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Disease Control and Biosecurity Measures on Specialized Beef Rearing Units in Sweden

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Disease control and biosecurity measures on specialized beef rearing units in Sweden

Sjukdomsbekämpning och smittskyddsåtgärder på svenska gårdar med specialiserad mellankalv- och ungnötsuppfödning

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ABSTRACT

The aim of this study was to investigate and evaluate how biosecurity measures are implemented on Swedish farms with specialized beef production.

In Swedish specialized beef production young calves are purchased for intensive rearing, mainly from dairy farms. The calves can be as young as two weeks old. They are reared and later sent to slaughter, and will be classified either as calves (about 8-11 months of age) or as young stock (bulls, heifers and steers older than 11 months). A large part of these beef producing herds purchase calves from many different farms, often through farm-to-farm agreements or through slaughterhouse agents. The agents collect young calves from different farms and thereafter sell and deliver them to specialized beef producers. Since the calves are very young and are mixed with calves from different farms there is a high risk of disease outbreaks. As in many parts of the world the two biggest health issues for calves are enteric and respiratory diseases, common disease pathogens are bovine Corona Virus (BCV), *Cryptosporidium parvum* (C. *Parvum*) and bovine respiratory syncytial virus (BRSV).

Disease introduction and outbreaks can be prevented through different preventive measures, i.e. biosecurity. The implementation of biosecurity is a common practice in the pig and poultry industry, but not as widespread in the cattle production. The actual extent in Sweden is not known and this study was therefore undertaken. A questionnaire on biosecurity measures was sent to a random sample of 200 farms with specialized beef production, and 100 replied. In addition, face-to-face interviews were made with two slaughterhouse agents and one person responsible for courses needed for authorization of animal transports.

The results showed that farmers at specialized beef rearing units perform few biosecurity measures; the majority performed rodent and bird control, participated in the voluntary salmonella program and swept the feed area. Larger herds performed more biosecurity measures compared to smaller farms. According to the participating farms not a large proportion of the calves expressed signs of diarrhea and pneumonia, but diarrhea is usually more common among younger calves than older ones and the age of the purchased calves varies between these herds. There was also a significant association between performing biosecurity measures and cases of diarrhea in the quarantine barn, less cases of diarrhea when implementing biosecurity but not a significant association between pneumonia and biosecurity. When interviewing slaughterhouse agents it seemed possible to implement a “health declaration” program for BRSV-calves in Sweden, similar to the previous BVDV-program. This might motivate specialized beef producers (and dairy herds) to improve their biosecurity. Nonetheless, there is room for an improvement of biosecurity in the Swedish specialized beef industry.

SAMMANFATTNING

Syftet med denna studie var att undersöka och utvärdera hur åtgärder för smittskydd genomförs på svenska gårdar med specialiserad mellankalv- och ungnötsuppfödning.

I den svenska specialiserade mellankalv- och ungnötsproduktionen köps unga kalvar in för intensiv uppfödning, främst från mjölkgårdar. Kalvarna som köps in kan vara så unga som två veckor gamla. De skickas senare till slakt antingen som mellankalv vid cirka 8-11 månaders ålder eller som ungnöt (tjurar, kvigor och stutar äldre än 11 månader). En stor del av dessa gårdar köper in kalvar från många olika gårdar, ofta genom mellangårdsavtal eller genom slakteriernas livdjursförmedlare. Livdjursfördmedlarna köper in unga kalvar från olika gårdar för att sedan sälja och leverera dem till mellankalv- och ungnötsuppfödare. Eftersom kalvarna är mycket unga och blandas med kalvar från olika gårdar finns det en stor risk för sjukdomsutbrott. Som i många delar av världen är de två största kalvhälsoproblemen tarm- och luftvägssjukdomar, där vanliga patogener är bland annat bovint coronavirus (BCV), *Cryptosporidium parvum* (C. *parvum*) och bovint respiratoriskt syncytialt virus (BRSV).

Introduktion och utbrott av sjukdom på gården kan förhindras genom olika förebyggande smittskyddsåtgärder. Implementering av olika smittskyddsåtgärder är vanligt förekommande inom gris- och fjäderfäindustrin, men inte lika utbredd i nötdjursproduktionen. Omfattningen är dock inte känd, varför denna undersökning genomfördes. Ett frågeformulär om smittskydd skickades till ett slumpmässigt urval av 200 gårdar med specialiserad nötköttsuppfödning, och 100 svarade. Därutöver gjordes personliga intervjuer med två djurförmedlare och med en person ansvarig för kurser som behövs för att få tillstånd att transportera levande djur.

Resultaten från denna studie visade att lantbrukarna i den specialiserade nötköttsuppfödningen utför få smittskyddsåtgärder. Majoriteten utför bekämpning av gnagare och fåglar, är med i det frivilliga salmonellaprogrammet och sopar foderbordet. Besättningar av större storlek utförde fler smittskyddsåtgärder jämfört med mindre gårdar. Enligt gårdarna som deltog i studien så hade inte en stor andel av kalvarna haft diarré och lunginflammation, men diarré är vanligare hos yngre kalvar än äldre och åldern på de inköpta kalvarna varierar mellan besättningarna. Det fanns ett signifikant samband mellan utförandet av smittskyddsåtgärder och antal djur med diarré i mottagningsstallet, där det var färre fall av diarré vid utförandet av fler smittskyddsåtgärder. Det var däremot inget signifikant samband mellan lunginflammation och smittskyddsåtgärder. Vid intervjuerna av livdjursförmedlare så verkade det som om det var möjligt att genomföra ett "hälsodeklarationsprogram” för BRSV-kalvar i Sverige, liknande det tidigare BVDV-programmet. Detta skulle kunna motivera specialiserade nötköttsproducenter (och mjölkkobesättningar) att förbättra smittskyddsarbetet på gården. Det finns utrymme för en förbättring av smittskyddet i den svenska specialiserade nötköttsindustrin.

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ABBREVIATIONS

BCV = Bovine coronavirus
BRD = Bovine respiratory disease
BRDC = Bovine respiratory disease complex
BRV = Bovine rotavirus
BRSV = Bovine respiratory syncytial virus
BSE = Bovine spongiform encephalopathy
BVD = Bovine viral diarrhea
BVDV = Bovine viral diarrhea virus
IBR = Infectious bovine rhinotracheitis
NFA = National Food Agency
PIV-3 = Bovine parainfluenza virus 3
SLS = Svenska Livdjur & Service
SVA = National Veterinary Institute
SvDHV = Swedish Animal Health Services (Svenska Djurhälsovården, now Gård & Djurhälsan)

1. INTRODUCTION

A majority of the beef meat produced in Sweden has its origin in the dairy production, either from culled dairy cows or from calves and young stock of dairy breeds (Gård & Djurhälsan, 2015a). According to Jordbruksverket (Swedish Board of Agriculture) in 2015 there were 15186 enterprises with calf production (animals younger than one year old) and 16 432 businesses with young cattle, one year and older heifers, bulls and steers, in Sweden (Jordbruksverket, 2015a). This can be compared to the number of dairy farms, which was as low as 4199 in September 2015 (LRF Mjölk, 2015). During 2013, 27 000 calves (age between 8-11 months), 140 000 young bulls (about 1.5 years old), 30 000 steers and 57 000 heifers were sent to slaughter (Svenskt kött, 2015). Eighty percent of the slaughtered calves came from cows of the two most common Swedish dairy breeds Swedish red (SRB) and Swedish Holstein (SLB) and the majority are bull calves. The majority of the steers were of dairy breeds compared to the heifers which were mostly beef breeds. About 50 % of the slaughtered young bulls were of the two dairy breed SRB and SLB and the other 50 % were beef breeds.

Farms with specialized beef production (calves and young stock) often buy very young calves from several different dairy and beef farms (not as common as from dairy farms), either directly from the farms or through slaughterhouse agents (Jamieson, 2010). The farms providing calves might have a varying disease status and when young animals from different farms are mixed together in a new environment the risk of diseases appearing among them is quite high. The most common health issues and mortality causes in young calves at both dairy and beef farms are diarrhea and respiratory infections (Roy, 1990; Svensson *et al.*, 2003; Svensson *et al.*, 2006; Gulliksen *et al.*, 2009b; Jamieson, 2010; Hegrestad, 2010; SVA, 2015a, SVA 2016).

