016

Sveriges Lantbruksuniversitet
Fakulteten för Veterinärmedicin och Husdjursvetenskap
Institutionen för husdjurens miljö och hälsa
Box 234, 532 23 SKARA
E-post: hmh@slu.se, **Websida:** www.slu.se/husdjurmiljohalsa

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1 SUMMARY

Chiapas is the poorest state of Mexico located southeast, with a hot and humid tropical climate and daily socio-economic challenges in rural conditions. The main cattle production system found is extensive dual-purpose production, producing both milk and meat. Society is getting increasingly aware of the ethical treatment of animals, with a growing concern about animal welfare and its importance in the production. Animal welfare assessments on farms are required to enable identification of any areas necessary of improvement and to inform the farm owner about the welfare status on their farm. Strategies for improving animal welfare can thereafter be implemented in order to improve the quality of animal production and its products. This study carried out welfare assessments on 34 farms, located in San Pedro Buena Vista, Chiapas. A modified welfare quality (MWQ) protocol from the Welfare Quality® Assessment protocol for cattle was used, adapted to the extensive production systems in the tropics. The Welfare Quality® protocol bases on the Five Freedoms and consists of the welfare principles "good feeding", "good housing", "good health" and "appropriate behaviour". This study focuses on "good health" and "appropriate behaviour". The main findings were that "absence of disease" and "absence of pain induced by management procedures" were areas that required improvements to achieve a better animal welfare. These criteria are also significantly positively correlating (r = 0.44, p = 0.0007). All farms (100 %) acquired a mean value (MV) score above the minimum score for improved level (>60.0) in relation to all eleven welfare criteria of the total study, where 100 was the maximum score. According to the seven criteria of health and behaviour, four of these had a MV above excellent level (>80.0), one criteria a MV just below excellent (80) and two criteria a MV of acceptable (>20.0). A total of 19 farms (56 %) scored above acceptable level (>20.0) in all seven welfare criteria, and two farms (6 %) scored not classified (<20.0) in two welfare criteria each. The welfare criteria "expression of other behaviours" and "good human-animal relationship" acquired the highest scores of animal welfare. The behaviour was good according to the protocol and the animals appeared to be healthy and prosperous. A total of 2031 animals were included in this study, with 782 cows (39 %) in milking production at the time. Of these 782 cows, only 8 cows (1 %; divided on six farms) were lame, 8 cows (1 %) had visible signs of mild integument lesions and 13 cows (2 %) had severe integument lesions. This indicates a major benefit for animals in these types of systems mainly kept on pasture and little concrete, with advantages of soft natural impact of the legs and hoofs decreasing the risks of lameness. Despite the outdoor management and lack of hygiene there were few injuries of the animals, indicating that these extensive systems on pasture provides a standard with good animal welfare. The animals were mainly kept on extensive pasture together, both cows, calves and bulls. Due to this united management, an extended study was carried out after assessing thirteen farms, with maternal and sexual behaviour and interactions between calves. This study presented a major maternal behaviour, being one of the natural behaviour of the cow if given the opportunity and since the calves often were young. Also, suckling cows decreases the risk of mastitis hence the cleaning of the teats, concluding that suckling cows are the future for intensive systems. Further improvements of the MWQ protocol are required and future studies should focus on health care management to improve "good health". It is also important to provide knowledge or motivation to the farmers to enable improvement of their animal welfare, and to find alternative management practices that has economical potential to increase their productivity. To improve the social interaction and health it would be beneficial to let the cow spend more time with the calf during longer periods or all day.

2 SAMMANFATTNING

Chiapas är den fattigaste staten i sydöstra Mexiko, med ett varmt och fuktigt tropiskt klimat och dagliga socioekonomiska utmaningar på landsbygden. Den huvudsakliga nötkreatursproduktionen är extensiv med djur producerandes både mjölk och kött. I takt med att allmänheten blir mer och mer medveten om det etiska perspektivet till hur djur behandlas, sker ett ökat engagemang för djurvälfärden och dess betydelse i produktionen. Bedömning av djurvälfärd på gårdar är nödvändigt för att kunna informera djurhållaren om välfärdsstatusen på dennes gård, och för att kunna identifiera områden nödvändiga för förbättring. Strategier för förbättring av djurvälfärd kan därefter implementeras för att kunna förbättra kvaliteten i djurproduktionen och dess produkter. Denna studie utförde bedömning av djurvälfärd på 34 gårdar i San Pedro Buena Vista, med hjälp av ett modifierat protokoll för djurvälfärd (MWQ protokoll) utifrån Welfare Quality® protokoll för nötkreatur, anpassat till extensiva system i tropikerna. Protokollet från Welfare Quality® baseras på de fem friheterna från Farm Animal Welfare Council (EU) och består av välfärdsprinciperna "god utfodring", "god inhysning", "god hälsa" och "lämpligt beteende". Den här studien fokuserar på "god hälsa" och "lämpligt beteende". De huvudsakliga upptäckterna var att "frånvaro av sjukdom" och "frånvaro av smärta inducerat av behandlingsprocedurer" var i behov av förbättring för att kunna uppnå en bättre djurvälfärd. Dessa kriterier var också signifikant positivt korrelerande (r = 0.44, p = 0.0007). Alla gårdar uppnådde ett medelvärde (MV) över minimumgränsen för förbättrad nivå (>60.0) i alla elva välfärdskriterier i den totala studien, där 100 var maximumpoäng. Gällande de sju kriterierna för hälsa och beteende uppnådde fyra av dessa ett MV över utmärkt (>80.0), ett kriterium ett MV precis under utmärkt (80) och två kriterier ett acceptabelt MV (>20.0). Totalt 19 gårdar (56 %) uppnådde poäng över acceptabelt (>20.0) i alla sju välfärdskriterier, medan två gårdar (6 %) inte uppnådde gränsen för acceptabelt (<20.1) i två välfärdskriterier var. Välfärdskriterierna "uttryck av andra beteenden" och "god relation mellan djur-människa" fick högst poäng för god djurvälfärd. Beteendet var generellt bra enligt protokollet och djuren bedömdes vara friska och välmående. Totalt 2031 nötkreatur ingick i studien, varav 782 kor (39 %) i mjölkproduktion vid tidpunkten då studien utfördes. Av dessa 782 mjölkkor var det endast 8 kor (1 %; uppdelat på sex gårdar) som var halta under bedömningarna, 8 kor (1 %) med synliga hudsår och 13 kor (2 %) med allvarliga hudsår. Det indikerar att nötkreatur i dessa typer av system huvudsakligen hållna på bete och liten del betong har en mjuk och naturlig inverkan på ben och klövar, vilket minskar risken för hälta. Trots djurhållning utomhus och brist på hygien var det få skador på djuren, vilket indikerar att dessa extensiva system på bete innebär en standard av god djurvälfärd. Dikor har också en minskad risk för mastit genom att kalven rengör spenarna, vilket ger slutsatsen att dikor är framtiden för intensiva system. Det behövs vidare förbättringar av MWQ-protokollet och ytterligare studier bör fokusera på förebyggande djurvård för att kunna förbättra "god hälsa". Det är viktigt att sprida kunskap eller motivation till lantbrukarna för att möjliggöra förbättring av deras djurvälfärd, samt att hitta alternativ djurskötsel med ekonomisk vinning för att kunna öka deras produktivitet. För att kunna förbättra social interaktion och hälsa vore det fördelaktigt att låta kon spendera mer tid med sin kalv under längre perioder eller hela dagen.

3 INTRODUCTION

Today, the concept of animal welfare is being established globally and it is becoming more important. Modern society is getting increasingly aware of the ethical aspects in animal husbandry, demanding that this should be included to an extended level (Smith & Brower, 2012). For example, many consumers want information about the origin of the product and inclusion of additives or not (such as hormones or antibiotics; Rigby & Cáceres, 2001). Animal welfare is directly and indirectly linked to the quality of animal products, and an engagement is spreading all over the world regarding this topic.

A limited number of studies have previously been grasping the full approach of animal welfare assessments during lowland tropical conditions (Orihuela, 1990; Eriksson, 2016; Hernández *et al.*, in prep). In these tropical regions, it is common with extensive system farms and animals kept on pasture. It is challenging seasons with various dryer periods and shortage of feed, increasing the risk of affecting the health and production of the animals. Evaluations of animal welfare in the rural tropics could answer some of the questions regarding animal welfare, which could affect their economy as animals in adequate conditions tend to perform better. Therefore, an area with an extensive production system that was available for assessment was required to conduct this study.

3.1 Agriculture in Chiapas

Mexico is a developing country, with varying climates and production systems from highly intensive to rural extensive, and Chiapas is the poorest state in the country (Gutierrez-Jimenez *et al.*, 2013). The state of Chiapas is classified as hot and humid with a marked dry season (INEGI, 2011). The local climate alters the seasonal agriculture and there are two marked seasons, one dry affecting crop production and the rainy season where fodder is more readily available (Sánchez-Cortés & Chavero, 2011), as livestock production is a pillar in the rural economy (Jiménez Ferrer *et al.*, 2003). Cattle production exist in all climate zones and regions of Mexico; the country is one of the ten largest cattle producing countries in the world. Family farming is considered essential among the extensive rural system areas (Rojo-Rubio *et al.*, 2009). There are few innovations, improvements, modern equipment and production systems in these areas (Nahed *et al.*, 2011).

The majority of subtropical areas like Chiapas use crossbreeds with *Bos indicus* (maternal line) and *Bos taurus* (paternal line), conforming a well-adapted cattle breed for the climate and production in this sites (Rojo-Rubio *et al.*, 2009; Delgado *et al.*, 2012). The farms are often small-scale with an average of 14 to 26 milking cows, milked once per day and kept on pasture (Nahed-Toral *et al.*, 2013). Most of the farms apply manual milking, using the technique "rejegueriá". This is a well-adapted milking technique in the tropics of Mexico, stimulating the milk let down by letting the calf suckle for two to three minutes before the milking procedure (Ortiz, 1982; Nahed-Toral *et al.*, 2013). Suckle cows of *Bos indicus* have been found to increase their milk yield by physical contact and suckling by their calf (Orihuela, 1990).

The extensive cattle management system in tropical Latin America is based primarily on extensive monocultures of grass, poorly suited to the region (Murgueitio *et al.*, 2011). The artificial grasslands have a low nutritional value and productivity that is degraded as a result of overgrazing (Szott *et al.*, 2000). During the dry season, the shortage of feed is a major issue and livestock is allowed to graze on larger areas of land or is given increased amounts of feed supplements when available (Szott *et al.*, 2000).

Nahed-Toral *et al.* (2013) studied 75 cattle farms in Tecpatan, Chiapas, with insufficient results in disease prevention and veterinary care, on average, only 31 % reached the favourable level. This showed a major issue as the farms are not able to prevent diseases or hire veterinarians to cure the animals if required. A modified OLPI (Organic Livestock Proximity Index) methodology system was applied for measuring animal welfare indicators (Mena *et al.*, 2011). The study showed that 80 % of the farms reached the favourable level of accepted welfare. In 100 % of the farms, cattle were shown to be free of brucellosis (plate agglutation test) and tuberculosis (bovine tuberculin test), although a few animals were seropositive and hence eliminated. All of the farms showed deficiencies and the data suggest a necessity of improvement in veterinarian care and a strict hygiene control in the milking parlour, equipment, the actual milking and milk management (Nahed-Toral *et al.*, 2013).

3.1.1 Socio-economics in Chiapas

Being the poorest state of Mexico (Gutierrez-Jimenez *et al.*, 2013), Chiapas is facing challenges of subsistence agriculture in extensive production systems at a daily basis. A majority (76 %) of the inhabitants in Chiapas lives in poverty, whereof 32 % lives in extreme poverty, with deficiencies in economic and socioeconomic assets (CONEVAL, 2014). This might reflect in social well-being (Gutierrez-Jimenez *et al.*, 2013) and difficulties with networking, due to lack of proper roads, vehicles, Internet or isolation, as well as the social development situation causing larger social gaps in the population (Reyes *et al.*, 2012).

Introduction of new methods in animal husbandry is always in balance between the new and the old traditions among the farmers in Chiapas (Bellon & Hellin, 2011). An anti-poverty program created by the federal government, along with empowerment of women, reflects the growing prosperity in the state. The farmers are interdependent and their production is influenced by consumer demands, cultural preferences and rural markets (Bellon & Hellin, 2011). A common resource is family or hired labour, often performing or helping with the milking and management (Nahed *et al.*, 2011).

3.2 Animal welfare

Animal welfare is part of sustainability (Broom, 2010) and it is considered a characteristic of an individual animal (Welfare Quality®, 2009). Animal welfare is an essential part of the animal (Broom, 2010). It is an aspect of the society's decisions whether animal husbandry systems are sustainable, and systems with poor welfare being unsustainable due to unacceptance among people. The quality of animal products is weighted with production ethics, as well as the impact on the animal welfare that the consumer may be able to affect by its choice of products. Also, breeding for genetic selection and management searching for a higher productivity may cause further diseases generating a poorer welfare (Broom, 2010).

Welfare is a term applied to physical and psychological health, including among other aspects ability to perform natural behaviours, physical comfort and absence of hunger or disease (Welfare Quality®, 2009). Animal welfare consists of three factors of an animal; emotional state, biological function and ability to show normal behaviour (Manteca *et al.*, 2009). However, the minimum level of acceptable welfare is not globally established (Phillips, 2002), and the different opinions of the significance of animal welfare may vary among humans (Animal Welfare®, 2009) and among cultures.

3.2.1 The Five Freedoms

The Five Freedoms is a definition of ideal conditions of animal welfare to be considered as acceptable, originally developed by Brambell (1965) and later established by the British Government (Farm Animal Welfare Council, 2009). Provision of the five factors to farm animals play a key role for good animal welfare (Webster, 2005).

1. Freedom from hunger and thirst – by ready access to fresh water and a diet to maintain full health and vigour.
2. Freedom from discomfort – by providing an appropriate environment including shelter and a comfortable resting area.
3. Freedom from pain, injury or disease – by prevention or rapid diagnosis and treatment.
4. Freedom to express normal behaviour – by providing sufficient space, proper facilities and company of the animal's own kind.
5. Freedom from fear and distress – by ensuring conditions and treatment to avoid mental suffering.

3.2.2 Health

A good health is crucial for a sustainable production (Gonzalez-Recio *et al.*, 2014). Sick animals cannot use nutrients efficiently and this will decrease the profit of the farm (Connor, 2015). However, the non-economic value of health traits should also be considered as consumers demand also socio-ethical aspects of animal welfare and product quality (Blokhuis, 2008; Hietala *et al.*, 2014).

One of the major issues in cattle production in developed countries is clinical mastitis (Hinrichs *et al.*, 2005), being the primary cause of culling (Shim *et al.*, 2004). However, in dual-purpose cattle in the tropics, suckler cows of *Bos indicus/Bos taurus* have improved the udder health with restricted suckling by calves (Fröberg *et al.*, 2007). By using the calves to clean the mammary gland whilst suckling it has shown an improved emptying of the udder, as well as inhibitors in the saliva of the calf, contributing to a bacteriostatic cleaning effect of the teats as a natural process (Mejia *et al.*, 1998). The udder is a problem in dairy cattle production if it affects the locomotion, comfort when resting or health. If it affects the fitness of the cow, leg and locomotion problems often follows, with correlated problems as housing, feed, management and genetic traits (Algers *et al.*, 2009).

Hoof disorders are common in cattle production, mainly caused by concrete flooring (Somers *et al.*, 2003). Lameness is considered a major economic and welfare issue (Broom, 2002) and is often associated with concrete flooring (Cook *et al.*, 2004; Bruijnis *et al.*, 2012). Standing and walking for long periods on concrete floors, or wet floors covered with manure, could cause severe health issues (Ahrens *et al.*, 2011). Altered or slow movement when lying down may also be signs of lameness or injury, or signs of a poor floor construction (Cook *et al.*, 2004; Bruijnis *et al.*, 2012). The living conditions of a cow affect the standing, walking and lying comfort (Ahrens *et al.*, 2011). If the cow is lame, there is an increased risk of getting a low body condition score, reduced fertility, mastitis or a metabolic disease, according to an EFSA report (Algers *et al.*, 2009). Lameness, productivity and mastitis is also associated with high producing dairy cows (Koeck *et al.*, 2013).

However, in systems with pasture or straw-yards these problems are minimal in cattle raised under semi intensive conditions (Algers *et al.*, 2009). Pasture has shown to improve the recovery of hoof and leg injuries (Hernandez-Mendo *et al.*, 2008). Straw-yards in intensive

systems have shown significantly lower numbers of hoof health disorders (55-60 %), compared to concrete flooring (80 %; Somers *et al.*, 2003). Sand stalls in dairy cattle herds have also shown improvements of leg and hoof health injuries (Norring *et al.*, 2008). The space allowance has proven to be significant for the health, reported in the EFSA report (Algers *et al.*, 2009), contributing if sufficient to a lower risk of injuries and lameness (Gygax *et al.*, 2007). Hoof-trimming is performed regularly in intensive production systems managed on concrete floors to lower the risk of lameness and to improve the welfare (Ahrens *et al.*, 2011; Bruijnis *et al.*, 2012). Hoof trimming is rarely performed in extensive systems where the animals mainly are kept on pasture with a natural hoof trimming (Algers *et al.*, 2009). Procedures as dehorning (removal of horn), disbudding (prevention of horn growth) and hot iron branding without analgesia or anaesthesia are considered very painful to the animal (Stafford & Mellor, 2011), as well as castration with insufficient analgesia or anaesthesia (Vasseur *et al.*, 2010), affecting the animal welfare negatively (Webster, 2005). The pain caused by dehorning or disbudding may be assessed by behavioural, physiological or production factors. Dehorning implies amputating of the horn, and disbudding can be carried out by cautery or chemical paste.