Sweden has a very restrictive use of antibiotics, and using growth promoting antibiotics in food animal production has been banned since 1986 (Casewell *et al*., 2003). Sweden has therefore one of the lowest usage of antibiotics in food animal production today in Europe (EMA, 2013). The restrictive antibiotic usage means that it is even more important to use preventive management strategies to minimize the risk of diseases infecting the animals (Wierup, 2004). Biosecurity is based on numerous methods to reduce the risk of pathogens entering and spreading within the herd and between herds and farms (Belk *et al*., 2007). This has been especially important within the pig and poultry industry, where comprehensive and detailed biosecurity programs have been developed as important parts of the production (Pescatore, 2006; Belk *et al*., 2007: see Nelson, 2004; Moore, *et al.*, 2008; Seaman & Fangman, 2011). However, the biosecurity status within the specialized beef industry in Sweden is less well known. Sweden is free from several diseases that are present in other countries, e.g. tuberculosis, bovine viral diarrhea (BVD), and have a very low prevalence of salmonella (SVA, 2012). The low frequency of these diseases is mainly a result of various disease control programs, where biosecurity measures has been integrated. There have been a few studies done on biosecurity in Sweden and other Scandinavian countries (Nöremark, 2010; Nöremark *et al.*, 2010; Kristensen & Jakobsen, 2011; Sahlström *et al.*, 2014) however not one on this type of production.

The aim of this study was to investigate and evaluate how biosecurity measures are implemented on Swedish farms with specialized beef production. This master thesis is a contributing part to the research project on "Risk factors for disease in Swedish feedlot calves and preventive measures".

2. LITERATURE REVIEW

2.1 Specialized beef production

Swedish specialized beef producers rear calves and young stock of both dairy and beef breeds. There are two main classifications of the meat; calf and young stock (young bulls, heifers and steers). In calf production the calves are about 8-11 months and has a live weight of about 300 kg (150 kg carcass weight) when being slaughtered (Jamieson, 2010; Svenskt kött 2015). The calves are mainly of dairy breed. If the animal is older than 11 months the production is regarded as young stock. Depending on type of production (intensive or extensive), type of breed (dairy or beef) and sex (bull, steer or heifer), the live weight and age at slaughter may vary for the young stock (Jamieson, 2010). The extensive production (mainly organic) demands a longer raising period to reach a good slaughter weight than the intensive production. Beef breeds are generally slaughtered at a higher live weight compared to dairy breeds and are finished faster as well. Bulls are ready for slaughter faster than heifers and steers. In an intensive production the young bulls are ready for slaughter at 13-16 months of age depending on breed and in an extensive production at 14-18 months. The live weight at slaughter will range between 600 and 700 kg. Intensively reared steers are generally 18-22 months old when slaughtered (depending on whether it's a dairy breed or heavy or light weighted beef breed). In organic production the animals will be slightly older, 24-30 months old. Intensively reared heifers (mainly beef breeds) will weigh about 560 kg and be 18-20 months old when sent to slaughter and in organic production they will be ready at an age of 20-24 months (Jamieson, 2010).

2.1.1 Means of purchase

The specialized beef rearing units buy calves from other herds, either through slaughterhouse agents or directly from farms with or without farm-to-farm agreements (in Swedish "mellangårdsavtal", written or oral; Jamieson, 2010). When purchasing calves through slaughterhouse agents, the calves are collected, weighed and delivered to specialized beef farm with the help of an animal transportation company. The slaughterhouse agent classify the calves and pays the selling farms accordingly, and the specialized beef farm pays the slaughterhouse through invoices. Many of the Swedish slaughterhouses classify the calves, which are collected and delivered through them, according to two different quality categories. These categories are based on a standard ratio of age and weight of dairy calves, which makes it possible to distinguish the older calves which weigh less than what a normal calf would weigh at that age. This would be a sign that these calves have had a poor growth in the herd in which they were born. These calves will then be sold at a lower price.

With farm-to-farm agreements the specialized beef farm has a number of dairy farms contracted from which it purchases calves (Jamieson, 2010). The contract specifies what quality the calves

should have. The qualities might include what the calves should be fed (nutrient quality of milk substitute and concentrate), how the calves should be fed colostrum, if the calves should be vaccinated against ringworm or not etc. The aim is to supply the beef producer with a more homogenous group of calves for rearing. The calves sold through farm-to-farm agreements are usually younger than calves sold through slaughterhouse agents. Swedish Board of Agriculture (Jordbruksverket) recommends that calves being transported should have reached an age of one month and have an acceptable weight (should be normal for the breed of the calf; Jamieson, 2010). However, the transportation regulations states the minimum age of transportation is two weeks and the navel have to be fully healed (Statens jordbruksverks föreskrifter och allmäna råd om transport av levande djur, SJVFS 2010:2, §20; Jordbruksverket, 2015b). Thus, some calves, which are sold through farm-to-farm agreements, are as young as 14 days old when being delivered to the specialized beef farms.

2.1.2 Housing and regulations

When the calves arrive at the farm they should be housed in a quarantine barn (Jamieson, 2010). There are many different regulations regarding how the quarantine and finishing barns should be designed and function. These regulations are stated in the Swedish animal welfare regulation (SFS 1988:539). The quarantine barns can be built as insulated or uninsulated loose housing. Today there are few barns built with insulated loose housing due to high capital costs. Another version of uninsulated loose housing is calf hutches kept outside. The hutches can be either individual or group hutches. The hutches are made of plastic, galvanized steel or laminated plywood. The advantages with the huts are the positive effect it has on the health of the calves and that the huts are cheap. The positive effect on calf health is due to a lower infection pressure (calves are kept individually and natural ventilation) and they are easy to clean and disinfect in between calves. Studies have showed lower morbidity and mortality with outdoor hutches compared to indoor housing (Davis *et al.,* 1954; Waltner-Toews *et al.,* 1986a; Waltner-Toews *et al.,* 1986b). Disadvantages are that the labor costs may be greater than with a standard uninsulated loose housing system and that it is more difficult to keep an eye on the calves when they stay in the huts (Jamieson, 2010). If the producer rear finishing bulls the animals usually stays within the barn until slaughter but steers and heifers may go on pastures during summer season. The Swedish animal welfare regulation states that all cattle, except dairy cattle, should be kept on pasture or be kept outside in another way, throughout the day during summer season (Djurskyddsförordningen, SFS 1988:539, §11; Jordbruksverket, 2015c). This outside period should be a cohesive period of time from 1st of May until 15th of October. However, calves younger than six months old, bulls and animals in quarantine are not included in this regulation. Length of outside period varies along the country due to shorter summer season in the northern part of Sweden.

In Sweden the specialized beef production is well regulated by legislation. There are regulations regarding type of housing and rearing with regards to the herd size. If the farm buys more than 50 calves per year, which are younger than four months old and comes from different farms, the farm must have a quarantine barn (Jordbruksverket, 2014). Furthermore the regulations state that if the calves are bought from more than five different farms, it is mandatory to keep a batch

rearing system (all in-all out) in the quarantine barn. The legislation also covers the recommended time periods for the batches as well as the maximum period between the first calf to be inserted into the group and the last one. There should be maximum three weeks between calf number one and the last calf, and the batch should be held in the quarantine barn for at least five weeks after that the last calf was introduced. If the farm is retrieving 50 calves or less per year (which are younger than four months old) it is not compulsory to have a quarantine barn. The barn section, which is housing the newly arrived calves, is only allowed to house a maximum of 100 animals. There is however an exception for larger producers, which rear the animals in the same building until slaughter. That is if they use a batch rearing system. Then it is permitted to house up to 150 calves in one section area. It should always be possible to move the animals to and from a certain barn section without having to pass through other sections, thus minimizing the risk of spreading pathogens between animal groups. A finishing barn, which receives the animals from the quarantine barn, should not house more than 300 animals. It is not allowed to house calves older than eight weeks old individually (Jordbruksverket, 2014).