An animal who is given too little or inadequate feed ration may get a low body condition, affecting the health negatively (without sufficient nutrition) and may cause a very thin and unhealthy animal (Bennett *et al.*, 2006). Body condition score can also effect the welfare, health, reproduction and productivity (Roche *et al.*, 2009).

3.2.3 Behaviour

The basic behaviour patterns in contemporary cattle of today are expected to be similar to their wild ancestors, indicating a low impact of genetic selection on behaviour (Phillips, 2002). The social organisation of cattle behaviour is dominance hierarchy (Šárová *et al.*, 2013), contributing to dominance or submission by established and maintained "pecking-order" among animals in a herd (Price, 2008). Considering natural animal behaviour, intensive systems may inherently involve problems to achieve actual necessities (Phillips, 2002), such as insufficient space allowance with stress inducement (Hickey *et al.*, 2003). The space allowance has proven to be significant for the behaviour and welfare of cattle in intensive systems (Cozzi *et al.*, 2009), contributing sufficiently to decrease aggression and competition (Algers *et al.*, 2009). Cows who are aggressive towards other cows are a potential high risk of poor animal welfare in a herd (Le Neindre *et al.*, 2002). Increased space allowance has also been shown to increase the lying behaviour, with increased time of lying in an outstretched position and more lying movements (Gygax *et al.*, 2007).

Lameness is considered as one of the major causes of culling, affecting the animal welfare by pain and discomfort (Garbarino *et al.*, 2004). The living conditions for a lame cow may affect the avoidance behaviour, with risks of adopting a major subordinate behaviour in the herd. This may affect the feed intake of a lame cow if the feed access is being neglected by other animals (Algers *et al.*, 2009). A sick cow may also present a subordinate depressed behaviour, or other behaviour signals about her health and welfare. By assessing behaviour, posture and body language the cow signals may reflect the well-being and welfare of the animals (Hulsen, 2013).

One of the primary instincts of cows is maternal behaviour with its own calf; licking, nursing calf, bonding, vocalizing, and aggressiveness towards other calves (Loberg & Lidfors, 2001; von Keyserlingk & Weary, 2007). Suckling and nursing have been found to reduce stress parameters (i.e. lowering the cortisol levels) in cows and calves in artificial rearing in dual-

purpose cattle in the tropics, with significantly higher stress levels in the cows (serum cortisol concentrations) compared to restricted suckling in extensive production (Hernández *et al.*, 2006). Dairy cattle production usually includes neglecting maternal behaviour, with removal of the calf within the first 24 hours, to ensure a higher level of milk production. A change in consumer demands and society awareness have increased the commitment to maternal behaviour in dairy systems, requesting an increased global organic production (von Keyserlingk & Weary, 2007) where slightly more emphasis is put on cow-calf interaction and contact.

3.3 Animal welfare assessment

To be able to improve animal welfare it is important to have an assessment tool that is reliable and possible to use repeatedly in a certain area (Webster, 2013). Family farming is still the main income in emerging economies in the tropical regions of the world (González-Garcia *et al.*, 2012). There is a common belief of unethical treatment of animals in rural dual-purpose farms, where village inhabitants often are being employees. To examine the current status of these farms and to estimate the animal welfare and be able to make necessary improvements, further research is required (Hernández *et al*., in prep). One approach is to measure the quality of the farms using a standardized animal welfare protocol, evaluating the current situation in a small society with dual-purpose production systems in the tropics.

Increasing consumer awareness along with society concerns of animal welfare, created the start-up of the Welfare Quality® project in 2004, funded by the European Commission (EU). Primarily animal-based on-farm animal welfare assessment protocols were in focus of the development, including one for dairy cattle. The Welfare Quality® project (2009) developed their four welfare principles from the Five Freedoms. The welfare quality system involves four basic areas of concern; "good feeding", "good housing", "good health" and "appropriate behaviour". The purpose of the system is to identify strengths and weaknesses in animal management, and to improve welfare by developing strategies (Blokhuis, 2008).

The Welfare Quality® Assessment Protocol includes uniform standards with defined characteristics of animal welfare. With the Welfare Quality® protocol, and other protocols, consumers will get an opportunity to choose products that have had an emphasis on animal welfare (European Commission, 2006; Blokhuis, 2008). The cattle welfare assessment protocol has been used in several scientific studies with European climate and conditions, mainly on larger commercial farms based on seasonal grazing or indoor housing all year with no grazing opportunities (Knierim *et al.*, 2009; Andreasen *et al.*, 2013; Popescu *et al.*, 2013).

A definition of "a healthy animal" has been established by the principles and criteria of the Welfare Quality® Assessment Protocol; including "absence of injuries", "absence of disease" and "absence of pain induced by management procedures". Injuries may, for example, include integument alterations, and disease may contribute to coughing, nasal discharges or diarrhea (Welfare Quality®, 2009). The definition of an animal performing an appropriate behaviour was also established by the principles and criteria of the Welfare Quality® Assessment Protocol. These criteria include "expression of social behaviours" and "expression of other behaviours", "good human-animal relationship" and "positive emotional state". The term of appropriate animal behaviour reflects the qualification of an optimized emotional state. Probably a suitable way to assess animal welfare in the rural tropics is to implement the Welfare Quality scale (The Welfare Quality® Assessment

Protocol), with possible modifications to a small scale extensive production (Welfare Quality®, 2009).

3.4 Vision of improvement

Mexico has set a goal to improve the animal welfare in their animal husbandry (CONEVAL, 2016). The long-term goal is to create a system that can evaluate the animal welfare of dual-purpose cattle, which is of importance for Mexico from a sustainability point of view. This could be achieved by presenting an impartial study of Mexico's animal welfare level of the farms, as well as identifying areas where improvements may be made. This may strengthen and improve the total image of Mexico as a country (CONEVAL, 2016) and its animal welfare.

This study is part of a project aiming to improve the extensive dual-purpose cattle production in Mexico. A sustainable solution involves the animal welfare aspect; hence, the project aims to present sufficient care and animal welfare of the production systems at the farms applied. This study and further research could be a future answer to a global introduction of this rural production system, as well as enable global improvements for a sustainable production.

3.5 Aim

This study is part of a project aiming to strengthen extensive production systems of dual-purpose cattle in Mexico, and present a proper management and good animal welfare. A future ambition is that this may be useful to globally strengthen the production system.

The specific study presented in this MSc thesis aims to assess the animal welfare, according to "good health" and "appropriate behaviour" from Welfare Quality® (2009), in dual-purpose cattle herds in the tropics of Chiapas, Mexico. Specific questions are health of the herds; in general, the situation of injuries, diseases and in relation to management. Also, behavior; if the herds show abnormal behaviours or seem calm due to the outdoor management on pasture, as well as the impact of keeping cows, bulls and calves together. Knowledge and management are important questions, i.e. if it is sufficient to acquire good animal welfare. Furthermore, societal factors are taken into account in order to assess the factors affecting the animal welfare and any necessary improvements.

4 MATERIAL & METHODS

The study was performed on 34 dual-purpose extensive system farms located in the area of San Pedro Buena Vista, Villa Corzo municipality, in the southern state Chiapas of Mexico (15°47' N and -92°29' W). The study was carried out from the 30th of June to the 23rd of July 2015 during the rainy season, with hot and sub-humid climate and summer rainfall. The temperature varied from 20-31°C and the humidity was on average 86 %.

The assessment was carried out together with Sofie Eriksson (master student in animal science, Swedish University of Agricultural Sciences, Uppsala, Sweden) who was focusing on housing and feeding. Also, Adalinda Hernández (MSc, veterinarian, Universidad Nacional Autónoma de México, Mexico City, Mexico) was modifying and evaluating the assessment process. Juan Castañeda Javier (veterinary student, Universidad Autónoma de Chiapas, Chiapas, Mexico) helped with the interviews at the farms and as a driver to the farms.

4.1 Farms

The farms studied in San Pedro Buena Vista belong to a rural production association society coordinating for example animal markets, farmer meetings, milk collecting vehicles and milk and cheese dairies. Most of the farms had no access to paved roads or roads in good condition, electricity or running water. The primary focus on all farms was milk production. Most of the produced milk was delivered to a local cheese factory.

The animal welfare assessments were performed once in each farm. Each assessment took 2-3 hours and was carried out between 7 to 12 am. The minimum and maximum temperature and average humidity were noted each day from an iPhone app, and was added to the data protocol. The assessments were made at the farms during morning milking in the milking parlour, and at pasture after milking.

Image 1. Typical milking pen with cow and calf tied up beside each other while the cow is being milked.

During morning milking, the cows received supplementary feed, without exact calculations of provided amount, consisting of chicken litter, ground corn and dry grass. The calves were often allowed to suckle before and after the milking. Milking took approximately two hours in each farm. In some farms, cows and calves were kept together all day, and in some farms also at night. In most farms the cows and calves were also kept together with one or two bulls.

Image 2. Cows assessed on pasture.

Only two farms used milking machines. After milking, the cows, calves and bulls were often let out on grass pasture until the next morning milking, since most of the farms only milked once per day.

The cows at the farms were generally crossbreeds (*Bos taurus* x *Bos indicus*), 3 to 10 years old, and the calves were approximately one day old up to six months of age. The herd sizes to assess varied from 7 to 90 cows per farm, approximately 2/3 of the farms within the range 15 to 35 cows. Male calves were sold for fattening and old cows in low subpar milk production were slaughtered for meat on the local market.

Image 3. Cows, calves and a bull (and a horse).

4.2 Structured interviews

An interview protocol (Appendix A) was developed and used during the farm studies (Hernández, 2015). The interviews were made by the two Mexican members of the team. Due to the valuable project cooperation with the farmers in the study for the future, the interviewers required a nice non-judgemental open-minded approach to make the interviewers feel comfortable.

Image 4. Cows milked by a De Laval machine.

The interviews were performed face-to-face at the farms. The interviews were primarily made with the farm owner, but sometimes were made with the employed workers. A brief presentation of the assessor and the interviewer, together with information of the study and its purpose was given before the interview and the assessment started. During the interviews, the farmers answered questions about management practises and health conditions of the cows.

4.3 Animal welfare assessments

The Welfare Quality® Assessment Protocol was modified in advance to accommodate small-scale dual-purpose herds in tropical climates (Appendix B). The welfare criteria not suited to the production system were excluded, for example "absence of infrastructure" (no indoor housing) that may cause injuries, serial testing of mastitis (California Mastitis Test) related to udder health, hence the lack of adequate infrastructure, and "thermal comfort", not fully developed yet in the WQ® protocol. Factors included in the MWQ protocol were for example; ear tagging, hot iron branding and oxytocin injections intramuscularly before milking (according to the criteria "absence of pain induced by management procedures"). Also, a livestock crush or other designs for management procedures as deworming or vaccination were added in the MWQ protocol.

Other criteria that were included in the MWQ protocol but not observed at any farm were for example "animals colliding with housing equipment", "lying outside the lying area", tail docking and castration. The behaviour was primarily assessed at pasture hence the assessed herds mainly were kept at pasture, and this was measured as one section.

The two Swedish members of the team and the Mexican veterinarian member performed the animal welfare assessment using the modified protocol. For efficient data collection the group of four students were divided into two students per farm, making two farm assessments per day. Both groups included one Swedish student and one Mexican student.

All assessed animals were adults (cows and bulls), except for assessment of the maternal behaviour and interactions between calves, where calves also were included. Assessment observations were supposed to take one hour at the milking parlour and one hour at the pasture, but in cases where the milking took too long the assessment were made for 1.5 hours at the milking parlour and for 0.5 hours at pasture. Binoculars were used for observations at pasture. At the latter, the animals were observed from a distance without the assessors touching the animals, avoiding influencing the behaviour of animals. Observations of animals took place early in the morning. Further observations other than the welfare assessment or the interview protocol were noted.

The modified welfare quality protocol (MWQ protocol) was pre-tested in April 2015, before the study started in Mexico. An assessment was performed and reviewed by the assessors at an European intensive system dairy herd at SLU's research farm; The Swedish Livestock Research Center, Uppsala, Sweden.

Table 1 presents the main welfare principles and the welfare criteria included in the study. All welfare criteria and indicators of animal welfare assessment of health and behaviour are described in the original WQ® protocol.

Table 1. Welfare principles and criteria copied from the WQ® protocol (Welfare Quality®, 2009) A = animal based measures, R = resource based measures & M = management based measures

Welfare principles		Welfare criteria
Good feeding	1	Absence of prolonged hunger (A)
	2	Absence of prolonged thirst (R)
Good housing	3	Comfort around resting (A)
	4	Thermal comfort (R)
	5	Ease of movement (R)
Good health	6	Absence of injuries (A)
	7	Absence of disease (A & M)
	8	Absence of pain induced by management procedures (M)
Appropriate behaviour	9	Expression of social behaviours (A)
	10	Expression of other behaviours (R & M)
	11	Good human-animal relationship (A)
	12	Positive emotional state (A)

4.3.1 Good health

Absence of injuries

Lameness was assessed on the entire herd during the total observation period, according to the indicators in the WQ® protocol for moving and standing cows. Integument alterations were noted for the whole herd during milking, including hairless patches and lesions/swellings.

Absence of disease

The number of coughs was noted during the total observation period and of all animals present. Observations for presence of disease symptoms, nasal and ocular discharge, hampered respiration, diarrhoea or bloated rumen were made during milking, also for all animals present. Since production records were absent, information of mortality was asked for in the interviews.

Absence of pain induced by management procedures

Management procedures performed were noted, along with the use of anaesthetics and/or analgesics in relation to these different management procedures. Direct observations and enquiries to the farmers were made.

4.3.2 Appropriate behaviour

Expression of social behaviours

Agonistic and cohesive behaviours were recorded during the total assessment of 120 minutes. The whole herd was assessed, and any agonistic or cohesive behaviours were noted.

Expression of other behaviours

This indicator was evaluated in an outdoor paddock or on pasture. In dual-purpose systems in the tropics pasture husbandry is common, with two hours of milking time in the mornings, waiting in a milking pen to get milked before moved to another pen followed by pasture release.

Good human-animal relationship

Avoidance distance was recorded during milking. The animals could avoid the assessors touch if wanted, hence the open limited space in the milking pen.

"Positive emotional state" was assessed when the animals were at pasture by observing the whole herd.

4.3.3 Maternal and sexual behaviours, calf interactions

Maternal and sexual behaviours and calf interactions were recorded at each farm (farm 14 to 34), and carried out together with the MWQ protocol during the total assessment of 120 minutes. Every observed behaviour was noted, recorded independent of the number of animals, and given a total score of occurrences (Table 3, Appendix D). Number of bulls, calves and cows were noted. The parameters of the maternal and sexual behaviours and calf interactions were predetermined before assessing farm 14, consisting of the most common behaviours in every parameter and observed at farm 1 to 13.

Maternal behaviours

Maternal behaviours were noted; mother licking (when the cow licked its calf), calf licking (when the calf licked its mother), suckling (by calf), playing (cow and calf), aggression (between cow and calf), calling the calf (cow, often when separated from calf) & bonding (cow and calf standing beside each other and bonding, touching other than previous behaviours).

Sexual behaviours

Sexual behaviours were noted; flehmen (by bull), mounting (bull mounting cow) & bull licking cow (often connected with assumption of the cow being in heat).

Calf interactions

Calf interactions were noted; playing (calf-calf), aggression (between calves) & licking (calf licking calf).

4.4 Calculation of scores

Calculation of scores were performed according to the statistics included in the WQ® protocol (Vessier *et al.*, 2009; Welfare Quality®, 2009). The final score is represented by a number from 0 to 100 and the farms are divided into four categories according to their final score in each category; Excellent: 80.1 – 100; Improved: 60.1 – 80; Acceptable: 20.1 – 60; and Not classified: 0 – 20. According to the WQ® protocol (Appendix C) all animal welfare criteria were measured once in order to avoid double counting, with every area allocated to one criterion.

The measurement "positive emotional state" was assessed throughout the whole two-hour assessment instead of 20 minutes as the WQ instructions state (Appendix B). The number of adult cows assessed in most of the measurements was 25. These modifications were made to simplify the assessment due to animals in movement and in larger herds. It was decided in advance to get an overall mean value for each measurement and herd. Thereby all the measurements being assessed for two hours were divided by eight. Eight were the number of quarters (15 minutes) during the total two-hour assessment, which were the general calculation for most of the measurements in the MWQ protocol (Appendix B). For example, the number of coughs was not measured on individuals (Appendix C, Figure 15). Instead, results were given for the whole herd, counting number of coughs divided by eight, divided by number of animals at the farm. The number of animals at the farm (sample size) might have exceeded 25 animals if the herd was larger, which may result in a higher total of number of coughs if the herd was smaller.

4.5 Data analysis

The protocol data was summarized on a Microsoft Excel sheet on a daily basis after the farm visits. When the 34 farms were assessed, the total data was compiled in the Excel sheet. The calculation of the welfare measurement, criteria and principle scores are presented in Appendix C. The total animal welfare score for each farm is presented in the results, calculated by instructions (Welfare Quality®, 2009). Standard deviation (STD) is calculated for every mean value (MV) of the criteria in health and behaviour (Figure 1), using Excel. Correlations between the welfare criteria were also analysed in Excel using the Pearson function, to find any correlations by the correlation coefficient (r) between -1 and 1 (Table 3, Appendix D).

5 RESULTS

Evaluation scores for all 34 farms are presented in Table 2 (Appendix D). A total of 9 farms (26 %) reached a level above the minimum scores acceptable (>20.0) for all categories. While 74 % of the farms scored below acceptable (<20.1) in one or more criteria categories of animal welfare. Of the welfare criteria of focus in this study (health and behaviour), 19 farms (56 %) scored above the minimum score for acceptable (>20.0) for all criteria, while two farms (farm 3 and 17) scored below minimum threshold (<20.1) for the acceptable level in two welfare criteria each.

An average score of each welfare criteria in the protocol was calculated (Figure 1). The criteria "absence of disease" and "absence of pain induced by management procedures" were the lowest scores, while "expression of other behaviours" and "good human-animal relationship" acquired the highest scores. "Absence of disease" was the criterion with the highest variation in standard deviation (STD), also "absence of pain induced by management procedures", "expression of social behaviours" and "positive emotional state" were of high variations in STD. The criterion "absence of injuries" has a mean value (MV) of 94 (Figure 2), and the criterion "absence of disease" has a MV of 48 (Figure 3).

A mean value (MV) score of 72.84 was calculated for all 34 farms when divided by all eleven welfare criteria, of a total of 100 as a maximum score. Comparing this MV, 16 farms scored above average MV (>72.83), whereof 18 farms scored below average (<72.84). Considering the welfare criteria scoring, this MV corresponds to the welfare criteria score for improved level (>60.0). The lowest MV score of a farm was 63.65 (farm 34), considering this all farms (100 %) scored above the minimum score for improved (>60.0).
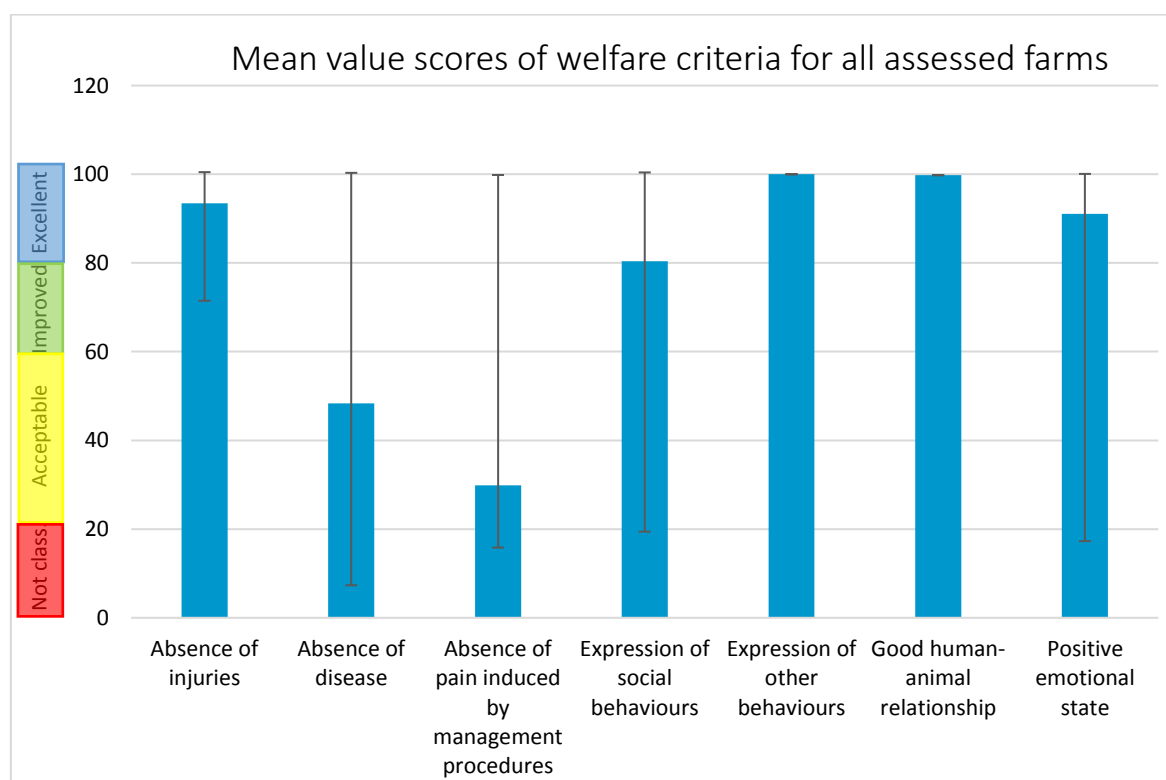

Figure 1. Mean value scores of animal welfare criteria for all 34 assessed farms, with focus on health and behaviour. Two criteria scored acceptable (>20.0), one criteria scored just below excellent (80) and four criteria scored excellent (>80.0). Standard deviation (STD) for every criterion is marked on each bar, with the highest variation in the criterion "absence of disease".

5.1 Modification for extensive production system with dual-purpose cattle

Some modifications had to be added to the MWQ protocol in order to improve the assessments during the study. In the original protocol, the welfare criterion "thermal comfort" has yet to be developed. With the objective to have an approximate temperature and humidity a weather application in iPhone was used.

Due to the conditions of the farms in the study with cows often kept with its young calf, interactions among adult cows were rarely seen, thus in the last 21 farms, maternal behaviours with their calves and sexual interaction with bulls were also noted. Maternal behaviour was assessed by recording any interactions between cow and calf; sexual behaviour was assessed by recording any interactions between cow and bull. Additionally, interactions between calves were recorded. Farm 1 to 13 was not included since this external behaviour study was organized and carried out until after farm 13 was assessed, mostly due to further interest and the common husbandry of keeping all animals together.

Two farms had milking machines, one farm had an extensive system adapted De Laval milking machine for four milking cows at a time (farm number 2), and one farm had a milking wagon for two milking cows (farm 22). To induce the milk let-down at farm 2, oxytocin was injected in a hind leg on the back of the large thigh muscle, together with a dry towel on the teats. The calves were allowed to suckle and share some cows after milking, probably a cause of why the cows were very thin. The other farm (farm 22) utilized a milking machine wagons on wheels for two cows, being very loud, with soap and water as teat cleaning before milking. The calves were kept by themselves and during the assessment they were not allowed to suckle, however the farmer answered that the calves were allowed to suckle and it could have happened after the assessment.

The majority of the farms systematically vaccinated against Brucellosis, Tuberculosis, Rabies, Leptospirosis, Clostridium and IVR-virus. The farms used to exchange bulls between each other to avoid inbreeding. However, the animals in some farms presented signs of being infected by bacteria of concern, such as Brucella s.p., and exchanging bulls could represent a high risk of infection.

5.2 Good health

In the parameters measuring good health, "absence of injuries" were ranked at the improved level (15 %) and in excellent level (85 %; Figure 2). The health conditions in "absence of disease" were ranked at the acceptable level (65 %) and in excellent level (24 %), thus two farms scored below the acceptable level (11 %; Figure 3).

The mortality of cattle on the farms during year 2015 varied between 0 and 38 %. This varied because of different response rates from the farmers, some did not want to answer, some may not have told the truth and some did not know. Mostly cows died from snake bites or cows falling off cliffs.

None of the farms in this study made any trimming of the hoofs (Appendix A). Farm 15 had two out of six cows with long hoofs, with one overgrowing the other.

Farm 22 (Figure 3) had many extremely thin and less healthy animals with coughs, nasal discharge, one animal with mild integument alteration and one with diarrhea. Also, the internal deworming procedure caused many cows to slip and fall down on the ground due to temporarily nerve injuries (Figure 4).
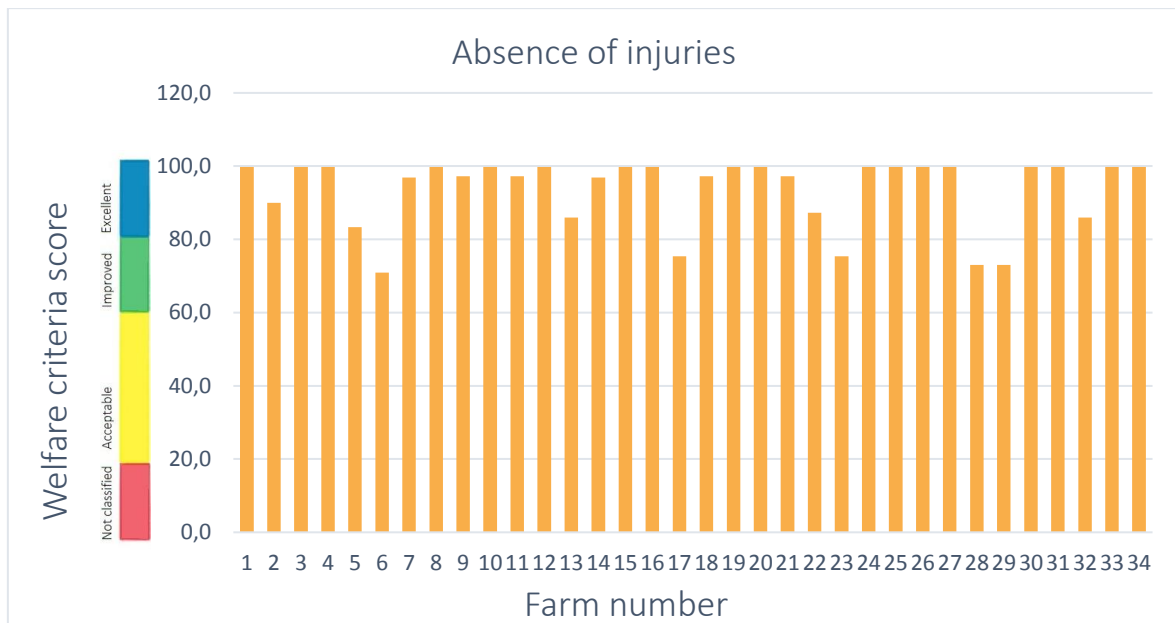
Figure 2. Results for the criterion "absence of injuries", displayed by farm.
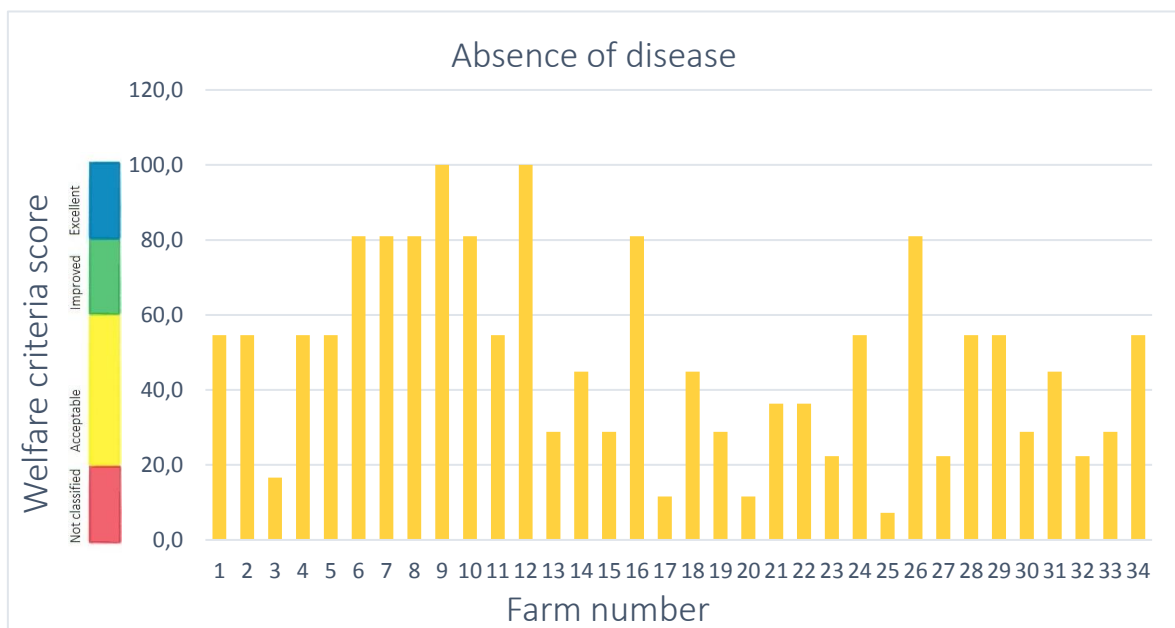
Figure 3. Results for the criterion "absence of disease" displayed by farm..

According to the health and behaviour parameters, "absence of pain induced by management procedures" was the major animal welfare issue detected in this study, with a MV of 30. A total of 11 (32 %) farms did not reach the minimum score for acceptable level of animal welfare, and only one farm scored on the excellent level (Figure 4).
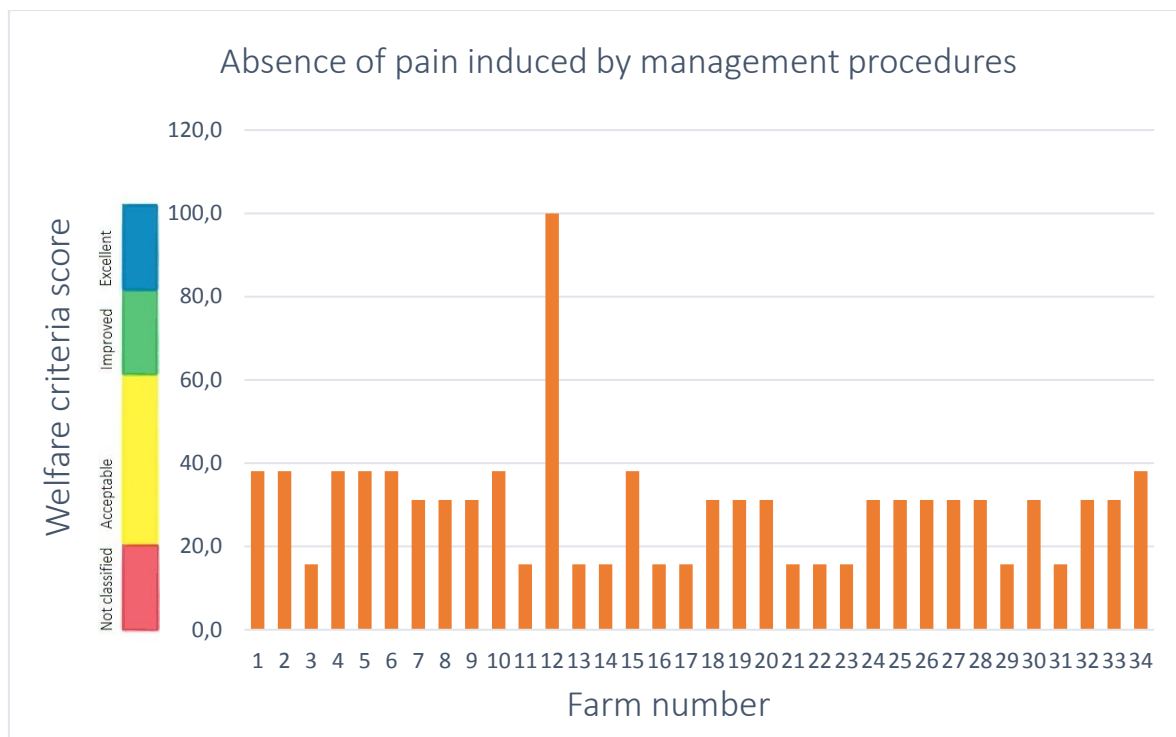
Figure 4. Results for the criterion "absence of pain induced by management procedures", displayed by farm.

5.3 Appropriate behaviour

The behaviour of the cows was assessed individually and on a herd-basis. The criteria "expression of social behaviours" has a MV of 80. One farm (number 2) scored below acceptable (<20.1) and farms number 15, 26, 33 and 34 scored acceptable (20.1 – 60.0; Figure 5). The farms scoring below excellent (<80.1) were 38 % of the total farms (Figure 5).
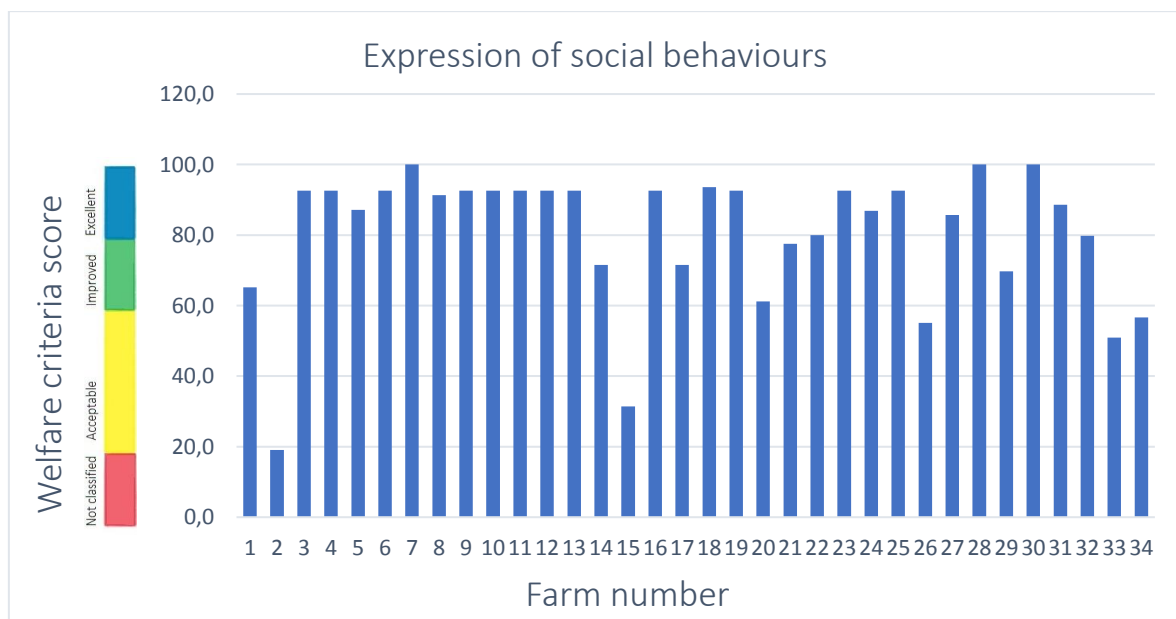
Figure 5. Results for the criterion "expression of social behaviours", displayed by farm.