2.2 Definition of biosecurity

The definition of biosecurity differs depending on author, country, group etc. Belk *et al*. (2007) discuss biosecurity within the livestock and food industry and they refer to several different definitions of biosecurity, both from a stricter veterinarian perspective and from a broader point of view, which includes both animal and human health. However, the definition they base their discussion on is

> *"a series of management practices designed to minimize or prevent the exposure to, and introduction of, subpopulations of livestock to human and animal disease infectious agents. Such management practices may include, but not necessarily be limited to, testing and screening protocols for surveillance and process verification, isolation and quarantine, immunization, waste management, selective purchasing and monitoring"* (Belk *et al*., 2007, p.355)

This definition will also be used in this thesis.

Belk *et al*. (2007) also define the expressions biosafety and biocontainment. Biosafety is *"the prevention of accidental release (loss of control) of human and animal disease infectious agents into the environment, or prevention of exposure of another subpopulation of livestock to an infectious agent"* (Belk *et al*., 2007, p. 356) and biocontainment is *"A series of management strategies to prevent the spread of human or animal infectious agents within or among subpopulations of livestock (i.e. control of a detected infectious outbreak)"* (Belk *et al*., 2007, p.356)

In this study the terms biocontainment and biosafety are replaced with the expression disease control.

2.3 Why disease control and biosecurity?

Today it is getting more common to buy calves as young as two weeks old from dairy farms (Gård & Djurhälsan, 2015b). Young animals are often more susceptible to diseases than older ones (Mims *et al.*, 2001) and often calves from several different farms are mixed together. This increases the importance of a good biosecurity and disease control program both at the sending and the receiving farm. Biosecurity measures are performed to prevent the introduction of diseases, both at farm and country level (European Commission, 2007). Also biosecurity and disease control are executed to prevent diseases and pathogens, which have been introduced, to spread further within a herd, between farms or at a larger scale within a country or between countries. Other reasons for implementing biosecurity are to prevent zoonoses (diseases which may infect both humans and animals) and to reduce the use of antibiotics as well as to minimize economic losses (Nöremark, 2010). Diseases are also an animal welfare issue. *The Five Freedoms* is a list of five different rights intended for farms animals, developed by the UK government and the Farm Animal Welfare Council (FAWC, 2010). The third of the five freedoms states that the animal should be free from pain, injury and disease, either by prevention or through quick diagnosis and treatment.

2.3.1 Pathogenic threats

There are both known and unknown pathogenic threats, which are the focus when talking about disease prevention (Nöremark, 2010). The known pathogens can be prevented at either an international and domestic level or at a farm or group level. International and national measures might be trade regulations and control programs and on farm measures may be basic biosecurity procedures, disease testing, quarantine periods for newly arrived animals, vaccination and vector control. Several factors might make an animal susceptible to a disease, e.g. age, genetics, environment and the current health of the animal (Mims *et al.*, 2010). Therefore, it is important to keep the animals in a good condition and make sure they do not catch any diseases, since if the animal is infected with a pathogen it may be more susceptible to more severe diseases. Through preventive measures for the known diseases, the unknown one might be stopped too.

There are several types of pathogenic agents which causes disease in cattle; bacteria, virus, parasites, fungus, protozoa and prions (Jamieson, 2010). The majority of these agents are harmless to humans and animals (i.e. nonpathogenic), however some might cause diseases and infections (i.e. pathogenic). Nevertheless, the non-pathogenic microorganisms might become pathogenic if the circumstances change, e.g. environmental factors or if they are allowed to grow and reach a threshold level, at which clinical signs might start to show (Anderson, 1998; Mims *et al.*, 2001). Also, some animals may be chronically infected and not show signs of disease but still be contagious and thus pose a risk for the other animals.

2.3.2 Prevention at farm, domestic and international levels

Through the different management practices that biosecurity includes, it is possible to minimize the risk of a disease entering a farm but also to prevent the disease from spreading within a farm and to other farms (Belk *et al*., 2007). A study done in UK showed that performing biosecurity

measures in a broiler chicken farm reduced the risk of thermophilic *Campolybacter* infection by 50% (Gibbens *et al*., 2001). The calf and young cattle feedlots are at a high risk of catching pathogens and disease due to that a large number of animals from different sources are mixed together in the new farm (Brandt *et al*. 2008). It might be difficult to control that all animals entering the farm are free from specific pathogens. However, based on experience from various control programs in Sweden and other countries in Europe, it can be done. One example is the implementation of the Swedish BVDV control program in 1993 (Hult & Lindberg, 2005; Ståhl & Alenius, 2012). Salmonella is another disease, which has been controlled and prevented with a good result in cattle, pig and poultry production (SVA, 2012).

Another reason for having good biosecurity on farms in Sweden is to protect from exotic diseases, which have not yet entered the country, and to decrease the possibility of eradicated diseases to appear again, hence minimize their potential damage (European Commission, 2010; Nöremark, 2010). Preventing the spread of diseases through good biosecurity is particularly important since newly introduced pathogens may have a "silent spread", i.e. it may take a long time between the introduction and a noticeable outbreak. Animal disease surveillance in Sweden includes bovine diseases such as bluetongue, bovine spongiform encephalopathy (BSE), bovine viral diarrhea (BVD), brucellosis, infectious bovine rhinotracheitis (IBR), paratuberculosis (Johne's disease) and salmonellosis (SVA, 2012). These are diseases, which we do not want to enter or spread within the country. Some of them have been present in Sweden but have been eradicated and some are present today but are kept under control via control programs and regular testing. One of the most important vectors for new diseases entering Sweden is live animal trading, also with "exotic" ruminants such as water buffalo, bison and alpacas, between countries. Wild animals are also important risk factors for spreading diseases. They might be reservoirs for disease and can cross boarders without being noticed.

2.3.3 Biosecurity might prevent economic losses

Another reason to implement biosecurity and disease control measures is that it will save the farmer money in the long run (Belk *et al*., 2007), because it is costly to have sick animals. Veterinary fees and the cost for the medicine itself are high as well as the cost for the withdrawal period (the safety period of time during which the animal cannot be sent to slaughter due to medicinal treatment e.g. antibiotics, hence there will be additional cost for housing and feed) and the extra work that is needed. Healthy calves will have a shorter growing period and therefore needs less feed than sick calves. If an animal dies there will be a loss in income for the farmer. Introduced diseases may have major impacts on countries or regions, since it may lead to trade restrictions. Also, a disease outbreak may have a negative effect on the consumers' willingness to buy meat, which have been seen when there have been outbreaks of e.g. BSE in Great Britain (Burton & Young, 1996). By keeping the animals healthy and the farm free from diseases the farmer can save money, since there have been studies on the economic losses in beef and dairy production when herds have had animals sick in diarrhea or respiratory diseases (Houe, 1999; Houe, 2003; Fourichon *et al.*, 2005; Snowder *et al.*, 2006; Hessman *et al.*, 2009).

There have also been studies done on bovine respiratory disease (BRD) and the economic losses caused by the disease. Snowder *et al.* (2006) did a study on BRD in feedlot cattle. The study was performed during a 15-year period (1987-2001) and included 18,112 feedlot cattle. Snowder *et al.* (2006) looked at the economic effect of BRD on average daily gain and calf death loss. Calves with BRD showed a lower average daily gain compared to healthy ones (0.95 kg verses 0.99kg). It was calculated that the lower weight gain would result in losses of $2108/1000 animals if the animals were slaughtered after 200 days on feed (according to the slaughter prices at that time). In addition to that there would be treatment costs and mortality losses. Mortality among calves detected with BRD was 3.9% and the total mortality among all calves due to BRD (died or were culled because of causes associated with BRD) was one percent. Average annual BRD incidence was 17%, but varied between 4.6 to 43.8% per year. Treatment costs were estimated to $1813/144 calves and cost of dead calves (mortality of one percent) were $9974/10 calves. In total the economic loss caused by BRD was calculated to $13,895/1000 animals, which did not include feed costs before the calves died, labor and other associated costs.

Diseases infecting animals on a dairy farm may have an indirect economic effect on the specialized beef rearing farms. For example, calves infected with bovine viral diarrhea virus (BVDV) at a foetal stage are often small and will not grow and develop normally (Houe, 1999). These calves will be more predisposed to other diseases and may die from mucosal disease.

Also, with a large herd the consequences are larger if a disease spreads within the herd, e.g. salmonella (Andersson, 2011). It will be more expensive to control the disease if the herd is large both for the farmer, society and the insurance companies. The risk for a disease to stay and grow in a herd is higher in a large herd compared with a smaller herd (Andersson, 2011) thus also increasing the costs for controlling the disease.