In the case of the type of farms in the study, "expression of other behaviours" includes behaviours possible to perform on pasture. This was represented in a high occurrence since all farms kept their animals on pasture, with a MV of 100 (Figure 6).
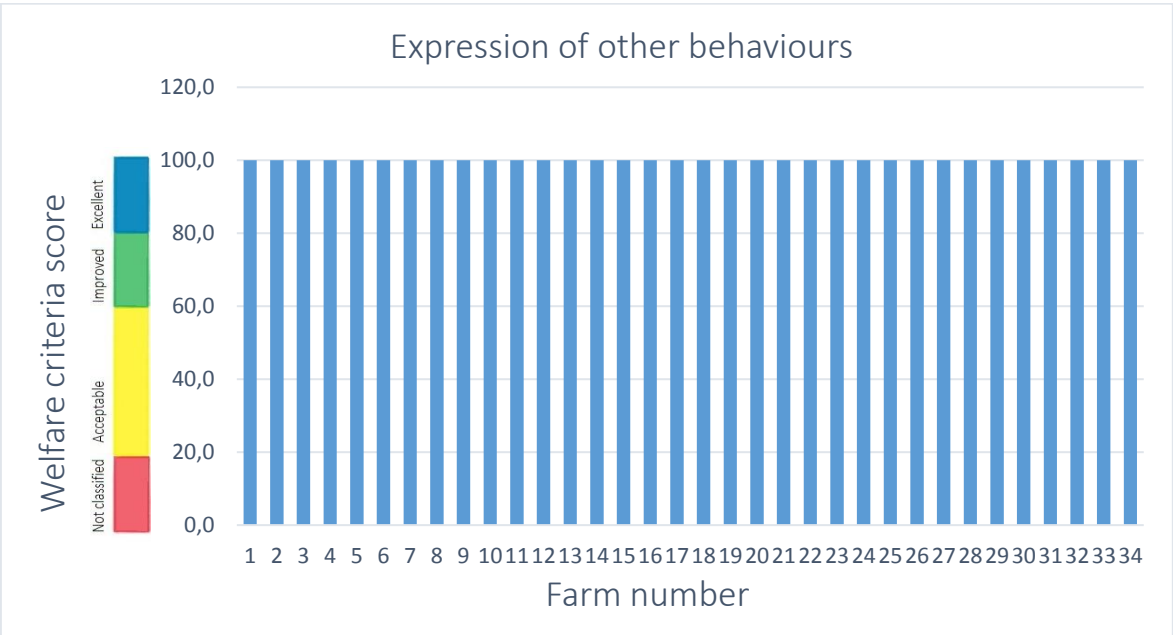
Figure 6. Results for the criterion "expression of other behaviours", displayed by farm.

The criteria "positive emotional state" has a MV of 91. One farm (number 15) scored below acceptable (<20.1) and farm number 22 scored acceptable (20.1 – 60.0; Figure 7). The farms scoring excellent (<80.1) were 88 % of the total farms (Figure 7).
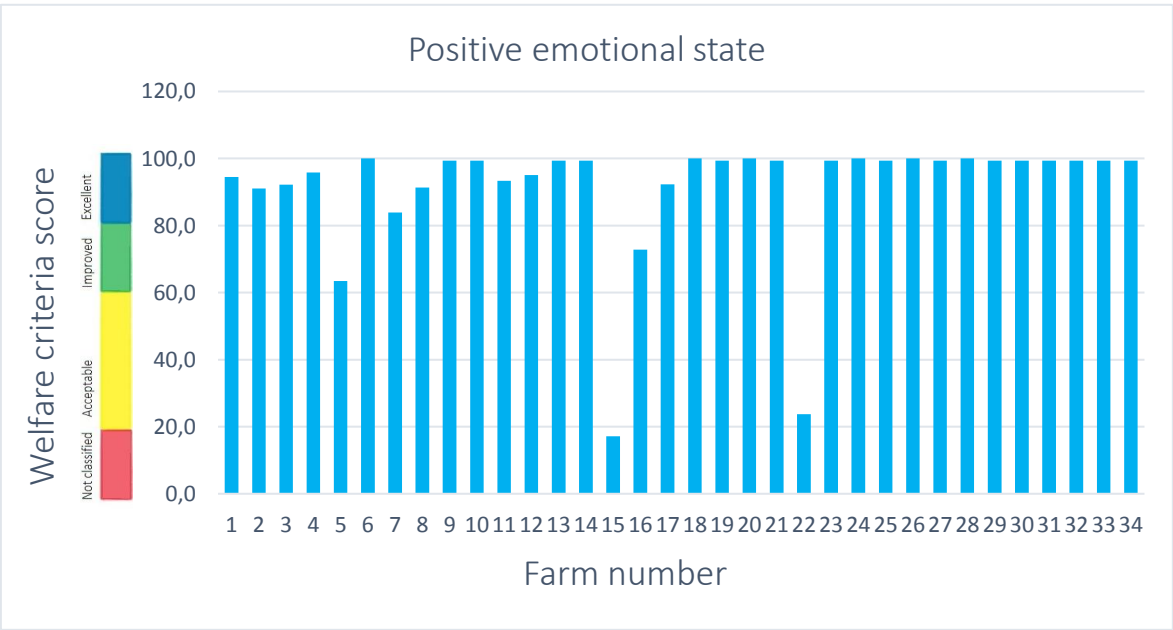
Figure 7. Results for the criterion "positive emotional state", displayed by farm.

The criteria "good human-animal relationship" has a MV of 100. Observe the y-scale (Figure 8).
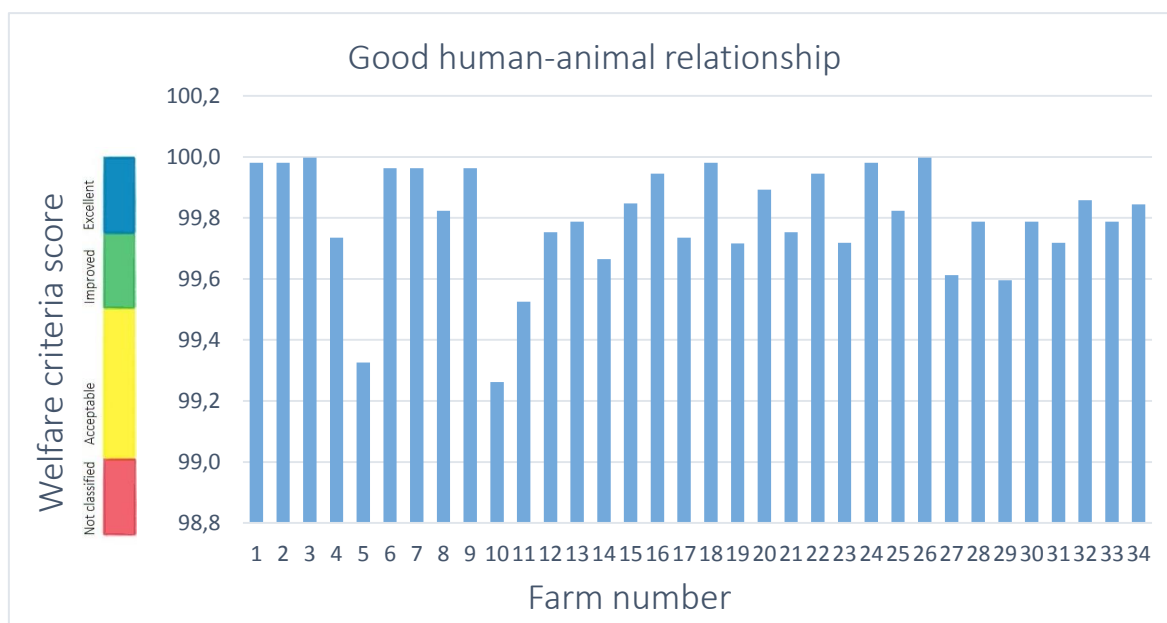
Figure 8. Results for the criterion "good human-animal relationship", displayed by farm.

5.4 Correlations between welfare criteria

Calculations of any correlations between the welfare criteria of health and behaviour were made, using Excel correlation tool to calculate the correlation coefficient (r). The highest significant positive correlation found was between "absence of disease" and "absence of pain induced by management procedures" ($r = 0.44$, $p = 0.0007$), also between "expression of social behaviour" and "positive emotional state" ($r = 0.28$, $p = 0.0279$) and between "absence of injuries" and "absence of pain induced by management procedures" ($r = 0.21$, $p = 0.0023$). This indicates further importance of improving both criteria in every correlation, hence the positive correlation coefficient both affect each other; a high score of "absence of disease" gives a high score of "absence of pain induced by management procedures", and vice versa. Further correlations are shown in Table 3 (Appendix D), others not mentioned are not significantly correlating.

5.5 Maternal and sexual behaviour, calf interactions

Each interaction observed of maternal and sexual behaviour and calf interactions at farm number 14 to 34 can be seen in Figure 9, 10 and 11. The number of animals assessed in this extended study varied at each farm (most often the same as for the MWQ protocol) between 6 to 100 cows, 0 to 2 bulls and 6 to 100 calves. The total number of occurrences a behaviour has been displayed can be seen in Table 4 (Appendix D). If a box is empty or showing 0 it is because the behaviour was not displayed, either because the animals where occupied doing something else or because the animals were not kept together (Table 4, Appendix D).

The behaviours of major occurrences were suckling (maternal behaviours; Figure 9), bull licking cow (sexual behaviours; Figure 10) and licking (calf-calf interactions; Figure 11). These behaviours were also the most varying with the largest standard deviation (STD) values.

5.5.1 Maternal behaviour

Several farms presented a low level of interaction behaviour between adult cows, with 38 % scoring below excellent (<80.1; Figure 5), however a high appearance of maternal behaviour was recorded in interactions with their calf (Table 4, Appendix D). The following interactions between cow and calf was recorded: mother licking (mean value MV: 9 occurrences), calf licking (MV: 5), suckling (MV: 30), playing (MV: 1), aggression (MV: 2), calling the calf (MV: 23) and bonding (MV: 20). A large variation within each interaction were observed, why STD was calculated (Figure 9).

Interactions between cow and any alien calf were also recorded. Due to the importance of daily milk yield, cows that lost their calf, were forced to feed anther calf, in some cases an orphan calf or one that were very small. Consequently, some aggressiveness towards the calf by the cow was observed, and often they were tied up, causing a non-positive behaviour.
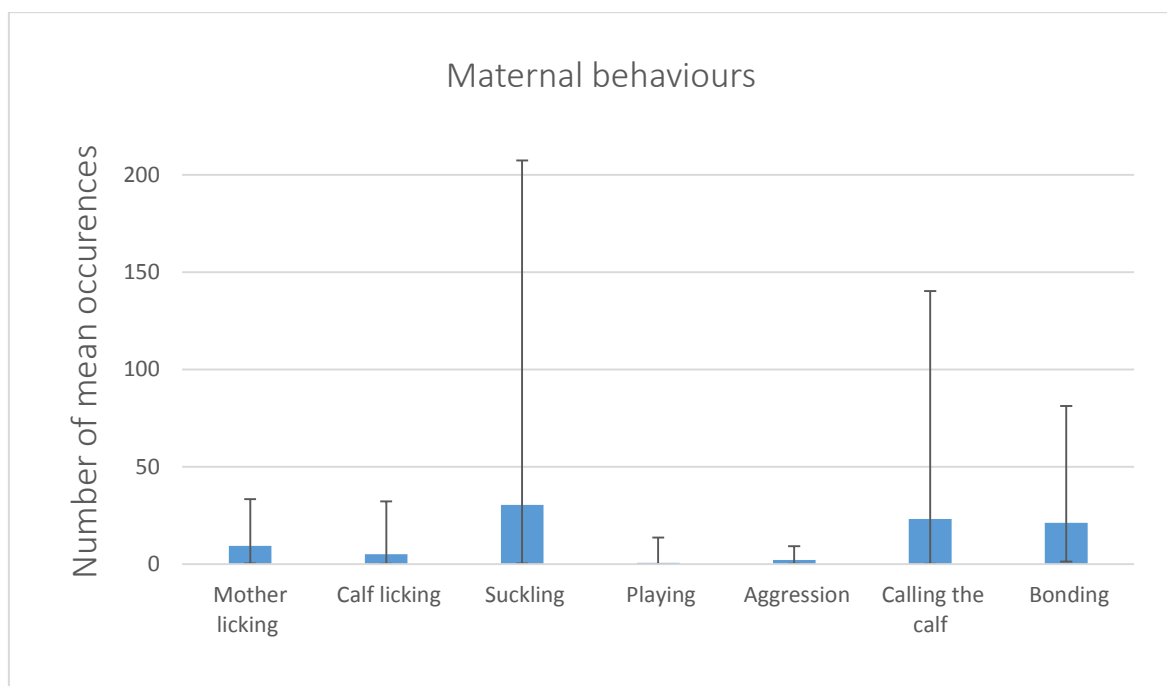
Figure 9. Mean number of recordings (± STD) for maternal behaviours in farms 14 to 34. Standard deviation (STD) for each criterion is marked on each bar.

The cows at farm 22 were kept without their calves during the assessment, and scored low in "positive emotional state" and "absence of pain induced by management procedures" (Table 4, Appendix D). Suckling, calling the calf and bonding were of major occurrence (Figure 9), also with the highest variation of STD. Farms 15, 17, 18, 23 and 29 had a high number of cows calling for their calf (MV: 67), where the other farms had a MV of 10 (Table 4, Appendix D). Farm 15 had several sexual behaviours (Table 4, Appendix D) and also a very low "positive emotional state" (Figure 7).

5.5.2 Sexual behaviour

In the presence of a bull in a herd, sexual behaviours related to interactions between cow and bull were recorded. The major occurrence recorded was that the bull was licking the cow (Figure 10).
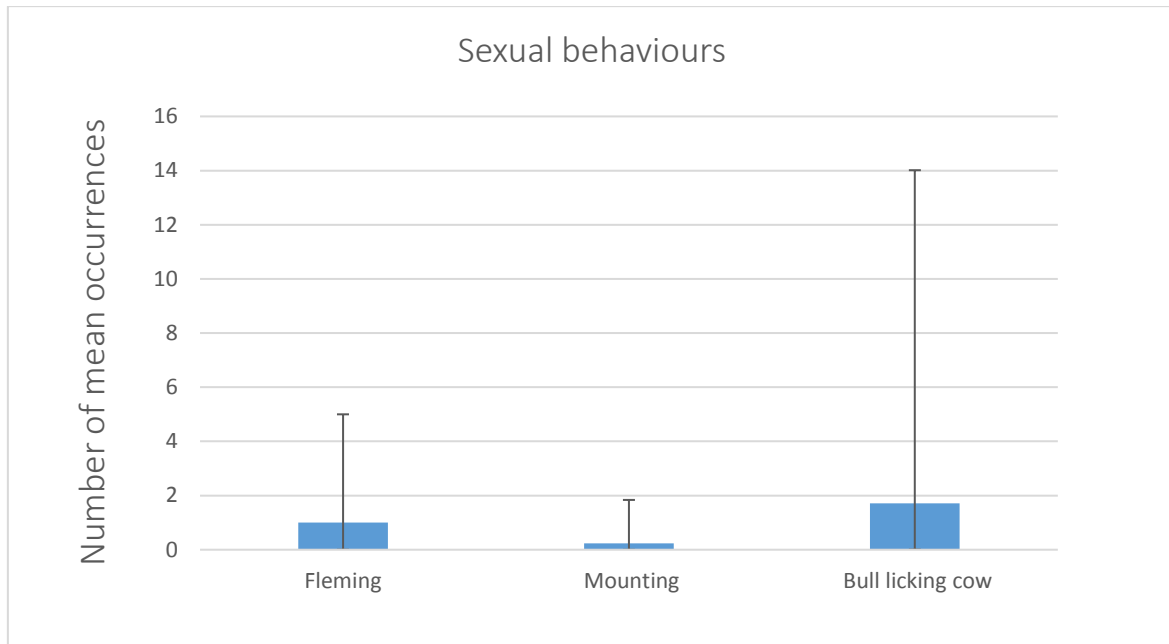
Figure 10. Mean numbers of recordings (± STD) for sexual behaviours in farms 14 to 34. Standard deviation (STD) for each behaviour is marked on each bar.

According to the sexual behaviours, flehmen had MV 1, mounting had MV 0 and bull licking cow had MV 2. The most varying criterion was bull licking cow with the largest STD value.

5.5.3 Calf interactions

Interactions between calves were mainly seen in husbandry systems where calves were kept separate from the cows, or at the milking parlour when the cows were waiting to get milked. The calves interacted when they were not interacting with their mother, either by playing, performing aggressive behaviours or licking. Licking were of major occurrence and also had the highest STD (Figure 11). Farm 30 scored high (27 occurrences) in licking (Table 4, Appendix D).
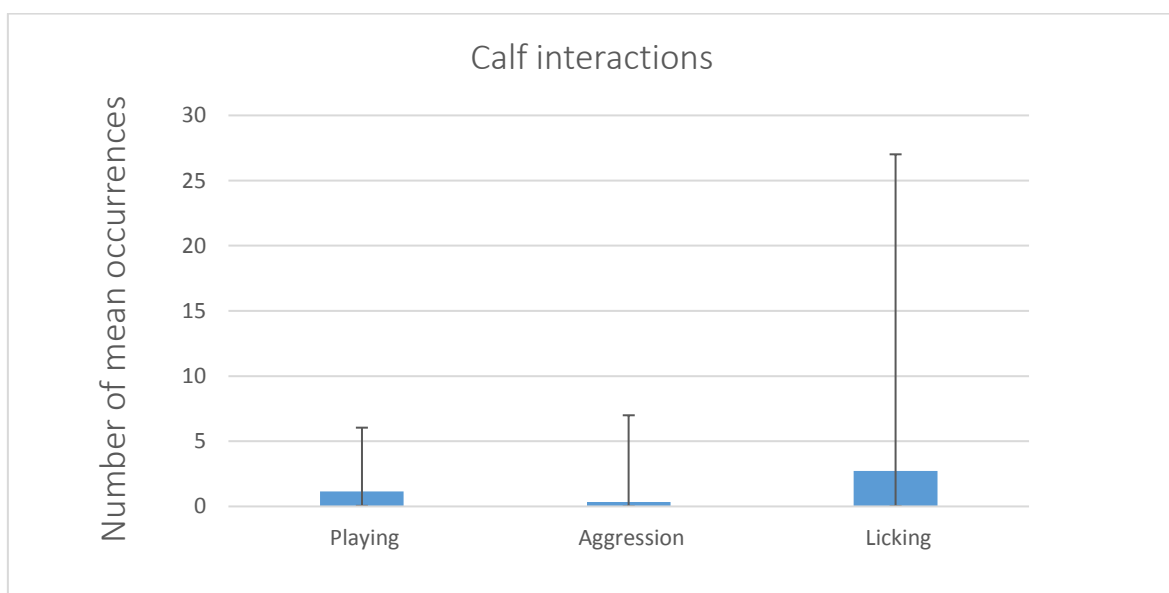

Figure 11. Mean numbers of recordings (± STD) for interactions between calves. Standard deviation (STD) for each criterion is marked on each bar.

6 DISCUSSION

In this study, scores of health and social behaviour were high, indicating a good animal welfare. In general, the cows appeared to be healthy and prosperous, satisfied and happy; behaviours included in the original WQ® protocol. Keeping cows and calves together may contribute to improved welfare, this also in accordance with Føske Johnsen *et al.* (2015). As most farmers in this area have economic problems, it is desirable to find ways both to keep the cattle healthy and to increase the profit for the farms.

In the total study, the main issue was that the cattle often were found to be undernourished. This was measured as "absence of prolonged hunger", and 18 out of 34 farms did not reach the acceptable level (Eriksson, 2016).

Our studies tend to support that the two most important issues affecting cattle performance and welfare are "absence of disease" and "absence of pain induced by management procedures". This result is in accordance with Nahed-Toral *et al.* (2013), where disease prevention and veterinary care were the major issues. The two criteria also show a significant positive correlation (r = 0.44, p = 0.0007), indicating these to significantly affect each other.

The farms of this study achieved a good overall assessment, with all farms scoring as improved (32 farms) or excellent (2 farms). This is supported by a Danish study of 44 farms in loose housed intensive dairy system (Andreasen *et al.*, 2013), with 20 farms scoring acceptable, 22 farms scoring enhanced (improved) and one farm scoring not classified. Similar results have previously been shown in dairy farms in Sweden, Belgium and France, with criteria MV of 62.6 (STD 27.5) together, and criteria scores between 3 – 100 (Anonymous, 2014).

As mentioned in the materials and methods, the present study should be considered as a pilot study, and a higher number of farms are required to make secure comparable conclusions of the material.

6.1 Cattle welfare on the farms in San Pedro Buena Vista

This study found 26 % of the 34 farms scoring above acceptable (>20.0) in every welfare criterion, with 56 % (19 farms) scoring above acceptable (>20.0) in every criteria of focus in this study (health and behaviour). However, a MV score of 72.84 was calculated for all 34 farms when divided by the 11 welfare criteria, of a total of 100 as a maximum score. Comparing this MV, 16 farms scored above average MV (>72.83), whereof 18 farms scored below average (<72.84). Considering the welfare criteria scoring, this MV corresponds to the welfare criteria score for improved (>60.0). The lowest MV score of a farm was 63.65 (farm 34), considering this, all farms (100 %) scored above the minimum score for improved (>60.0).

Findings of previous assessments of animal welfare in dairy cattle using the WQ® protocol scored above the minimum score for acceptable (>20.0) in 83 % of the herds assessed (de Vries *et al.*, 2013). The farms scoring not classified (<20.1) in de Vries *et al.* (2013) showed significantly more very lean cows and more severe lameness than the farms scoring above acceptable (>20.0). The farms classified as acceptable (>20.0) showed more lesions, could not be approached closer than 100 cm, had fewer cows with diarrhoea and scored lower in the descriptions "relaxed" and "happy" ("positive emotional state") than farms classified as enhanced (improved in this present study). The findings of de Vries *et al.* (2013) shows a lower welfare score than the present study, with 100 % of the farms scoring a total score

above improved (>60.0), concluding that the farms of the present study have a higher and more improved animal welfare.

The findings of this study also considers a different approach than de Vries *et al.* (2013). The farms scoring above acceptable (>20.0) are considered acceptable in all criteria categories, with separate welfare criteria scores of "not classified", "acceptable", "improved" or "excellent" of every welfare criterion each. Also, considering all seven welfare criteria of health and behaviour in this study, all criteria have a MV of 80 (one criteria had 80) or higher, (corresponding to the minimum score of excellent (>80.0). The two criteria of concern are, as expected, "absence of disease" (MV: 48) and "absence of pain induced by management procedures" (MV: 30).

A total of 2031 animals were included in the study, with 782 cows in milking production at the time. Of these, only 8 cows (divided on six farms) were lame during the assessments. There were 8 cows with visible signs of mild integument lesions and 13 cows with severe integument lesions, out of these 782 milking cows. These numbers are very low and indicates a major benefit for animals in these types of systems mainly kept on pasture and little on concrete, with advantages of soft natural impact on the legs and hoofs decreasing the risks of lameness. Despite the lack of hygiene and outdoor management, there were few injuries on the animals. Mastitis caused by bacteria is very common in intensive systems (Hinrichs *et al.*, 2005), as well as integument alterations due to lying down on hard concrete. This indicates that these extensive systems on pasture provides a standard with good animal welfare. Also, suckling cows decreases the risk of mastitis hence the cleaning of the teats (Mejia *et al.*, 1998), concluding that suckling cows are the future for intensive systems, also in accordance with Hernández *et al.* (2006) and Fröberg *et al.* (2007).

6.2 Good health

The criteria "absence of injuries" scored high. This could be due to the open space areas and absence of equipment or constructions that could have been risks of injuries. This was probably due to that the management allowed the animals being outdoors on large grass pastures with large individual space and only being kept on concrete with few sharp equipment in the milking parlour. This is also in accordance with de Vries *et al.* (2013), where the farms classified as acceptable (>20.0) had problems with the cows colliding with equipment while lying down as well as lying outside the lying area.

The results of "absence of injuries", with a MV of 93 and the farms scoring between improved and excellent (71-100), are supported by Andreasen *et al.* (2013), with excellent scores of 95 at all farms. Also, "absence of disease" scoring is supported by Andreasen *et al.* (2013), with MV of 48 (between 7-100 at the farms; not classified to excellent) in this study and 12-71 (not classified to improved), respectively.

The farms scored lowest in the parameters "absence of disease" and "absence of pain induced by management procedures". This may be due to the animals being exposed easily to diseases when the bulls are used in many different farms. Also, there is little preventive care of diseases. As many cows are very thin in the majority of farms, the cows might be more prone to diseases. The most common causes of death in the area are diseases, snake bites and falling off cliffs. Common diseases that are vaccinated against are Brucella, Tuberculosis, Rabies, Leptospirosis, Clostridium and IVR-virus. To improve the "absence of disease" it is vital that the animals avoid diseases as far as possible. This may be prevented by all farms vaccinating against the same diseases, exchange of animals between farms only when necessary and disinfection of both transport vehicles and animals, as well as any sick

animals being cured or culled. Nahed-Toral *et al.* (2013) also found deficiencies of disease preventions, which is consistent with this study. Also, to provide sufficient feed to the animals to keep them from malnutrition and to keep a general good hygiene level. Many farmers lack knowledge of how to perform preventive care, such as deworming, and veterinarians were at the farms very seldom, which is in accordance with Nahed-Toral *et al.* (2013). The management procedures most often causing pain are internal parasite deworming, vaccination, dehorning, disbudding, ear tagging or branding iron without anaesthesia or analgesia, by persons without correct knowledge how to perform the procedures. To improve the "absence of pain induced by management procedures" education and interest are important aspects in the area.

A contemporary practise in the area was dehorning or disbudding of cattle without any analgesia or anaesthesia. Other health concerns were hot iron branding, also performed in the area without analgesia or anaesthesia. This is affecting the animal welfare negatively (Webster, 2005); and therefor the Five Freedoms are not fulfilled (Farm Animal Welfare Council, 2009), particularly not freedom from pain, injury or disease. It also concludes this being very painful procedures, requiring improvements in the welfare criteria "absence of pain induced by management procedures", which is in accordance with Stafford & Mellor (2011). Cautery disbudding and dehorning results in specific pain related to behaviour indicators during and after the procedure, whereas caustic disbudding causes less response during the procedure, but it is often followed by pain related behaviour (Stafford & Mellor, 2011). All three procedures cause specific plasma cortisol (stress-related hormone) responses; being the significantly highest in dehorning amputation and it lasts for up to 9 hours post-treatment (Stafford & Mellor, 2011). Local anaesthesia in advance of dehorning or disbudding eliminated the pain related behaviour and reduced the plasma cortisol response, and application of both local anaesthesia and an anti-inflammatory drug (NSAID) showed cortisol responses being low or absent (Stafford & Mellor, 2011). Chronic pain in the following days after the procedure with wound healing for up to three months, post-procedure for both, dehorning and disbudding, is a problematic welfare issue, causing large amount of suffering for the animal (Stafford & Mellor, 2011). If pain reliefs are not available, cautery disbudding is the preferable procedure (Stafford & Mellor, 2011). Local anaesthesia with anti-inflammatory is preferable, to minimize the risk of pain (Stafford & Mellor, 2011). The farms performing dehorning, disbudding or iron branding without analgesia or anaesthesia are thereby not fulfilling the level of accepted animal welfare. Castration was not performed on the examined farms.

None of the farms in this study made any trimming of the hoofs (Appendix A). This could be observed at farm 15 in two out of six cows with long hoofs and one overgrowing the other, which may be due to age of the animals, but also due to management issues or lack of knowledge. However, most animals on the assessed farms have natural trimming of the hoofs since they were kept at pasture, and are able to trim the hoofs on the hard concrete in the milking parlour. This is considered as a natural way of hoof maintenance and contribute to strong legs and prevention of lameness, also in accordance with the EFSA report (Algers *et al.*, 2009).

None of the farms had problems with the udder health in the herd. This is an important result, considering that the calves were allowed to suckle during the day and before and after milking. Previously, it has been shown that restricted suckling may improve the udder health, which is also concluded in this study and shown by Fröberg *et al.* (2007) and concluded in the EFSA report by Algers *et al.* (2009). Some farms did not let the calves suckle during the day and some only after milking. This may contribute to risks of udder problems if the teats

were cleaned with a towel instead, hence the suckling by the calf being the most natural way of teat cleaning. However, the allowance of restricted suckling decreased this risk compared to not allow suckling at all, also shown by Fröberg *et al.* (2007).

6.2.1 Body condition score reflecting the health

This study was performed during the wet season with an increased grass pasture volume than during another wet season that may be dryer (37 % very thin cows in body condition score; Eriksson, 2016). We know this because a dryer wet season leads to an increased percentage of thinner cows. A reference area with a wider perspective with a similar study during the dryer wet season would probably reflect in a more accurate, lower value of percentage of very thin cows. This is shown by Yigrem *et al.* (2008) where wet seasons in south Ethiopia provides a better roughage supply to dairy cattle, with higher milk yields and better performance than dry seasons. Hence, the results of this study in "absence of hunger" (a direct measure of body condition score of an animal, and thereby its health if very thin), had a better score than expected (Eriksson, 2016). This is from an expected value by the assessors and the interviewers, and expectations of the grass nutrient content being low during the assessment.

At farm 22 many extremely thin and less healthy animals could be observed, with coughs, nasal discharge, one animal with mild integument alteration and one with diarrhea. The internal deworming procedure with an injection in the upper hind leg, also caused many cows to slip and fall down on the ground due to temporarily nerve injuries. The combination of very low body condition score and observed diseases and injuries may be connected in this situation. The significant correlation between "absence of disease" and "absence of pain induced by management procedures" is in this case relevant, and the body condition score may reflect the health of the animals.

6.3 Appropriate behaviour

The results of the criteria "expression of other behaviours" did not correspond to Andreasen *et al.* (2013), in this study all farms scored 100 (excellent), in the other study the score varied between 0-73 (with 29 farms out of 43 scoring not classified; Andreasen *et al.*, 2013). This is a major difference and is based on pasture access, not classified equals no pasture access, and excellent corresponds to a full pasture access in this study. The compared study was assessed during the indoor season of 43 intensive dairy farms with loose housed systems in Denmark (Andreasen *et al.*, 2013).

Overall, the farms scored the highest in "expression of other behaviours", which might be related to the grazing conditions, and that the cows, calves and a bull were kept together. This indicates that a united husbandry of both cows and calves on pasture may be related to a better animal welfare, also concluded by Føske Johnsen *et al.* (2015). The maternal behaviour is one of the natural behaviour of a cow, allowing the performance not only by the united husbandry but also due to the large individual space at the pasture.

Social interactions between cows are also a natural behaviour, creating social bonds in the herd. However, a cow raising a young calf prefer to interact with its calf if given the opportunity (Loberg & Lidfors, 2001). The parameter "good human-animal relationship" also obtained a top score, indicating that the cows were accustomed to human contact and handling, despite that the animals were kept on pasture most of the time. Milking, most often by hand, may not represent an unpleasant experience to them.

Behaviour of social interactions may be lower in this type of system than in intensive systems, primarily due to all of the animals being kept together and a low stocking density at large pasture areas. Other interactions with other animals than cattle were observed during the assessments, such as horses, poultry, pigs, dogs and wild fauna. This may be taken into consideration when assessing "expression of social behaviour" in this type of farm systems.

Popescu *et al.* (2013) found a significant positive effect in the cows allowed regular outdoor exercise in pasture or paddock, among 80 dairy tie-stall farms. The health and behaviour criteria MV were higher, except for "expression of social behaviours". The lowest scores for both outdoor allowance and not allowed exercise outdoors were "positive emotional state". Also, many criteria correlated. None of the farms were considered excellent, and in the not classified category were only tie-stall farms not allowing outdoor exercise. Only farms with outdoor access were classified as improved, concluding the welfare quality being significantly better for dairy cows allowed outdoor exercise (Popescu *et al.*, 2013). This conclusion supports this present study, with a MV of 91 (varying between 17-100) in "positive emotional state", and a full-time pasture allowance.

The part "positive emotional state" can be difficult to measure and most of the farms scored equally, with most of the cows grazing during this assessment. One farm scored below acceptable in "positive emotional state" scale, with many agonistic behaviours. This was primarily due to a young heifer being dominant and displaying many aggressive behaviours towards the other five cows in the herd, and the farmer did not have the heart or economy to get rid of her. This affected the total "positive emotional state" negatively since it was only divided by six animals compared to the other herds.

The lack of awareness about the correct use of medicaments and the impossibility to hire a trained veterinarian, reflects negatively in the animal welfare. One of the farms in the study scored low on "absence of pain induced by management procedures" and "positive emotional state", due to an overdose of deworming shot causing cows to fall down. Additionally, the milking parlour was very small compared to the number of animals, causing a slippery concrete floor due to wet manure, causing the animals to look distressed and anxious.

It was hard to appreciate differences between herds unless any agonistic behaviours were presented, however rarely seen. Most of the farms were similar with positive scores indicating a satisfied herd, often grazing at the pasture or if calves were present, performing maternal behaviour. If a herd is satisfied it may be difficult to assess, with the terms of animal welfare continuously being researched and developed. However, it is still concluded in the WQ® protocol, and may be assessed as far as the knowledge of natural behaviour goes. The assessment was occurring the last 30 minutes of the 120-minute assessment, if possible. This was due to the cows being left alone and only observed from a distance. Each emotion was noted once and not calculated after certain minutes as described in the original WQ® protocol. A general assessment of the herd was required since equal behaviours often were presented during these 30 minutes. It is a challenge to assess this welfare criterion and what it could be used for, since emotional values are hard to study and verify. It is a challenge to assess behaviours that are emotional and the research has not gone this far. It is hard to know if a cow is content, happy, bored or uneasy. These psychological measures are difficult and the closest possibility is to measure physical behaviours and read the cow signals. The development of this part is still on-going and further education in assessing these behaviours is necessary. Addition of behaviour terms such as "enjoying" and "eating" would be preferable, especially in tropic rural areas where the animals most often are kept on pasture. These behaviour terms may be scored equally positive as the other positive behaviours in

the welfare criterion "positive emotional state. A suggestion to better assess "positive emotional state" is to combine this together with "expression of social behaviour", with interactions between all animals in the entire herd (Das *et al.*, 2001). This instead of assessing the positive states that may be dependent on the assessor. Overall, the result displays a major good "positive emotional state" of the assessed herds in this study.

One farm scored lower in "positive human-animal relationship" due to that the assessors were not able to touch any cow, but were able to approach 33 % of the animals closer than 50 cm but not touching them, 56 % of the animals could be approached between 50 to 100 cm and 11 % could not be approached closer than 100 cm. Another farm scored lowest due to that 7 % of the animals could be touched, 7 % could be approached closer than 50 cm but not touched and 7 % could not be approached closer than 100 cm, with approximately 80 % being able to approach between 50 to 100 cm. Nevertheless, the y-scale is very narrow and the differences between the farms are small. In de Vries *et al.* (2013) the assessors could not approach cows closer than 100 cm at farms classified as acceptable, thus this increasing with higher level of classification score. However, "good human-animal relationship" is a challenge to assess, hence the animals in the tropics are often kept in large pasture areas and allowed individual spaces, but this does not necessarily mean that they are being afraid.

If a farm does not fulfil the Five Freedoms (Farm Animal Welfare Council, 2009) related to behaviour; freedom from discomfort, fear or distress, or freedom to express normal behaviour, the animal welfare cannot be classified as accepted welfare. The majority of the farms in this study did fulfil these freedoms, concluding that most of the farms fulfil the goal and allows the animals to perform natural normal animal behaviour.