2.3.4 Biosecurity – an important part of the pig and poultry industry

Within the beef industry (internationally at least) antibiotics and vaccines have been seen as the best way to get rid of or prevent diseases (Anderson, 1998). Preventive measures like well-designed buildings (ventilation, sectioning, materials), animal and equipment management (cleaning, equipment handling, animal handling, quarantine etc.) have not been equally prioritized. In contrast, the pig and poultry industry has seen biosecurity as a very important part of the production, in addition to using antibiotics and vaccines, and they have detailed descriptions on what measures needs to be taken to prevent a disease from entering the farm (Belk *et al*., 2007). Studies in both Sweden and Finland have showed that pig producers perform more biosecurity measures compared to beef producers (Nöremark *et al.*, 2010; Sahlström *et al.*, 2014).

Important measures are to prevent contact between animals (direct and indirect) as well as managing the purchase of new animals in a good way (e.g. buy animals from sellers with known health status and quarantine the animals when arriving at the new farm; European Commission, 2007). If visitors and vehicles, which have been on other farms, need to enter a farm, they have

to follow certain procedures like cleaning and disinfecting, so that spreading of pathogens can be avoided (Belk *et al.,* 2007). In e.g. the US, it is common that employees and visitors on poultry and pig farms has to shower in the facility and change to the farm's own coveralls and boots before being allowed to enter into the sections where the animals are housed. The clothing never leaves the premises and is laundered at the farm. The tires of the vehicles are sprayed with disinfectant as well as all the supplies that enter the farm (Belk *et al.,* 2007).

2.4 Common diseases in specialized beef production units

2.4.1 Diarrhea

Diarrhea is common among young calves all over the world (Waltner-Toews *et al.,* 1986a; Gardner *et al.,* 1990; Kaneene & Hurd, 1990; Virtala *et al.,* 1996; Busato *et al.,* 1997; Svensson *et al.,* 2003; Svensson *et al.,* 2006; Gulliksen *et al.,* 2009a; Gulliksen *et al.,* 2009b; Nilsson, A., 2012; SVA, 2015a). It is seen as one of the most important health issues in young calves and is the main reason for death in calves within the first weeks of age (Virtala *et al.,* 1996; Heinrichs & Radostits, 2001; Svensson *et al.,* 2006). There are both infectious and noninfectious reasons to diarrhea and the severity of the disease varies. The main microorganisms, which causes diarrhea in calves, are bacteria, viruses and protozoa/parasites (Heinrichs & Radostits, 2001; Svensson *et al.,* 2006; SVA, 2015a) and calves may be infected by several pathogens at the same time (Björkman *et al.,* 2003). *E. coli* and *Salmonella* are two common diarrhea-causing bacteria although they are not commonly seen in Sweden (Heinrichs & Radostits, 2001; SVA, 2015a). Viruses that may cause diarrhea are BCV, BRV and BVDV, although BVDV is now eradicated in Sweden. Common parasites that cause diarrhea are *Cryptosporidium parvum,* and *Eimeria coccidia* (Svensson *et al.,* 2006; SVA 2015a). Colostrum gives the young calf immunity which could last up to a few months of age (Davis & Drackley, 1998, see: Johnson *et al.* 2007). Young calves and calves which has not been provided with enough colostrum of sufficient quality will be more severely infected and diarrhea will appear earlier in life than in older calves or calves with a stronger immunity (Svensson *et al.,* 2003).

2.4.1.1 Bovine corona virus (BCV)

The BCV has been observed all over the world and the majority of all cattle will be exposed to the virus (Kapil *et al.,* 2008: see Boileau & Kapil, 2010). BCV can cause both enteric and respiratory infections (Saif *et al.,* 1986; Heckert *et al.,* 1990; Hasoksuz *et al.,* 2002; Niskanen *et al.,* 2002; Boileau & Kapil, 2010) and is mainly a problem during the winter months (Kapil *et al., 1990*). Depending on the age of the animal and how good its immune system is the severity of the infection will vary among animals (Mebus *et al.,* 1973; Bridger *et al.,* 1978; Clark, 1993).

The clinical signs of an infection with BCV enteritis (enteric infection) are similar to the ones for a BRV infection. The calf will have diarrhea, which may continue for up to 6 days. The color may vary from yellow to green. The virus may be present in both normal and diarrheic feces (Snodgrass *et al.,* 1986: see Foster & Smith, 2009). During the acute phase of BCV infection the calf often decrease its feed intake and become lethargic and some calves may

develop anorexia (Bridger *et al.,* 1978). In severe cases the calf may develop fever and become dehydrated (Saif *et al.,* 1986; Niskanen *et al.,* 2002). BCV may also cause the severe disease winter dysentery, which causes bloody diarrhea and mainly affects adult cattle (Saif, 1990: see Cho *et al.,* 2000; Alenius *et al.,* 1991).

Cases of the disease are more frequent during the winter months since they are usually kept inside during this period and therefore the risk of infection is higher (November-April; Roy, 1990; SVA, 2015b). The virus infects calves from both dairy and beef production and the age of the infected animals ranges from one-day-old calves up to three months old. However the signs of diarrhea shows at between one and two weeks of age. The regular treatment is to try to replace the lost fluids and electrolytes, which is done through fluid replacement therapy (Clark, 1993). Sick animals should be separated from the others and placed in an insulated section with fresh bedding. Signs of respiratory infection of BCV are increased respiratory rate and higher respiratory sounds as well as nasal discharge and cough (McNulty *et al.,* 1984; Cho *et al.,* 2001; Hasoksuz *et al.,* 2002; Niskanen *et al.,* 2002).

Since the virus is found in both feces, nasal and mouth secretion as well as exhaled air, the environment, which the infected animal is housed in will be contaminated and animals held in the same area may get infected through ingestion or direct contact between the animals (Torres-Medina *et al.,* 1985: see Foster & Smith, 2009; Clark, 1993; SVA, 2015b). People may also spread the disease and transmit the virus between animals and herd through contaminated clothing, hands, boots and equipment (SVA, 2015b).

2.4.1.2 Bovine rotavirus (BRV)

BRV infections, like BCV, also causes diarrhea in calves (Torres-Medina *et al.,* 1985, see Janke, 1989). It is one of the main diarrhea causing pathogens in young calves in Sweden and in many parts of the world (de Verdier Klingenberg & Svensson, 1998; García *et al.,* 2000; Alfieri *et al.,* 2006; Lanz Uhde *et al.,* 2008; Izzo *et al.,* 2011; SVA, 2015c). It is usually peaking during the winter season, due to the higher stocking density (when more animals are kept inside), consequently higher infection density. Most calves are between 1-3 weeks old when becoming diarrheic according to SVA (2015c) and they are most susceptible to the virus during the first week of life (Tzipori *et al.,* 1981). Although another study states that the average age is 10-12 days for both dairy and beef calves (Torres-Medina *et al.,* 1985: see Janke, 1989).

Incubation period is normally between 18-22 hours (SVA, 2015c) but it can be as short as 12 hours (Torres-Medina *et al.,* 1985: see Janke, 1989). On the other hand, if the calf only ingests low quantities of the virus or if it has ingested colostrum or milk antibodies the incubation time is generally longer, about 24-48 hours. If a calf is housed in a heavily contaminated environment and has not ingested enough colostrum or ingested colostrum of poor quality, the calf probably will get diarrhea within 24 hours. This means that diarrhea caused by BRV will generally appear during the calves' first days of life if it is held under poor conditions. However it is more common that the calves only have a subclinical infection due to low virus levels in the surrounding environment and good immune systems (from the colostrum), or the BRV diarrhea

usually do not occur until the second week of life, when the antibodies in the intestines have decreased to a level that does not provide adequate protection (Janke, 1989).

The clinical signs of BRV may vary. Pre-diarrheic signs are reduction in feed-intake (anorexia), depression and fever. The severity of the infection depends on multiple factors like the virulence of the virus, age of the calf, level of virus exposure, level of immunity of the calf, environmental conditions and if the calf is healthy or already has an infection. Shedding of the virus generally occurs during the first week of infection, however only 50% of the calves will get diarrhea (Reynolds *et al*., 1985: see Janke, 1989). The calves may get two types of diarrhea, malabsorptive or secretory dirarrhea (Foster & Smith, 2009). The diarrhea is yellow in color (Goto *et al.,* 1986).

The virus thrives under moist environments and may remain virulent for months (Goto *et al.,* 1986). Through replication by shedding and fecal matter as well as being able to survive for a long time in moist environments it is possible for the virus to stay within a herd. The rotavirus is dived into groups, subgroups and serotypes and there are several different serotypes of BRV (Dea *et al.,* 1986; Snodgrass *et al.,* 1990; Chinsangarm *et al.,* 1995). Even if a calf is infected by one serotype it does not mean it will get immunity against the other ones (Janke, 1989). The most common group of bovine rotavirus in Sweden is type A (Reoviridae family; SVA, 2015c).

2.4.1.3 Cryptosporidium parvum

Cryptosporidium parvum (C. *parvum*) is a diarrhea-causing parasite (Harp, *et al.,* 1990; SVA, 2015d). It mainly affects young calves, one to four weeks old (SVA, 2015d). The incubation time is generally two to seven days. The route of transmission is oral and it infects the enteric system. The parasite continues to spread via the manure, and may infect another individual when it either comes in direct contact with the feces or if there is contamination of the floors, walls and feeding areas. Employees that have contaminated clothes, boots and hands might also spread the parasite between calves. A study shows that calves may become resistant to the parasite after being exposed at one to three months of age (Harp *et al.,* 1990). At the first exposure of *C. parvum* the calves were one week old and they all got diarrhea and shed oocytes but when being reexposed at one and three months of age they did not become diarrheic nor did they shed oocytes (Harp *et al.,* 1990). Clincal signs of C. *parvum* infection are watery diarrhea sometimes with a yellow color (Uga *et al.,* 2000; SVA, 2015d).

2.4.1.4 Salmonellosis

Salmonella is very uncommon in Swedish dairy and beef herds, mainly because a very efficient disease control program that has been running for many years. Salmonella is only detected in 4-13 herds per year (SVA, 2015a). There are many different strains of Salmonella (Dargatz *et al.,* 2003) but the most common type in Swedish cattle is *Salmonella Dublin* (SVA, 2015e). Infection with S. *Dublin* often results in clinical disease and decline in production. The National Veterinary Institute (SVA, 2015e) states that international studies have shown that mainly calves are affected by S. *Dublin* and the disease increases calf mortality. The second most common type of Salmonellosis is *Salmonella Typhimurium*, which is also very common in other

animal species. Another recently discovered serotype of Salmonella in Sweden is *Salmonella Reading*. Some of the consequences of Salmonellosis are diarrhea, fever, abortion, lethargy, decreased feed intake, pneumonia, arthritis, sepsis, decreased milk production in infected dairy cows and increased mortality in both adult cattle and calves (Roy, 1990; Anderson *et al.,* 2001; Mohler *et al.,* 2006; Mohler *et al.,* 2008; SVA, 2015e). How severe the infection becomes depends on serotype, level of immunity and dose of infection (SVA, 2015e). A study made in the Netherlands showed that purchase of new animals was a risk factor for S. *Dublin* (Vaessen *et al.,* 1998). Also, if the cows only grazed during summer with no extra feed the risk S. *Dublin* infection increased significantly. Other sources of infection are feedstuff (Mohler *et al.,* 2009; Papadopoulou *et al.,* 2009) and water which have been contaminated, fertilizer, wildlife, insects, people and equipment (Mohler *et al.,* 2009).

2.4.1.5 Escherichia coli (E. coli)

Escherichia coli (E. *coli*) is a bacterium, which comes in many different strains and can cause different diseases in both animals and humans (Quinn *et al.,* 2011). However, in Sweden E. *coli* F5+ is the main type of E. *coli* that causes calf diarrhea (SVA, 2015f). Although this E. *coli* F5+ only causes disease during the first days of the calf's life, after two weeks it is no longer susceptible to disease. Nevertheless, the calves may be carriers of the bacteria. E. coli is excreted in the feces and will infect the calf either through contact with other infected animals or through contact and ingestion with a contaminated environment.

There are different types of diseases which E. *coli* can cause in calves; e.g. Enterotoxigenic E. *coli* (EHEC), Enteropathogenic E. *coli* (EPEC) and Shiga toxin producing E. *coli* (STEC; Quinn *et al.,* 2011). The latter one can be divided into two types, Enterohaemorrhagic E. *coli* and strains of E. *coli* producing oedema disease (only causing oedema disease in weaned piglets). Enterotoxic E. *coli* may cause secretory diarrhea in neonatal calves and clinical signs of EPEC may vary from only slight changes in feces to haemorrhagic diarrhea. When it comes to EHEC it usually do not cause any disease in cattle, calves may in rare cases get haemorrhagic diarrhea, but at most times cattle are asymptomatic carriers. A big issue is that cattle may spread EHEC to humans through contaminated food products (SVA, 2015g). A common type of EHEC, which causes disease in humans, is E. *coli* O157. EHEC may also be known as Verotoxin-producing E. coli (VTEC).

Clinical signs of EHEC are often watery diarrhea, dehydration and death (Dean-Nystrom *et al.,* 1997; Andrews, 1983; Acres, 1985: see Roy, 1990). Calves get infected during the first week of life (Acres *et al.,* 1977; Acres, 1985: see Roy, 1990) and the peak in mortality is at day six or seven (Acres, 1985: see Roy, 1990). On the other hand, one study made in Spain showed that the risk for VTEC (the same as EHEC) infection in calves increased with age and the calves which were between 22-30 days old were at a higher risk than younger calves (Orden *et al.,* 1998). Nevertheless it has been shown that healthy cattle may be carriers of the bacteria (Blanco *et al.,* 1996) and another study showed that calves shed detectable EHEC bacteria for a longer time than adult cattle (Cray & Moon, 1995). Their results showed that calves might shed the

bacteria for up to 20 weeks after the infection happened compared to adult cattle, which did not shed for more than 14 weeks.

2.4.2 Respiratory infections

Pneumonia is common among Swedish calves and a study in dairy herds indicates that it might be the main cause of calf mortality in 31-90 days old dairy calves (Svensson *et al.,* 2006). In calves younger than 31 days enteritis was the main cause of death. Respiratory diseases in calves and adult cattle are generally caused by bovine respiratory syncytial virus (BRSV), BCV, and bovine parainfluenza virus 3 (PIV-3) (Stott *et al.,* 1980; Stortz *et al.,* 2000; Hägglund *et al.,* 2006). In 1999 Swedish researchers studied the prevalence of BRSV, BCV, PIV-3 and BVDV and the dynamics of these viruses in bovine respiratory disease complex in calves in 115 Swedish dairy herds (Hägglund *et al.,* 2006). The results showed in the first sampling that the prevalence of BRSV, BCV and PIV-3 was 30%, 48% and 34% respectively. The second sampling disclosed 26%, 38% and 50% prevalence for BRSV, BCV and PIV-3 respectively in the dairy herds.

Pardon *et al.* (2011) made a similar study in Belgium but with all in - all out white veal calf production (September 2007-January 2009). They studied the prevalence of disease pathogens in 25 respiratory disease outbreaks in 15 Belgian herds. The results showed that the bovine respiratory disease generally was introduced gradually into the herds rather than with a sudden outbreak. The first cases of disease predominately arose during the first week after arrival. However, after an average of 22.2 days after arrival 10% of the animals showed signs of clinical bovine respiratory disease. In this study the animals were tested for bacteria, mycoplasma and viruses. The majority of the calves (22.6%) carried a combination of the bacterium *Pasteurella multocida* and Mycoplasma species. *Mycoplasma bovis* was tested on 155 calves of which 32.9% carried M. *bovis* antibodies. Out of these 155 calves 21.3% had developed detectable antibodies to at least one viral pathogen, e.g. 5.2% to BVDV, 3.9% to PIV-3, 3.9% to BCV and 1.9% to BRSV.