6.4 Maternal and sexual behaviours, calf interactions

To be able to evaluate and compare the farms according to the maternal and sexual behaviours and the calf interactions, future studies should calculate a mean number of recordings per hour on the same number of animals for each farm. This study presents the number of occurrences independent of number of animals per farm during the two-hour assessment.

6.4.1 Maternal behaviour

Maternal behaviours (interactions between cows and calves) were more frequent in this study than interactions between adult cows. This could mean that given the chance cows prefer to interact with their calf, this is accordance with previous papers (Loberg & Lidfors, 2001; von Keyserlingk & Weary, 2007). Additionally, the calves were mainly young and therefore the cows were more prone to express maternal behaviour. An issue interpreting these results in this type of production system is the maternal factor; a herd does not necessarily have a bad animal welfare level based on social behaviours of cow interactions. One of the natural behaviours for a cow is to interact with its calf. Some farms did not display some maternal behaviour, any sexual behaviour or calf interaction. This may be due to the husbandry system where cows were kept separate during the assessment. Cows kept with calves displayed mainly maternal behaviours. The lower scores of maternal behaviour (below MV for each category) may be due to the calves being older.

The farms that let the calves be with the cows during all day, with exception during or before milking, seemed to have calmer cows with less calling for calf (noted during each observation and by "positive emotional state"). Suckling, calling the calf and bonding were

of major occurrence. Farms 15, 17, 18, 23 and 29 had a high number of cows calling for their calf (MV: 67) compared to the other farms (MV: 10). Farm 15 (only six cows and one bull) had a very low "positive emotional state" caused by one very aggressive and dominant cow with many agonistic behaviours that the farmer did not have the heart to get rid of. This herd had a high occurrence of calling for the calf and became calmer when the calves were allowed to suckle the cows before milking, and when the cows were allowed to graze with their calves for thirty minutes after milking. On average the total herd behaviour seemed acceptable, despite the low score on "positive emotional state", that seemed to get balanced by the maternal behaviour.

Farm 22 scored 0 in maternal behaviour because of the cows and calves being kept apart during milking (the full assessment period). Due to this, no calf-calf interactions were assessed at this farm. Farm 23 had high occurrences of calling for the calf, however with four newborn calves, thus a very high score in "positive emotional state". Farm 18 had a very high occurrence of suckling (207 times), probably because of many newborn or young calves, but also due to keeping them together for a longer period during the assessment. This could also be seen by the occurrences of mother licking, calf licking, calling for calf and bonding.

6.4.2   Sexual behaviour

Sexual behaviours were assessed due to the combined husbandry of bulls present in the herds. At several farms the bull did not display any sexual behaviour, which may be due to no estrus signs of the cows, cows being pregnant or separate location of the bull and the cows during the assessment. Farm 15 had several sexual behaviours and also a very low "positive emotional state". Farm 22 had a bull with the cows in the milking pen, with several attempts to perform sexual behaviour, and riding them despite the small space. This was nevertheless assessed only by bulls attempting to perform sexual behaviours on adult cows, and a parameter that could be available for assessment of the bull. On farms without any sexual behaviour it may also be due to a too high number of cows for one bull to be able to perform natural mating, although some farms had two bulls. Natural mating may inflict on the health of the bull if not allowed to rest in between. In this study it was not feasible to separate sexual or dominant behaviours, neither were there any records of the cows being pregnant. Furthermore, it is not feasible to indicate with precision when the bulls were rotated between the farms. It is also a risk that heifer calves get mated too early in life.

6.4.3   Calf interactions

The calves were mainly interacting with their mothers, primarily due to the calves being young during this season. Farm 30 scored high (27 occurrences) in calves licking each other compared to the other farms, which may be because of the calves being kept beside the milking parlour, and were only allowed to suckle before milking. There was little time for other maternal interactions due to the calves being tied up beside the cow during milking and separated after milking. Hence the calves often being kept beside or close to the cows, the calf interactions were possible to assess, despite if they were being kept separated from the cows. There were many calves in this farm that were new-born or very young that licked each other very frequently. Some calves also suffered from diarrhoea, which could have been affecting the health of the herd.

6.5 Methological reflection

A risk of error in this study was the method chosen to observe the animals. The farmers lacked equipment of internet communication and social media, hence giving the circumstances a question survey for the interviews was not an option. The presence of surveys would probably result in other material, since the farmers may lack knowledge and problems as misunderstandings or protests could occur. Giving this, an interactive practical approach to the farms were preferable. A low response frequency could be a major risk of error. The probability of an interactive interview and animal welfare assessment at the farm is that the questioner has a possibility to ask follow-up question when required, as well as the assessor has a major possibility to actually assess the animals by itself. The consequences of the chosen method can have resulted in language interpreting issues during the assessments leading to misleading judgemental scores for the farms in different categories. Also, the scores could be miscalculated, the tables and graphs summarized wrong due to both assessments or only badly created. The total conclusion could thereby have been affected. Nevertheless, the welfare seemed to be good in these farms and the summarized score and evaluation of the MWQ protocol will be further reported in Hernández, in prep.

No specific lying area or cubicles were found at the farms, making the criteria "lying outside the lying area" difficult to assess. "Lying in the shade" is a criterion that may replace "lying outside the lying area", however this may be difficult to assess since the animals were rarely lying down when kept at pasture, and no visible preference of shade or sun were observed. Also, it would be preferable to assess the stocking density in the milking pen, where the animals often were kept at night, giving a better approach instead of assessing other housing factors (Schneider, 2010).

Also, "absence of livestock crush" or other procedure designs for deworming or vaccination, that were observed at added to the MWQ protocol, may induce a major stress and also found by Orihuela & Solano (1994). Suggestions of assessing the udder health in the MWQ protocol may be observations of hygiene at milking, instead of serial mastitis testing requiring adequate infrastructure. This was in major performed by the calf suckling before and after milking (Das *et al.*, 2001). Any clinical mastitis was not observed. This may be combinations of calf suckling, previously shown to improve the udder health (Fröberg *et al.*, 2007), and the low level of milk production of the assessed herds.

Criteria are evaluated as percentages, and may affect the total score of a farm if only one of ten animals in a herd is diseased or injured, constituting a significant proportion without meaning that the total herd is at risk.

6.5.1 Miscellaneous observations

A common procedure at the farms was to let the calf suckle immediately prior to or after milking. Before milking suckling induces the milk-let down and after milking it enables access to the residual milk, both procedures cleaning the teats in the most natural way (Fröberg *et al.*, 2007). Allowing the calf to suckle only once leaves more milk to sell, as well as helping the body condition of cows.

6.5.2 Reliability of the animal welfare assessment

In general, to assess the animal welfare on these farms it was applicable to use the MWQ protocol from Welfare Quality® (2009). However, some seasonal effects occurred with varied welfare since there were considerable variations in the climatic conditions during the

year. This study was carried out during the rainy season, and the welfare of the animals is expected to be different during the dry season. The number of very thin animals would probably be higher than in this study (37 %; Eriksson, 2016). The pasture is affected by the season, and during the dry season the availability of forage and water will be limited. The grass also contains less nutrients causing higher mortality due to limited nutritional components. The protocol could be further adapted to different seasons to enable a better assessment of the animal welfare. The temperature and humidity and the "thermal comfort" (yet no measure is developed in the original WQ® protocol), should be included and evaluated in the MWQ protocol. This would highly affect the well-being and health of the animal, especially if the animal is being very hot or have a low body condition score. More questions or parameters related to seasonal factors could be included in the MWQ protocol.

An important factor of assessing the health, such as the number of diseased animals in a farm, is the herd size, varying from 7 to 90 cows in this study. One single animal presenting signs of disease or signs of injury can result in a high percentage of diseases or injuries if the herd is small. This might give a false reflection of the health condition in the herd. A low score for "absence of disease" may be influenced if the herd size is small, which shows number of animals with a visible disease divided by 15. A herd with fewer animals than 15 may result in a higher score of diseased animals, compared to a herd with a higher number of animals in a herd that also is divided by 15, to give a representative score. Suggestions are instead to divide the number of diseased animals with the actual number of adult animals on the farms, when the herds are small.

6.5.3 Reliability of the farm questionnaire

The welfare indicator "mortality of animals" (Appendix A) was examined in all farms, and the results was extremely varied (0-38 %). However, the results of the variable were depending on many factors, and the results may not be reliable. It is possible that many farmers did not want to answer correctly or diminish the truth, to decrease eventual bad reputations, or simply did not know the actual number of diseased animals. The farmers did not keep any animal records, complicating this type of recording. Other welfare indicators are also hard to implement since the lack of recordings, such as number of animals at the farm and number of milk producing animals at the farm. This was in many farms not fully assured. During the interviews, many answers to the number of animals or milk producing animals were told not to be certain and some were guesses, especially if it was a larger herd. Nevertheless, the experience of farmers or workers may also be questioned whether it is valuable, in some cases the workers hold more knowledge than the farmers being interviewed, or the time of experience of farm work necessarily not matching the actual knowledge. This may be reflected in the question of "mortality of animals" and health parameters affecting the results in "good health".

6.6 Further development of the MWQ protocol of the present study

A development of the modified welfare quality protocol is necessary in relation to behaviour and health. This followed by a suggestion to adjust it to different seasons and weather, since it differs depending on feed access and water provision, affecting the health and body condition score. In some cases, a dry season may even affect the behaviour of the animals.

The assessed health parameters being divided by 15 animals to give a representative mean score may be more accurate scored if median value are calculated instead. This is a better way of reflecting these small animal populations since the median value gives a center value, while the mean value can get unevenly distributed if there is only few animals with different

values in a small herd. Suggestions for future studies are that median values are used instead of mean values when calculating health scores.

6.6.1 Important aspects of a sustainable production

Most probably, the present farmers do not require improved economy or education, they may have knowledge but lack motivation, or are simply satisfied. This may create a risk for the development of necessary welfare criteria, such as "absence of disease" or "absence of pain induced by management procedures". Also, considering their correlation this may contribute to further difficulties improving both criteria of the farms assessed. Questions raised for the future are, what is important; quantity or quality of milk, many cows with low production versus fewer with higher production. There are discussions of what is sustainable and what is important in this area, what should be in focus. Some cows can milk more but with low quality, which could give the farmers a lower payment. An on-going and future progress with the farmers in the study is to use a better network, to increase the milk contents fatty acids Omega 3 and 6, eventually decrease the bacteria amount and improve the milk hygiene of the milk storage, to get a higher payment, better milk quality and better animal welfare. This is a continuing process with the Universidad Nacional Autónoma de México (UNAM), Universidad Autónoma de Chiapas and the interested farmers in the area.

A high production is not as important as keeping the cows alive and healthy with a good animal welfare. A major issue on the observed farms is very lean cows or even malnutrition, and this requires an animal husbandry that observes and keeps the cattle in a higher body condition score. This will increase the production and health to a low cost if more animals stay alive, especially if provided grass with a higher nutrition content or the farmers are able to provide good concentrates. It is important for the farmers to keep a balance so that the extra milk actually pays off with the increased health and welfare. The challenge is to assess and implement this. Farmers are not going to change their management unless provided an economical encouragement. This affects the management procedures, where prevention of pain induced by management procedures with analgesia or anaesthesia may not be applied unless the farmers get economic benefits. Veterinarians and agronomists that work with the farmers could give expert advice to improve the situation for each farmer.

6.6.2 Choice of area and time for the study

One suggestion is to change the animal husbandry depending of the quality of the season, for example to let the calf suckle just before or after milking instead of twice if the season is dryer than usual and the cows have difficulties sustaining its body condition. Also, it would be of value to add supplements in some cases, and to grow other improved grass species varieties during the dry periods. To deworm all animals during the wet season, with higher access to grass, would also improve the health. To improve the social interaction and health it would be beneficial to let the cow spend more time with the calf during longer periods or all day. It would also be advantageously to do further studies in other areas in the country, other states with equal extensive systems, and during other seasons.

6.6.3 Future studies necessary

For further studies, important aspects are that it was colder temperature in the mornings during milking when we assessed the animals compared to later in the afternoon. This may have affected the proportion of animals that were lying down, standing in the shade,

ruminating, aggressions in the milking pen, competition for food, milking, bull or space etc. Area and space is also something worth considering in relation to behaviour.

According to the extended study of maternal and sexual behaviours and calf interactions, this has to be developed further. This study was aiming to get an overall picture of the actual behaviours necessary for assessment. To evaluate and compare the farms, equal number of animals requires assessment at each farm during, for example, one hour. This may also be divided by two, hence the two-hour assessment of today. It may also be considered as a separate behavioural study, however in this case further developments are necessary to acquire optimal behaviour assessment.

7 CONCLUSIONS

The animal welfare quality was, with focus on health and behaviour, in general good at the dual-purpose cattle herds under rural tropical conditions in Chiapas, Mexico. The main findings were that "absence of disease" and "absence of pain induced by management procedures" were areas that required improvements to achieve a better animal welfare. These criteria also correlated. The welfare criteria "expression of other behaviours" and "good human-animal relationship" acquired the highest scores of animal welfare. The behaviour was good according to the protocol and the animals appeared to be healthy and prosperous, indicating a major benefit for animals in these types of systems mainly kept on pasture providing a standard with good animal welfare. Also, this study presented a major maternal behaviour, being one of the natural behaviour of the cow if given the opportunity. Further improvements of the MWQ protocol are required and future studies should focus on health care management to improve "good health". Knowledge or motivation are important to enable improvement of the animal welfare in the area, and to find alternative management practices with economical potential to increase the productivity. The Welfare Quality® Assessment Protocol can be used in rural areas in developing countries, with the modifications necessary and according to this master thesis.

8 ACKNOWLEDGEMENTS

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10 APPENDIX

10.1 APPENDIX A. Collection of farm data – interview protocol

Production

Inventory of animals	
Total of animals:	

Milk production	
Average milk production kg/cow/day:	
Number of animals in milk production:	
Hygiene at milking:	
Main purchasers of milk:	

Beef production	
Number of animals/month:	
Main purchasers of beef:	

Medical care

Veterinary assistance		
Regular veterinary assistance	Occasional veterinary assistance	No veterinary assistance

Procedures and frequency	
Vaccination (specify):	
Internal deworming	
External deworming	
Curative care	

Procedure applied by	Veterinary	Owner	Worker
Vaccination			
Deworming			
External deworming			

Procedure	Analgesia		Place		Applied by		
	Yes	No	Specific place	Anywhere	Veterinary	Owner	Worker
Castration							
Dehorning							
Disbudding							
Tail docking							
Hoof trimming							
Ear tagging							
Tattoo							
Branding iron							
Supernumerary nipple removal							
Nose ring							
Other (Specify):							

Reproductive assistance

Reproductive assistance		
Free natural mating	Controlled natural mating	Artificial insemination (A.I.)

Food

Food source			
Own production	Local production	National production	Foreign production
Organic		Non-organic	
Non-processed		Processed	

Food storage		
Clean and dry place designated to food storage only	Clean and dry place shared with any other stuff	Uncontrolled place

Waste management

Faeces disposal	
Faeces disposal in open spaces	
Faeces disposal in milking parlour	
Faeces disposal in pens	
Corpses' disposal:	
Other organic waste disposal:	
Inorganic waste disposal:	

Infrastructure

Milking parlour		
Automatic milking machine	Partial automatic milking machine	Manual milking

Infrastructure	
Night pens:	
Infrastructure for shade:	
Infrastructure for heat dissipation:	
Infrastructure for cleanliness:	
Livestock crush:	
Silo:	

Farm accessibility

Distance from purchasers:	
Distance from slaughterhouse:	
Paved road:	

Farm facilities

Farm clothes		
Special for farm	Spare change clothes brought by workers	Everyday clothes brought by workers
Farm vehicles:		

Farm owner

Age:	
Sex:	
Education:	
Time dedicated to farming:	
Time being a farmer:	

Workers

Number:	
Age:	
Sex:	
Education:	
Family related:	
Experience:	

Other

Any additional information about the farm:

10.2 APPENDIX B. Modified Welfare Quality Assessment protocol for cattle

10.2.1 Good feeding

Absence of prolonging hunger

Title	Body condition score		
Scope	Animal-based measure: family-farm system cows		
Sample size			
Method description	View the animal from behind and from side in the loin, tail head and vertebrae. Animals must not be touched but only watched. Animals are scored with regard to four criteria as follows;		
	Body region	Very lean	Very fat
	Cavity around tail head	Cavity around tail head	Tail head cavity full and folds of fatty tissue present
	Loin	Visible depression between backbone and hip bones (tuber coxae)	Convex between backbone and hip bones (tuber coxae)
	Vertebrae	Ends of transverse processes distinguishable	Transverse processes not discernible
	Tail head, hipbones, spine and ribs	Tail head, hip bones (tuber coxae), spine and ribs visible	Outlines of fat patches visible under skin
	Individual level: 0 –Regular body condition 1 –Very lean 2 –Very fat		
Classification	Herd level: Percentage of very lean cows Percentage of very fat cows		
Optional additional information	Based in dual purpose breeds		

Absence of prolonged thirst

Title	Water provision
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	All water points in question are assessed within the area of the animal unit where behavioural observations have been made. Check the type of the water points per area of study, and count the number of animals per area. In the case of open troughs, measure the length of the trough. In the case of bowls with reservoirs, bowls, nipple drinkers or drinkers with balls/antifrost devices, count the number of water points.
Classification	Group level: Number of animals and number of each type of water points. Length of troughs in cm.