Signs of respiratory disease are e.g. hampered respiration, nasal discharge and coughing (Brscic *et al.,* 2012). Brscic *et al.* (2012) preformed a cross-sectional study in three European countries, France, Netherlands and Italy, in which they studied the frequency of respiratory disorders in veal calves and what possible risk factors there are. There were both veterinarian evaluations made on live animals and on the lungs from a random sample of slaughtered animals. The results showed that not more than 7% of the living calves expressed signs of respiratory diseases. Conversely the post-mortem inspections showed that 13.9% of the lungs had mild signs of pneumonia and 7.7% had moderate or severe signs of pneumonia. The prevalence of pleuritis was 21.4%.

2.4.2.1 Bovine respiratory syncytial virus (BRSV)

The BRSV may infect cattle of all ages, however young calves are those that experience the most severe signs of disease (Ellis, 2013). Some of the signs are mucous discharge from nose and eyes, extended tongue, high fever, cough and difficulty in breathing (Verhoeff *et al.,* 1984:

see Valacher & Taylor, 2007; Elvander, 1996; Ellis, 2013). More severe signs might be a major decline in feed intake and depression (Verhoeff *et al.,* 1984: see Valacher & Taylor, 2007; Elvander, 1996; Van Der Poel *et al.,* 1993). The clinical signs usually appear around three to five days after infection and may last for one to two weeks (Ellis, 2013). The virus is transmitted between animals through aerosolized secretions. BRSV mainly occurs during autumn and winter (Stott *et al.,* 1980; Van Der Poel *et al.,* 1993). Nonetheless, there have been outbreaks during summer season too (Elvander, 1996).

2.4.2.2 Bacterial causes

Pneumonia is often a multifactorial disease, i.e. caused by several different pathogens. It is not uncommon that sick calves have been infected by both viruses and bacteria (Allen *et al.,* 1991; Stortz *et al.,* 2000; Giovannini *et al.,* 2013). *Pasteurella multocida* (P. *multocida)* is a gram-negative bacterium, may cause enzootic pneumonia in dairy calves and shipping fever in weaned stressed beef calves (Fulton *et al.,* 2000; Stortz *et al.,* 2000; Dabo *et al.,* 2008). Clinical signs of P. *multocida* infection are cough, strained breathing, fever and reduced feed intake (Dowling *et al.,* 2002; Dowling *et al.,* 2004).

Mycoplasma bovis (M. *bovis*) is another major cause of respiratory issues (e.g. pneumonia) in cattle, but is also a common reason for mastitis and arthritis (Nicholas & Bashiruddin, 1995 and Nicholas *et al.,* 2000a: see Nicholas & Ayling, 2003; Maunsell *et al.,* 2009), although the pathogen is not common in Sweden. The animals get infected through the respiratory tract, teat canal or genital tract (when using AI). An infection of M. *bovis* is extremely difficult to eradicate from a herd, due to the continuous shedding that might be extended for months or even years. The herd will function as a reservoir for the mycoplasma (Gourlay *et al.,* 1989 and Pfützner, 1990: see Nicholas & Ayling, 2003). During the first two weeks of infection the mortality rate will be 10%. If animals die when infected by M. *bovis* it is mainly due to severe pneumonia. Several studies have shown that calves dying from pneumonia have been infected with M. *bovis*, and also that many of these pneumonic calves had coinfections with both M. *bovis* and P. *multocida* (Buchvarova and Vesslinova (1989): see Nicholas & Ayling, 2003; Shahriar *et al.,* 2002; Soehnlen *et al.,* 2012). M. *bovis* causes large economic losses for the farmers. In total the pathogen causes disease costs for 576 million Euros in cattle all over Europe (Nicholas *et al.,* 2000b: see Nicholas & Ayling, 2003). The recommended preventive measures are to improve ventilation in the barns and to reduce the stocking density.

2.5 How do diseases spread?

Diseases might spread between and within herds through several different routes, depending on the pathogen. Common transmission routes are: introduction of animals, contact between contiguous animals (e.g. by nose-to nose contact, biting, saliva, blood, open wounds), animal secretion and excretion (urine, manure, saliva, nasal discharge etc.), fomites (e.g. farm equipment), vehicles, feed, visitors, water, soil and other species (wildlife, rodents, birds, insects etc.; Cleere *et al.*, 2008; Nöremark, 2010). BCV may for example be shedded via feces

and nasal discharge (Thomas *et al.,* 2006). Salmonellosis is for example often spread through the animals feed or water (Papadopoulou *et al.,* 2009; Nöremark, 2010).

An animal, which has been infected, may shed the pathogen during different phases of an infection; incubation period, the clinical phase as well as during a chronic infection, through e.g. manure, saliva or nostril secretions (Nöremark, 2010). Aerosol transmission is also very common, e.g. when an animal is coughing or sneezing the pathogens spread with the moisture droplets in the air (Cleere *et al.,* 2008). Pathogens may also spread with the wind, e.g. the foot and mouth disease virus can spread great distances with the wind (Donaldson & Alexandersen, 2002). Cattle may shed the virus for four to five days from the day of infection. Another possible transmission rout is through reproductive activity, i.e. when the animals are mating or getting inseminated (Cleere *et al.,* 2008).

Strains of salmonella have been found in feedlot runoff and litter, which indicates that there are possible risks of the pathogens to spread to humans from the animal production. E. *coli* O157, Salmonella and Campylobacter have been shown to survive in manure storages and in dirty waters for up to three months (Nicholson *et al.,* 2005). Also rodents might be possible vectors for disease. Mice have been shown to spread Salmonella to cattle and poultry (Hunter *el al.,* 1976; Tablante & Lane, 1989 and Davies & Wray, 1995: see Barrington *et al.,* 2006).

Objects used in the barns, e.g. manure srcapers, towels, boots etc., might be a big part of disease transmission. Whether a pathogen will survive on these objects depends on surrounding environment, the object and pathogen properties (England, 1982: see Boone & Gerba, 2007). Environmental and object properties which may have a positive effect on the survival of the pathogen are: moisture, cleanliness and whether the surface is porous or not. Other environmental factors are pH, temperature, humidity, UV exposure and whether there are other pathogens present or not (competition). Pathogenic characteristics that affects survival rate are: genetics (type of pathogen), inoculum size and suspending medium.

Disease transmission through direct contact between animals is a common and important route of transmission. For example calves infected with M. *bovis* may have gotten the infection through contact with the mother's udder or by being fed milk from an infected cow (Waltz *et al.,* 1997; Butler *et al.,* 2000).

Direct and indirect animal contacts, air movement between barns and manure are the most common disease pathways within the beef industry (Jamieson, 2010c). Purchased animals are a possible source of disease and there is a great risk of disease transmitting from the new animals to the rest of the herd.

2.6 Examples of current recommendations on how to prevent spread of animal diseases

Disease control involves breaking transmission routes (Andersson, 2011). It is important to control both internal and external disease pathways, but the most important is to not allow direct contact between infected animals. However, external factors are as important as what you do on the farm. Pathogens can enter the farm though e.g. wildlife, vehicles (e.g. slaughterhouse transport vehicle (transport to slaughter facility) and slaughterhouse calf mediating vehicle (between farms) and visitors (e.g. veterinarians, animal welfare inspectors, animal transport drivers, private visitors).

Belk *et al*. (2007) recommends ten different disease control principles regarding breeding stock, however most of them might be applicable for specialized beef production too. The principles that may be applicable and efficient in Swedish specialized beef production are e.g.:

- Isolation of new animals, i.e. to keep the new animals in a separate area away from other animals.
- Have the calves tested for diseases before purchase.
- Test for diseases common in your region to be able to quickly detect sick calves and to place calves carrying a certain pathogen together and keep them apart from healthy calves.
- Make sure that vehicles that carry dead animals and are used for rendering cannot enter the farm.
- Cadavers should be brought outside of the farm, where they can be picked up.
- Calf transportation vehicles should be cleaned regularly.
- All people visiting the farm (general visitors, veterinarians, drivers etc.) should wear clean boots/shoes/shoe covers.
- Set up a biosecurity order, where animals and sections needing the strictest biosecurity measures and careful handling are categorized, e.g. new born/young calves are more sensitive than older calves. Thus, people and traffic should move from the least contaminated areas, where the young sensitive animals are, to the more contaminated areas, e.g. sick pens, quarantine sections.
- Boots and clothes should be washed before a person can return to the animals in a low contamination area. It is highly recommended to store farm specific boots or shoe covers, which visitors may lend.
- Make sure to keep a logbook where anyone visiting the farm (truck drivers, general visitors and employees) should register that they have been on the farm. If there is a disease outbreak it will be easier to trace it back to a possible source and to contact everybody who have visited the farm if it is a zoonosis that may do harm to anyone infected.

Within the pig industry, except for the principles above, it is also important to make sure to clean all rooms with high water pressure and a broad spectrum disinfectant and to separate animals of different ages to avoid physical contact and shared air space between the animals

(Seaman & Fangman, 2001). In addition to this they also recommend to minimize the number of visitors on the farm, keep an all in – all out system, keep buildings clean from rodents, birds, insects and other domestic animals and isolate sick animals in a separate pen. Seaman & Fangman (2001) clarifies that biosecurity does not mean that you get rid of all pathogens. Because there will always be pathogens within the herd, it is rather to try to prevent new pathogens from entering the herd, especially the endemic pathogens and reduce their impact on the production.

Gård & Djurhälsan (2015c) and Smittsäkra.se (2015a) list some recommendations regarding biosecurity measures for visitors on Swedish beef farms. For example visitors should only be allowed to go into the barns if necessary. If an animal is supposed to be collected from the herd, the farmer should be the one retrieving the animal from the barn and walk it to the barn entrance. It is always good to have an unloading space in the barn. Both websites also mention that protective clothing should always be used by the visitors, preferably coveralls and boots, which the farm supplies. If the farm do not have any boots or coveralls to lend out, the visitor should bring either shoe covers or boots that have been thoroughly cleaned and a clean coverall/coat that is only used on this farm. A plastic coat is also okay.

Other recommendations are e.g. not to bring foreign equipment if not necessary, hence always try to use the farms own equipment if possible (Smittsäkra.se, 2015b). Equipment should always be cleaned and disinfected between each farm visit. Personal hygiene is also an important factor and hands should be washed and disinfected before and after a visit (smittsäkra.se, 2015a). If visiting several farms during a day (e.g. veterinarians) should make sure to plan the visits according to the different farms' health status. That is, a farm that is known to have problems with cough and/or diarrhea should be the last farm to be visited. Smittsäkra.se (2015b) also identifies that it is important to avoid transporting calves from farms that are known to have problems with infectious diarrhea or cough. All animals, on a farm that had an outbreak of diarrhea or cough, should have fully recovered before delivering animals again. It is recommended that there should be a waiting period of three weeks before starting to transport animals again and during this time there should not be any signs of disease like fever, cough or diarrhea.

2.6.1 Vaccination

As seen above many of the infectious diseases in calves are caused by viruses and parasites, thus antibiotics cannot be used to treat the infection. Therefore vaccination may be a method to prevent viral disease outbreaks, since it can hold back the spread of a disease and also reduce the possible costs of a disease outbreak (Jin *et al.,* 2009). There have been several studies on vaccination against several of the infectious agents mentioned above. Some of these studies have shown positive effects on disease prevalence and reduced morbidity (Thurber *et al.,* 1977; Wright *et al., 1994;* Harp & Goff, 1995*;* Kohara *et al.,* 1997; Orsel *et al.,* 2005; Newcomer *et al.,* 2015). Harp & Goff (1995) studied the effect of vaccination against *C. parvus* in calves. Their study showed that calves vaccinated against *C. parvus* either did not show any signs of

diarrhea or had a shorter diarrheic period compared to the unvaccinated calves. Also the vaccinated calves did not shed or shed less oocytes than the unvaccinated calves.

Wright *et al.* (1994) did a study where they vaccinated against five different pathogens; bovine rhinotracheitis, parainfluenza-3, BVD, BRSV and *Pasteurella haemolytica*. In addition to the vaccine they also gave the calves a supplement of chromium. Their results showed that these calves had a higher feed intake and an increased average daily gain compared to the unvaccinated calves. However, the vaccination and chromium supplement did not reduce the morbidity among the calves but there were less relapses among the vaccinated calves.

BVDV is a good example of a disease that has been handled differently in countries tackling the disease. Some countries like Sweden decided not to use a vaccination program, instead a preventive program based on farmers voluntarily participating and sending in samples from their animals to test for BVDV-antibodies was used (Greiser-Wilke *et al.,* 2003; Hult & Lindberg, 2005). This prevention program started in 1993 and today Sweden is considered free of BVDV (SVA, 2015, h). In Germany however, they have used a vaccination program in which the pregnant heifers and cows are vaccinated twice, first with an inactivated vaccine and later with a live vaccine boost (Frey & Eicken, 1995 and Frey *t al.,* 1999 and Eicken *et al.,* 2004*: see* Moennig *et al.,* 2005; Frey *et al.,* 2002). This gives a high antibody response and a fetal protection, i.e. prevents the calves from becoming persistently infected (PI). If the fetus is infected with the virus it may result in abortion but it may also result in a calf, which is immune to the disease, and does not show signs of the disease but continuously shed the virus and therefore spread the disease among the rest of the herd.

There are several possible issues that might occur with vaccination. For instance there are several subspecies of viruses, which display a great antigenic diversity, consequently it is difficult to give immunity to all types of a virus (Blancou & Pearson, 2003; Fulton *et al.,* 2003; Vilcek *et al.,* 2004; Moennig *et al.,* 2005) Other issues are inconsistent use of vaccines, failure to remove PI animals, too frequent vaccination may result in antigen specific tolerance and autoimmunity (Chase *et al.,* 2008), contaminated vaccines (Bolin *et al.,* 1991; Barkema *et al.,* 2001; Niskanen & Lindberg, 2003) and that the calves may get infected by the vaccine instead of building up immunity (Schreiber *et al.,* 2000). There is also that farmers may get a false feeling of security when using a vaccination program, thinking that vaccination gives full protection which it does not (Graham *et al.,* 2004; Fulton *et al.,* 2005). It is not always possible to distinguish between a vaccinated animal from an infected one, which could continue to be infectious for a long period of time even though it seem to have recovered (Breeze, 2004). In addition to this the effect of vaccination differs in animals of different ages (Platt *et al.,* 2009).

3. MATERIAL AND METHODS

3.1 Questionnaire

A questionnaire was constructed to investigate biosecurity measures in farms with specialized beef production and to get an understanding of the farmers' thoughts regarding biosecurity and disease control. The questionnaire was dived into three parts: *A. The farm and background*, *B. Purchase and housing of animals* and *C. Disease occurrence and control measures.* Part A consisted of questions such as geographic location, what type of specialized production the farm had (i.e. calf, young bull, steer or heifer), if there was any other type of animal production on the farm, what type of housing system they have in the quarantine barns and finishing barns etc. Questions in part B regarded e.g. the age of the animals when they arrive on the farm, where they are purchased from (dairy or beef farms), how they are purchased (through a contractor or directly from farms via contract or not), how often they purchase animals and if animals from different farms are mixed together on the new farm etc. Part C covered e.g. when the animals got sick, how high frequency there was of diarrhea and pneumonia in the different barns, how many animals had been treated with antibiotics during the last year, how high had the mortality been the last year, what type of biosecurity/ disease control measures were performed/used, the cleaning of the slaughter truck and slaughterhouse calf mediating truck and cleaning of the barns etc. In the end of the questionnaire there was a possibility for the farmer to provide the farm identification number. Throughout the survey it was also possible to write extra comments. The full questionnaire can be seen in Appendix 2.

The design of questions in the questionnaire was created in an iterative fashion involving experts in the field. The questionnaire was subsequently tested in a pre-pilot with two experienced researchers and, after some modifications, in a pilot test with two farmers and two persons with good knowledge about this type of animal production. After the pilot test editions were made and thereafter the questionnaire was sent out.

Farms with specialized beef production and clients of Svenska Djurhälsovården (Swedish Animal Health Services (SvDHV), now called Gård & Djurhälsan[1]), was the sampling frame. A random sample of 200 farms received the questionnaire together with a cover letter describing the purpose of the study. There was no specification for e.g. herd size, region, organic or conventional production etc. The survey was sent out on September 23, 2013, and a reminder, including the full questionnaire, on October 10, 2013. The last day to answer the survey was October 19, 2013.