Title	Cleanliness of water points
Scope	Animal-based measure: family-farm system cows
Sample size	

Method description	All water points in question are assessed within the area of the animal unit where behavioural observations have been made.
	Check the cleanliness of the water points with regard to the presence of old or fresh dirt on the inner side of the bowl or trough as well as staining of the water.
	Water points are considered as clean when there is no evidence of crusts of dirt and/or decayed food residues. Note that some amount of fresh food is acceptable.
	In case of natural water points consider water aspect, odour and colour, and whether it is still or running water.
Classification	Group level: 0 –Clean: drinkers and water clean at moment of inspection 1 –Partly dirty: drinkers dirty, but water fresh and clean at moment of inspection or only part of several drinkers clean and containing clean water. 2 –Dirty: drinkers and water dirty at moment of inspection

Title	Number of animals using the water points
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	All water points in question are assessed within the area of the animal unit where behavioural observations have been made.
	Count the number of animals in the area of study that have access to the water points.
Classification	Group level: Number of animals in the area of study having access to the water points

10.2.2 Good housing

Comfort around resting

Title	Time needed to lie down
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	This measure applies to all adult animals, and applies to all observable "lying down" movements (minimum sample size of 6 or 8 is required).
	Time needed to lie down is recorded continuously according to the following method: time recording of a lying down sequence starts when one carpal joint of the animal is bent and lowered (before touching the ground). The whole lying down movement ends when the hind quarter of the animal has fallen down (touched the ground) and the animal has pulled the front leg out from underneath the body.
	Record the time needed to lie down. Observations in large spaces should be divided in segments with not more than 25 animals per segment. Total net (overall) observation in the farm (together with social behaviour). Minimum duration of observation per area/segment is 10 minutes.
	Individual level: Duration of lying down movement in seconds
Classification	Group level: Mean duration of lying down movement in seconds
Title	Animals colliding with housing equipment during lying down (Only if applies)
Scope	Animal-based measure: family-farm system cows
Sample size	

Method description	This measure applies to all adult animals kept in confined spaces. It considers all lying down movements for which time needed to lie down has been recorded (minimum sample size of 6 is required).
	A collision is defined as occurring during lying down; the cow collides with or contacts housing equipment with any part of the body (usually hind quarter or side). The collision is obviously seen or heard.
	Collisions with housing equipment are recorded continuously in the focus segment. The duration of a lying down movement is only taken when undisturbed by other animals or human interaction and, in case of cubicles and littered systems, if it takes place on the supposed lying area. Observations take place in segments of the barn.
	Individual level: 0 –No collision 2 –Collision
Classification	Herd level: Percentage of animals colliding with housing equipment (i.e. score 2)

Title	Animals lying partly or completely outside the lying area/shade		
Scope	Animal-based measure: family-farm system cows		
Sample size			
Method description	In confined spaces: Assess the number of animals which are lying and how many of them are lying with their hind quarter on the edge of the cubicle or the deep littered area (edge markedly pressing into the hind leg of the animal), lying with hind quarter (both hind legs) or completely outside the supposed lying area (cubicles, deep littered area).		
	Observations take place in segments of the observation area. Animals lying partly/completely outside the lying area are recorded at the start and at the end of each segment observation.		
	In open spaces: Assess the number of animals which are lying and how many of them are lying with their hind quarter outside a natural or artificial shade.		
	Group level: Number of animals lying Number of animals lying partly/completely outside lying area/shade		
Classification	Herd level: Percentage of animals lying partly/completely outside lying area/shade out of all lying animals		

Title	Cleanliness of the animals
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	From a distance not exceeding 2 m, one side of the focal animal is examined including as much of the underbelly as is visible but excluding head, neck and legs below the carpal joint and hock (tarsal joint), respectively.
	Evaluations under pasture conditions will have to take place at a minimum of 5 mts using a pair of binoculars to accurately assess their welfare. The conditions under pasture make it rather difficult to assess them closer.
	The criterion for cleanliness is the degree of dirt on the body parts considered: • covering with liquid dirt • plaques: three-dimensional layers of dirt

	Random selection of the side of the animal observed (left or right) has to be ensured. To prevent biased results, the side selection has to be done before the examination. In most cases, the side which is seen first when approaching the animal can be chosen.
	Individual level: 0 –Less than 25% of the area in question covered with plaques, or less than 50% of the area covered with liquid dirt 2 –25% of the area in question or more covered with plaques, or more than 50% of the area covered with liquid dirt
Classification	Herd level: Percentage of dirty animals (score 2)

Thermal comfort

This part is quite important as heat dissipation in animals in the tropics should have to be measured, the presence of trees, shades made by humans as opposed to natural shades will need to be accounted for. Useful measurement could be THI (temperature, humidity index) of the black globe thermometer.

Ease of movement

Title	Pen features according to live weight (Only if applies)
Scope	Animal-based measure: family-farm system cows
Sample size	Animal unit
Method description	The length and width of the pens is measured. The number of animals in each pen is counted. The average weight of the cattle is estimated in each pen in categories of 100 kg (e.g. 200, 300, 400… kg).
Classification	Group level: Length/width in m and Number of animals and Estimated weight of the animals in kg (per 100 kg)

10.2.3 Good health

Absence of injuries

Title	Lameness
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Lameness describes an abnormality of movement and is most evident when the animal (and so the legs) is in motion. It is caused by reduced ability to use one or more limbs in a normal manner. Lameness can vary in severity from reduced mobility to inability to bear weight. Assess the animal for presence of one of the indicators mentioned below, according to the description for either standing or moving animals. Indicators in moving animals: Irregular foot fall Reluctance to bear weight on a foot Uneven temporal rhythm between hoof beats Weight not borne for equal time on each of the four feet Indicators in standing animals: Resting a foot (bearing less/no weight on one foot). Frequent weight shifting between feet ("stepping"), or repeated movements of the same foot

	Standing on the edge of a step
	Individual level: 0 –No evidence of lameness: animals showing none of the indicators listed above 2 –Evidence of lameness: animals showing one indicator in the case of either moving or standing animals
Classification	Herd level: Percentage of not lame animals (score 0) Percentage of moderately lame animals (score 1) Percentage of severely lame animals (score 2)

Title	Integument alterations (hairless patches and lesions/swellings)
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Integument alternations are defined as hairless patches and lesions/swellings. Assess one side of the animal for integument alterations. Hairless patches and lesions/swellings are counted in accordance with the criteria provided below: Only skin alterations of a minimum diameter of 2 cm at the largest extent are counted. Hairless patch • Area with hair loss • Skin not damaged • Extensive thinning of the coat due to parasites • Hyperkeratosis possible Lesion/swelling • Damaged skin either in form of a scab or a wound • Dermatitis due to ectoparasites • Ear lesions due to torn off ear tags • Completely or partly missing teats From a distance not exceeding 2 m, three body regions on one side of the assessed animal have to be examined with regard to the criteria listed above. Evaluations under pasture conditions will have to take place at a minimum of 5 mts using a pair of binoculars to accurately assess their welfare. The conditions under pasture make it rather difficult to assess them closer. These body regions are scanned from the rear to the front, excluding the bottom side of the belly and the inner side of the legs, but including the inner side of the opposite hind leg. Random side selection (left or right) has to be ensured. To prevent biased results, the side selection has to be done before the examination. In most cases, the side which is seen first when approaching the animal can be chosen. In the case of more than 20 alterations per category only ">20" is noted. The maximum (">20") is also given if the area affected is at least as large as the size of a hand.

	If there are different categories of alterations at the same location (e.g. swelling and lesion at one leg joint) or adjacent to each other (e.g. around hairless patch with a lesion in its centre) all these alterations are counted. Individual level: Number of hairless patches Number of lesions/swellings
Classification	Herd level: Percentage of animals with no integument alteration (no hairless patch, no lesion/swelling) Percentage of animals with mild integument alterations (at least one hairless patch, no lesion/swelling) Percentage of animals with severe integument alterations (at least one lesion/swelling)
Optional additional information	For the calculation of scores, this measure is taken into account as the total number of counts from all body regions. However, for advisory purposes more detailed information may be necessary.

Absence of disease

Title	**Coughing**
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Coughing is defined as a sudden and noisy expulsion of air from the lungs. The number of coughs is counted using continuous observations, in the case of very large areas, in segments. Per segment not more than 25 animals should be assessed on average. Total net observation time is 120 minutes. Recording of coughs is carried out together with social behaviour and resting behaviour observations.
Classification	Herd level: Mean number of coughs per animal in 15 min.

Title	**Nasal discharge**
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Nasal discharge is defined as clearly visible flow/discharge from the nostrils; it can be transparent to yellow/green and often is of thick consistency. Animals are scored with regard to the nasal discharge criteria. Individual level: 0 –No evidence of nasal discharge 2 –Evidence of nasal discharge
Classification	Herd level: Percentage of animals with nasal discharge (score 2)

Title	**Ocular discharge**
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Ocular discharge is defined as clearly visible flow/discharge (wet or dry) from the eye, at least 3 cm long. Animals are scored with regard to the ocular discharge criteria.

	Individual level:
	0 – No evidence of ocular discharge
	2 – Evidence of ocular discharge
Classification	Herd level:
	Percentage of animals with ocular discharge (score 2)

Title	**Hampered respiration**
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Hampered respiration rate is defined as deep and overtly difficult or laboured breathing. Expiration is visibly supported by the muscles of the trunk, often accompanied by a pronounced sound. Breathing rate may only be slightly increased.
	Animals are scored with regard to the criteria for hampered respiration.
	Individual level:
	0 – No evidence of hampered respiration
	2 – Evidence of hampered respiration
Classification	Herd level:
	Percentage of animals with hampered respiration (score 2)

Title	**Diarrhoea**
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Diarrhoea is defined as loose watery manure below the tail head on both sides of the tail, with the area affected at least the size of a hand.
	Animals are scored with regard to the criteria of diarrhoea.
	Individual level:
	0 – No evidence of diarrhoea
	2 – Evidence of diarrhoea
Classification	Herd level:
	Percentage of animals with diarrhoea (score 2)

Title	**Bloated rumen**
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Bloated rumen is defined as a characteristic "bulge" between the hip bone and the ribs on the left side of the animal.
	Animals are scored with regard to the criteria of bloated rumen.
	Individual level:
	0 – No evidence of bloated rumen
	2 – Evidence of bloated rumen
Classification	Herd level:
	Percentage of animals with bloated rumen (score 2)

Title	**Mortality**
Scope	Animal-based measure: family-farm system cows
Sample size	Animal unit

Method description	Mortality is defined as the 'uncontrolled' death of animals as well as cases of euthanasia and emergency slaughter.
	The animal unit manager is asked about the number of animals which died on the farm, were euthanized due to disease or accidents, or were emergency slaughtered during the last 12 months. Additionally the average number of animals with a weight of more than 200 kg live weight in the animal unit is asked. Farm records may also be used.
Classification	Herd level
	Percentage of animals dead, euthanized and emergency slaughtered on the farm during the last 12 months.

Absence of pain induced by management procedures

Title	Disbudding/dehorning
Scope	Animal-based measure: family-farm system cows
Sample size	Animal unit
Method description	The animal unit manager is asked about the disbudding/dehorning practices on the farm with regard to the following: • Procedures for disbudding calves or dehorning cattle • Use of anaesthetics • Use of analgesics
Classification	Herd level: 0 –No dehorning or disbudding 1 –Disbudding of calves using thermocautery 2 –Disbudding of calves using caustic paste 3 –Dehorning of cattle and 0 –Use of anaesthetics 2 –No use of anaesthetics and 0 –Use of post-surgery analgesics 2 –No use of analgesics

Title	Tail docking
Scope	Animal-based measure: family-farm system cows
Sample size	Animal Unit
Method description	The animal unit manager is asked about tail docking practices on the farm with regard to the following: • Procedures for tail docking • Use of anaesthetics • Use of analgesics
Classification	Herd level: 0 –No tail docking 1 –Tail docking using rubber rings 2 –Tail docking using surgery and 0 –Use of anaesthetics 2 –No use of anaesthetics and 0 –Use of analgesics 2 –No use of analgesics

Title	Castration
Scope	Animal-based measure: family-farm system cows
Sample size	Animal unit

Method description	The animal unit manager is asked about castration practices on the farm with regard to the following: • Procedures for castration • Use of anaesthetics • Use of analgesics
Classification	Herd level: 0 –No castration 1 –Castration using rubber rings 2 –Castration using Burdizzo 3 –Castration using surgery and 0 –Use of anaesthetics 2 –No use of anaesthetics and 0 –Use of analgesics 2 –No use of analgesics

10.2.4 Appropriate behaviour

Expression of social behaviours

Title	Agonistic behaviours
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Agonistic behaviour is defined as social behaviour related to social hierarchy and includes aggressive as well as submissive behaviours. Here, only aggressive interactions are taken into account. Assess the occurrence of the behaviours listed below. Areas with more than 25 animals are divided into 2 or more segments, which will be observed for 10 min each. Animals with a weight between 200 and 350 kg and animals with more than 350 kg live weight are observed proportionally to their presence within the observation time. Observations should always be approximately randomly distributed across the area and also within the weight categories. Total net (overall) observation time is 120 minutes. Minimum duration of observation per segment is 10 minutes. Agonistic behaviours are recorded using continuous behaviour sampling always taking the animal carrying out the action (actor) into account. Interactions between animals in different segments are recorded if the head of the animal carrying out the action (actor) is located in the focus segment.
	Parameter	Description
	Head butt	Interaction involving physical contact where the actor is butting, hitting, thrusting, striking or pushing the receiver with forehead, horns or horn base with a forceful movement; the receiver does not give up its present position (no displacement, see definition below).
	Displacement	Interaction involving physical contact where the actor is butting, hitting, thrusting, striking, pushing or penetrating the receiver with forehead, horns, horn base or any other part of the body with a forceful movement and as a result the receiver gives up

		its position (walking away for at least half an animal-length or stepping aside for at least one animal-width). Penetrating is defined as an animal forcing itself between two other animals or between an animal and barn equipment (e.g. at feeding rack, at water trough). If after a displacement neighbouring animals also leave their feeding places but physical contact as described above is not involved, this reaction is not recorded as displacement.
	Chasing	The actor makes an animal flee by following fast or running behind it, sometimes also using threats like jerky head movements. Chasing is only recorded if it follows an interaction with physical contact. If, however, chasing occurs in the context of fighting then it is not counted separately.
	Fighting	Two contestants vigorously pushing their heads (foreheads, horn bases and/or horns) against each other while planting their feet on the ground in 'sawbuck' position and both exerting force against each other. Pushing movements from the side are not recorded as head butt as long as they are part of the fighting sequence. A new bout starts if the same animals restart fighting after more than 10 seconds or if the fighting partner changes.
	Chasing-up	The actor uses forceful physical contact (e.g. butting, pushing, and shoving) against a lying animal which makes the receiver rise.
		Before starting and after finishing the behaviour observation in the area/segment the number of animals present in the area/segment has to be counted. In the case of multiple segments, animals which are found lying, standing or feeding across the boundaries of segments are counted in the section where the main part of their body is situated. Note that agonistic and cohesive behaviours are recorded at the same time and therefore the number of animals at the start and the end of each observation period is only recorded once. Group level: Number of animals in the area/segment at the start and the end of each observation period. Number of aggressive behaviours per area/segment and observation period. Duration of observations
Classification		Herd level: Mean number of aggressive behaviours per animal and hour

Title	Cohesive behaviours
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Cohesive behaviour is defined as behaviour promoting group cohesion. Assess the occurrence of the behaviours listed below. Areas with more than 25 animals are divided into 2 or more segments, which will be observed for 10 min each.

<table>
<tr><td rowspan="3"></td><td colspan="2">Animals with a weight between 200-350 kg and animals with more than 350 kg live weight are observed proportionally to their presence. Observations should always be approximately randomly distributed across the area and also within the weight categories.

Total net (overall) observation time is 120 minutes. Minimum duration of observation per area/segment is 10 minutes. Cohesive behaviours are recorded using continuous behaviour sampling always taking the actor into account. Interactions between animals in different segments are recorded if the actor's head is located in the focus segment.

Before starting and after finishing the behaviour observation in the area/segment the number of animals present in the area/segment has to be counted. In the case of multiple segments, animals which are found lying, standing or feeding across the boundaries of segments are counted in the section where the main part of their body is situated.</td></tr>
</table>

	Parameter	Description
	Social licking	The actor touches with its tongue any part of the body (head, neck, torso, legs, and tail) of another group mate except for the anal region or the prepuce. If the actor stops licking for more than 10 s and then starts licking the same receiver again, this is recorded as a new bout. It is also taken as a new bout, if the actor starts licking another receiver or if there is a role reversal between actor and receiver.
	Horning	Head play with physical contact of two animals: The animals rub foreheads, horn bases or horns against the head or neck of one another without obvious agonistic intention. Neither of the opponents takes advantage of the situation in order to become a victor. It is taken as a new bout if the same animals start horning after 10 seconds or more or if the horning partner changes.
		Note that agonistic and cohesive behaviours are recorded at the same time and therefore the number of animals at the start and the end of each observation period is only recorded once.

Group level:
Number of animals in the area/segment at the start and the end of each observation period.
Number of cohesive behaviours per area/segment and observation period.
Duration of observations. |
| **Classification** | | Herd level:
Mean number of cohesive behaviours per animal and hour |

Good human-animal relationship

Title	Avoidance distance
Scope	Animal-based measure: family-farm system cows
Sample size	
Method description	Test at least half of the animals in the study area. The animals selected for the behavioural observations should be included.

Place yourself on the feed bunk at a distance of 3 meters (if possible) in front of the animal to be tested. The head of the animal has to be completely past the feeding rack / neck rail over the feed. If you do not have 3 meters in front of the animals in |

which to approach them, then choose an angle of up to 45 degrees with the feeding rack, and start at a distance of 3.5 meters. If a distance of 3.5 meters is not possible, continue with the assessment but note down the maximum distance possible on the recording sheet.

Make sure that the animal is attentive or is taking notice of your presence. If an animal is not obviously attentive, but also not clearly distracted, it can be tested. A way to attract the animals' attention is to make some movements in front of them (at the starting position).

Approach the animal at a speed of one step per second and a step length of approximately 60 cm with the arm held overhand at an angle of approximately 45° from the body. When approaching, always direct the back of the hand toward the animal. Do not look into the animal's eyes but look at the muzzle. Continue to walk towards the animal until signs of withdrawal occur, or until you can touch the nose/muzzle.

Withdrawal movement is defined as the following behaviours: the animal moves back, turns the head to the side, or pulls back the head trying to get out of the feeding rack; head shaking can also be found. In the case of withdrawal the avoidance distance is estimated (= distance between the hand and the muzzle at the moment of withdrawal) with a resolution of 10 cm (300 cm to 10 cm possible). If withdrawal takes place at a distance lower than 10 cm, the test result is still 10 cm. If you can touch the nose/muzzle, an avoidance distance of zero cm is recorded.

Make sure that the hand is always closest to the animal during the approach (not the knee or the feet). Especially when getting close to animals that are feeding or have their heads in a low position, bend a little in order to try to touch them.

Note that neighbouring animals react to an animal being tested and so should be tested later on. In order to reduce the risk of influencing the neighbour's test result, every second animal can be chosen.

Retest animals at a later time if the reaction was unclear.

Individual level:
0 – The assessor can touch the animal
1 – The assessor can approach closer than 50 cm but cannot touch the animal
2 – The assessor can approach within 100 to 50 cm
3 – The assessor cannot approach as close as 100 cm

Classification	Herd level: Percentage of animals that can be touched Percentage of animals that can be approached closer than 50 cm but not touched Percentage of animals that can be approached as closely as 100 to 50 cm Percentage of animals that cannot be approached as closely as 100 cm

Positive emotional state

Title	Qualitative behaviour assessment
Scope	Animal-based measure: family-farm system cows
Sample size	Animal unit
Method description	Qualitative Behaviour Assessment (QBA) considers the expressive quality of how animals behave and interact with each other and the environment, i.e. their 'body language'. Select between one and eight observation points (depending on the size and structure of the farm) that together cover the different areas of the farm. Decide

	the order to visit these observation points, wait a few minutes to allow the animals to return to undisturbed behaviour. Watch the animals that can be seen well from that point and observe the expressive quality of their activity at group level. It is likely that the animals will initially be disturbed, but their response to this can be included in the assessment. Total observation time should not exceed 20 minutes, and so the time taken at each observation point depends on the number of points selected for a farm:								
	Number of observation points	1	2	3	4	5	6	7	8
	Duration of observation per observation point in minutes	10	10	6.5	5	4	3.5	3	2.5

When observation at all selected points has been completed, find a quiet spot and score the 20 descriptors using the visual analogue scale (VAS). Please note that scoring is not done during observation, and that only one integrative assessment is made per farm.

Each VAS is defined by its left 'minimum' and right 'maximum' point. 'Minimum' means that at this point, the expressive quality indicated by the term is entirely absent in any of the animals you have seen. 'Maximum' means that at this point this expressive quality is dominant across all observed animals. Note that it is possible to give more than one term a maximum score; animals could for example be both entirely calm and entirely content.

To score each term, draw a line across the 125 mm scale at the appropriate point. The measure for that term is the distance in millimetres from the minimum point to the point where the line crosses the scale. Do not skip any term.

Please be aware when scoring terms that start with a negative pre-fix, such as unsure or uncomfortable, as the score gets higher, the meaning of the score gets more negative, not more positive.

The terms used for QBA are:

Active	Indifferent	Nervous
Relaxed	Frustrated	Boisterous
Uncomfortable	Friendly	Uneasy
Calm	Bored	Sociable
Content	Positively occupied	Happy
Tense	Inquisitive	Distressed
Enjoying	Irritable	

Classification

Herd level:
Continuous scales for all body language parameters from minimum to maximum

10.3 APPENDIX C. Calculation of scores
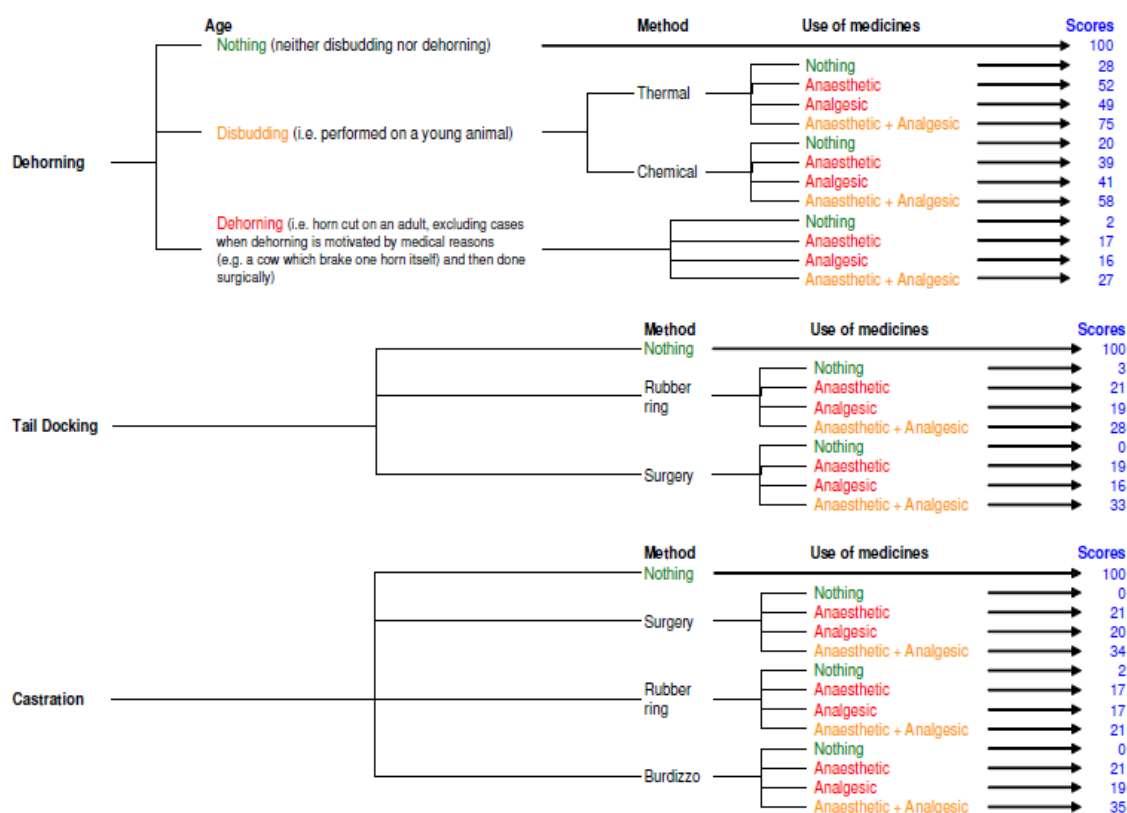
Figure 12. A "decision tree" applied to the welfare criterion "absence of pain induced by management procedures" (Hernández, origin Welfare Quality®, 2009).

Partial score for integument alterations	
When Ii <65	Score =(0.43168*Ii)-(0.0065044*Ii^2)+(0.00012589*Ii^3)
When Ii >65	Score=(29.8965836056+-0.9444498651*Ii)+(0.0145299979*Ii^2)+(0.0000192484*Ii^3)
Partial score for lameness	
When Ii <78	Score =(0.0988*Il)-(0.000955*Il²)+(5.34E^{-05}*Il³)
When Ii >78	Score =-2060+(79.3*Il)-(1.02*Il²)+(0.00439*Il³)
Good human-animal relationship	
When I < 65	Score=(1.44732957*I)-(0.02226661*I^2)+(0.00019627*I^3)
When I > 65	Score=117.471056-(3.97441147*I)+(0.06114479*I^2)-(0.00023148*I^3)

Figure 13. Use of "weighted sum and I-spline functions" applied to the welfare criteria "absence of integument alterations", "absence of lameness" and "good human-animal relationship" (Hernández, origin Welfare Quality®, 2009).

Expression of social behaviours		
If Y1 < 0.5	When I < 85	Score=57.9999745363695+(0.388083494115609*I)+(0.0043823226865423*I^2)-(4.70122820048543*10^-5*I^3)
	When I > 85	Score=-1103.05408986355+(41.3664545487207*I)-(0.477716075811182*I^2)+(0.00184356936389565*I^3)
If 0.5 < Y1 < 1.5	When I < 85	Score=33.9999521188202+(0.682099060722142 x I) -(0.00195952922169403*I^2)-(1.25327903803408*10^-5*I^3)
	When I > 85	Score=-5409.99869694617+(192.823191797772*I)-(2.26244257697619*I^2)+(0.00885210516370731*I^3)
If 1.5 < Y1 < 3	When I < 85	Score=23.9999360534004+(0.555539107885598*I)-(-0.00316998938699416*I^2)+(0.121211485198511*10^-5*I^3)
	When I > 85	Score=-9244.0877565184+(327.664455108955*I)-(3.85150950305552*I^2)+(0.0150927371526195*I^3)
If 3 < Y1 < 8	When I < 85	Score=7.99996220862464+(0.479014947625655*I)-(0.00377860309080861*I^2)+(0.862849506660717*10^-5*I^3)
	When I > 85	Score=-13321.8892279187+(470.945604038117*I)-(5.538 67868184848*I^2)+(0.0217141154552035*I^3)
If 8 < Y1	When I < 85	Score=1.84771270333218E-05+(0.195437882151419*I)-(0.00229926920215343*I^2)+(0.901674197170915*10^-5*I^3)
	When I > 85	Score=-17183.1466985407+(606.659326014577*I)-(7.13716729244669*I^2)+(0.0279888867759231*I^3)

Figure 14. Use of "Choquet integrals" of the welfare criterion "expression of social behaviour" (Hernández, origin Welfare Quality®, 2009).

Absence of disease

Measure	Description of the measure	Warning threshold	Alarm threshold
Nasal discharge	% of animals with nasal discharge	5%	10%
Ocular discharge	% of animals with ocular discharge	3%	6%
Coughing	nb of coughs (during 15 min) / nb of animals in the herd	4%	8%
Hampered respiration	% of animals with hampered respiration	5%	10%
Bloated rumen	% of animals with bloated rumen	5%	10%
Diarrhoea	% of animals with diarrhoea	3%	6%
Mortality	nb of dead animals * during a year / nb of animals in the herd	2%	4%

If in an area, the frequency of at least one symptom is above the warning threshold and the others are below the alarm threshold, there is a warning s attributed to the area

If in an area, the frequency of one symptom is above the alarm threshold, then an alarm is attributed to the area

When I <70	Score =(0.39094656*I)+(0.00217984*I^2)+(3.0794*10^-5x I^3)
When I >70	Score =-105.607674+(4.91698974*I)-(0.06247792*I^2)+(0.00033869*I^3)

Figure 15. Use of "alarm thresholds" applied to the welfare criterion "absence of disease" (Hernández, origin Welfare Quality®, 2009).

10.4 APPENDIX D. Evaluation scores of the 34 farms

Table 2. Scores for each farm for each indicator of animal welfare. Scores below minimum threshold for the acceptable level are highlighted in yellow. "Ease of movement" and "expression of other behaviours" were excluded from the table since all farms obtained the maximum score (= 100) for these indicators.

Farm	Absence of prolonged hunger	Absence of prolonged thirst	Comfort around resting	Absence of injuries	Absence of disease	Absence of pain induced by management procedures	Expression of social behaviours	Good human-animal relationship	Positive emotional state
1	20.2	29.0	100.0	99.8	54.6	38.1	65.2	100.0	94.5
2	5.1	29.0	65.0	90.0	54.6	38.1	19.0	100.0	91.1
3	39.3	93.0	100.0	99.8	16.6	15.7	92.6	100.0	92.2
4	20.2	46.0	100.0	99.8	54.6	38.1	92.6	99.7	95.9
5	6.4	13.0	78.0	83.3	54.6	38.1	87.2	99.3	63.4
6	10.5	46.0	100.0	70.9	81.0	38.1	92.6	100.0	100.0
7	12.8	46.0	100.0	96.9	81.0	31.2	100.0	100.0	83.9
8	39.3	46.0	98.5	99.8	81.0	31.2	91.3	99.8	91.4
9	30.3	93.0	77.7	97.2	100.0	31.2	92.6	100.0	99.3
10	30.3	13.0	82.1	99.8	81.0	38.1	92.6	99.3	99.3
11	12.8	38.0	100.0	97.2	54.6	15.7	92.6	99.5	93.3
12	30.3	46.0	100.0	99.8	100.0	100.0	92.6	99.8	95.1
13	57.0	46.0	90.6	85.9	28.8	15.7	92.6	99.8	99.3
14	30.3	46.0	95.8	96.9	44.9	15.7	71.6	99.7	99.3
15	23.3	93.0	100.0	99.8	28.8	38.1	31.4	99.8	17.2
16	38.7	38.0	63.9	99.8	81.0	15.7	92.6	99.9	72.9
17	16.1	46.0	94.3	75.3	11.6	15.7	71.6	99.7	92.3
18	20.0	93.0	95.1	97.2	44.9	31.2	93.6	100.0	100.0
19	23.3	93.0	86.6	99.8	28.8	31.2	92.6	99.7	99.3
20	20.0	46.0	91.0	99.8	11.6	31.2	61.2	99.9	100.0
21	24.7	93.0	78.8	97.2	36.3	15.7	77.5	99.8	99.3
22	3.8	46.0	100.0	87.3	36.3	15.7	80.0	99.9	23.8
23	20.0	46.0	35.1	75.3	22.3	15.7	92.6	99.7	99.3
24	6.5	38.0	92.2	99.8	54.6	31.2	86.9	100.0	100.0
25	38.7	38.0	50.3	99.8	7.3	31.2	92.6	99.8	99.3
26	3.8	38.0	100.0	99.8	81.0	31.2	55.1	100.0	100.0
27	30.3	46.0	92.8	99.8	22.3	31.2	85.7	99.6	99.3
28	20.0	20.0	100.0	73.0	54.6	31.2	100.0	99.8	100.0
29	30.3	46.0	65.7	73.0	54.6	15.7	69.7	99.6	99.3
30	3.8	20.0	100.0	99.8	28.8	31.2	100.0	99.8	99.3
31	5.1	46.0	92.8	99.8	44.9	15.7	88.6	99.7	99.3
32	30.3	46.0	100.0	85.9	22.3	31.2	79.8	99.9	99.3
33	46.5	38.0	69.1	99.8	28.8	31.2	50.9	99.8	99.3
34	6.5	38.0	92.0	99.8	54.6	38.1	56.6	99.8	99.3

Table 3. Calculations of correlations between the welfare criteria of health and behaviour.

Correlating criteria	Corr. coeff. = r	Sign. P-value
Absence of disease : Absence of pain induced by management procedures	0,4354252	0,0006
Expression of social behaviour : Positive emotional state	0,277199	0,0279
Absence of injuries : Absence of pain induced by management procedures	0,2125980	0,0023
Expression of social behaviour : Good human- animal relationship	-0,1994459	
Absence of disease : Expression of social behaviour	0,1610286	
Absence of injuries : Good human-animal relationship	0,1260028	
Absence of injuries : Absence of disease	0,08279355	
Absence of injuries : Expression of social behaviour	-0,0737966	
Good human-animal relationship : Positive emotional state	-0,0548052	
Absence of disease : Positive emotional state	0,0481724	
Pain induced by management procedures : Expression of social behaviours	-0,0477626	
Absence of disease : Good human-animal relationship	0,0379749	
Pain induced by management procedures : Positive emotional state	0,0296986	
Absence of injuries : Positive emotional state	0,0070522	
Absence of pain induced by management procedures :Good human-animal relationship	-0,0022698	

Table 4. Maternal behaviour, sexual behaviour and calf interactions on farm 14 to 34.

| | | | | Number of interactions / 120 minutes | | | | | | | | | | | | |
| | | | | Maternal behaviour | | | | | | | Sexual behaviour | | | Calf interaction | | |
Farm	Number of bulls	Number of calves	Number of cows	Mother licking	Calf licking	Suckling	Playing	Aggression	Calling the calf	Bonding	Flehmmen	Mounting	Bull licking cow	Playing	Aggression	Licking
14	0	16	16	11	5	9	3	2	19	9	0	0	0	0	0	0
15	1	6	6	10	1	9	1	3	140	10	3	2	4	0	1	0
16	1	17	16	2	1	15	1	2	11	2	0	0	0	0	0	0
17	1	22	23	5	0	20	0	1	43	11	0	0	0	0	0	3
18	1	38	39	27	32	207	1	2	76	52	0	0	0	3	1	3
19	1	10	13	12	7	4	0	0	9	14	2	0	2	0	0	0
20	1	25	25	11	5	15	0	5	14	21	1	1	0	5	0	0
21	0	18	17	11	5	29	2	6	9	12	0	0	0	1	1	6
22	1	18	36	0	0	0	0	0	0	0	1	1	1	0	0	0
23	1	28	30	8	4	16	2	2	36	19	1	0	0	2	0	0
24	1	14	18	6	2	32	0	0	9	8	0	1	8	0	0	0
25	1	25	26	1	5	14	1	1	0	13	0	0	0	0	0	2
26	1	10	20	14	1	30	0	0	7	19	0	0	1	1	0	1
27	1	9	16	18	5	6	1	2	6	45	2	0	3	0	0	2
28	0	19	11	2	7	18	0	2	7	4	0	0	0	3	0	0
29	2	100	100	8	1	51	2	2	40	19	0	0	0	0	1	2
30	1	15	16	0	0	30	0	0	9	0	0	0	1	0	0	27
31	1	20	20	15	12	44	0	4	20	80	5	0	14	2	0	8
32	1	15	20	0	0	15	0	0	5	0	0	0	0	0	2	0
33	1	6	9	2	12	29	0	3	6	19	5	0	1	1	1	1
34	1	11	11	33	3	44	0	9	21	68	1	0	1	6	0	2

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