The questionnaire was also available on the Internet, using Netigate (Netigate, 2013). A link to the questionnaire was published on the website of Taurus (Taurus, 2013) and also in their newsletter and on their Facebook page. Taurus was a company that provided Swedish beef farmers consulting, knowledge, news and research results regarding beef production (www.taurus.mu, now www.gardochdjurhalsan.se). It was merged with SvDHV. Also the

[1] An organization providing animal health programs for pigs, cattle and sheep and performing specific disease control and surveillance programs; http://www.gardochdjurhalsan.se/sv/in-english/

journal Nötkött published information about the questionnaire on the 16th of October referring to the Taurus website. The journal Nötkött is addressed to Swedish beef producers, veterinarians, consultants, teachers and personnel within the meat industry and it provides news and information about beef production, breeding, feed, animal health, economy etc (Nötkött, 2015). The Internet survey was open until November 30, 2013.

The paper versions of the questionnaire were entered in Netigate and the data exported to Microsoft Excel and further processed. Statistical analysis (chi^2 test and Fisher's exact test) was done on the websites http://www.socscistatistics.com/, http://www.openepi.com (row by column table) and http://graphpad.com/.To be able to test and analyze the associations between the different factors, some levels had to be combined in to broader intervals. Chi^2 and Fischer's exact test were used depending on the sample size (numerical size and number of intervals). If it was possible both tests were used to see if there was a significant result but usually the factors and intervals had to be changed. Fisher's exact test was mainly used if there were 2x2 factors being analyzed (e.g. pneumonia or no pneumonia vs. diarrhea or no diarrhea). If there were more factors being tested, chi^2 was used instead, since more rows and columns are allowed to be added with this test.

3.2 Interviews

Interviews were made with two different slaughterhouse agents; Buska Åkeri AB and HKScan Agri. At the time of the interview HKScan Agri was called Svenska Livdjur & Service (SLS). The interview with Buska Åkeri AB was made in person with the CEO Anders Persdahl. Buska Åkeri AB conveys and transports animals for Lövsta Kött AB and Faringe Kött och Slakt AB, two meat-producing companies with slaughter facilities in Uppland. The interview with HKScan Agri was carried out through email with Jakob Danielsson (Business Area Manager - Beef) and Kristher Svensson (Site Transport and Settlement Manager). HKScan Agri is the organization within the meat producing company HKScan Sweden, which purchase and conveys Swedish cattle (calves, beef, pregnant heifers etc) and piglets (HKScan Agri, 2015). They also purchase lamb for slaughter. HKScan Sweden is the largest meat and deli company in Sweden (HKScan Sweden, 2013).

Interview questions concerned what biosecurity and disease control measures the company performed, how many animals they convey per year, how many farms they convey animals to and from, the cleaning of the vehicles etc. Interview questions can be seen in Appendix 2.

Jan Gardell at the consulting company EnviroGard was contacted via email and asked about the animal transportation course he is managing for Transportfackens Yrkes- och Arbetsmiljönämnd (TYA), which all conveyors have to take to be authorized to transport animals. TYA is a cooperation between employer associations and worker unions in the transport sector and provides courses, programs and further education regarding the transportation sector (TYA, 2015).

4. RESULTS

4.1 Questionnaire

Answers from one hundred farmers were received. However six of the answers were from farmers, which did not have specialized beef rearing units and these answers were removed and not included in the study. This resulted in 78 paper questionnaires being processed and 16 answers through the Internet-based questionnaire (83% and 17% respectively).

The response frequency varied among questions, maybe as a result of unclear statement of the question but also as a consequence of specifically directed questions e.g. towards farmers who had a contract with a slaughterhouse agents. Consequently some questions have a low response rate (see table 9, 11, 14, 15 22 and 23). Also some of the data from certain questions has not been possible to process due to written answers (not tick in a box questions): The written answers varied too much in "quality", in terms of specified information, e.g. the questions about average age of slaughter and average carcass weight. For example, a few did not answer these questions at all, some only partially answered the questions (e.g. only gave age at slaughter for steers but not for heifers if they had both types) and some answered another question within that writing space

4.1.1 The farm and background

Answers came from farms from 18 counties in Sweden (table 1), although the majority of farms were situated in Västa Götaland and Skåne. There were no answers from the provinces of Stockholm, Västernorrland and Norrbotten.

Table 1 *In which province is the farm situated? Response rate 99% (93/94)*

Province	Number of farms	% of farms
Blekinge	2	2.2%
Dalarna	4	4.3%
Gotland	6	6.5%
Gävleborg	4	4.3%
Halland	7	7.5%
Jämtland	1	1.1%
Jönköping	6	6.5%
Kalmar	6	6.5%
Kronoberg	3	3.2%
Skåne	12	12.9%
Södermanland	3	3.2%
Uppsala	6	6.5%
Värmland	2	2.2%
Västerbotten	1	1.1%
Västmanland	2	2.2%
Västra Götaland	21	22.6%
Örebro	2	2.2%
Östergötland	5	5.4%

The most common type of specialized beef rearing was young bull (table 2), while the rarest type of production was steer rearing. Ten farms only produced calves. However, almost 40% of the farms hade more than one type of specialized beef production (36 farms). Out of these 36 farms 32 had young bull production and one or two more types of specialized beef production. The majority had a combination of young bull and heifer production (21 farms).

Table 2 *What type of specialized beef production is conducted on the farm? Response rate 98% (92/94)*

Type of production	Number of farms	% of farms
Calf	16	17.4%
Young bull	77	83.7%
Steer	10	10.9%
Heifer	31	33.7%

The type of rearing differed a little bit between the quarantine and finishing barns, but the majority of farms had continuous production in both barns (table 3). Nonetheless, in the quarantine barns almost the same number farms had batch rearing and continuous production. However, ten farms had more than one type of rearing in the quarantine barns (10.8%).

Regarding the finishing barns, two farms had more than one type of rearing, which were batch and continuous rearing for both farms (2.2%).

Table 3 *Distribution of farms according to main type of rearing in the quarantine and finishing barn*

	Quarantine barn		Finishing barn	
Type of rearing	Number of farms (n=93)	% of farms	Number of farms (n=92)	% of farms
Batch rearing (all in-all out)	41	42.7%	13	14.1%
Continuous	45	46.9%	76	82.6%
Don't have a quarantine barn, purchase suckler calves which are placed into the finishing barn*	14	14.6%	-	-
Other	3	3.1%	5	5.4%

* This alternative was only presented in the question regarding the quarantine barn

Regarding the answers to the question about how many animals were inserted into the quarantine barn each batch, the answers varied so much that it was too difficult to process them and present them in a table. Also, not all of those who reported that they had a batch rearing system, answered the question about the number of animals inserted each batch. Some farmers purchased and inserted animals every month, and some every other week. Sixteen farms inserted less than 30 animals each batch, but for one farm the number of animals varied between 40 and 70. Two farms installed as many as 330 and 500 animals, respectively. One farm had huts for the calves and placed 12 calves in each hut.

Table 4 presents the number of calves that have been purchased during the last year. The herd sizes varied a lot, nonetheless the highest percentage of farms had purchased between 200 and 299 animals during the past 12 months.

Table 4 *Number calves purchased during the past 12 months*

Number of calves purchased	Number of farms (n=89)	% of farms
1 - 49	7	7.9%
50-99	11	12.4%
100-149	13	14.6%
150-199	12	13.5%
200-299	16	18.0%
300-399	9	10.1%
400-499	12	13.5%
500-1000	7	7.9%
> 1000	2	2.2%

As seen in table 5a, the majority of farms, which have purchased more than 50 calves during the past 12 months, use a continuous production in the quarantine barns (39 farms continuous versus 37 batch rearing) as well as in the finishing barns. Due to too small expected values, the association tests (chi-2 with Row by Column test) did not give any reliable results. However the table gives a good overview of the relation between herd size and type of rearing in the participating farms.

In table 5b, the groups with the number of purchased animals were reduced to two groups: 1-200 and more than 200 animals purchased during a year. The results for the quarantine barn shows that farms that purchase more than 200 animals per years mostly uses batch rearing and farms with smaller herd sizes more often uses continuous production.

Table 5a *Herd size versus type of production in different barns*

	Quarantine barn		Finishing barn	
Number of purchased animals	Batch rearing	Continuous	Batch rearing	Continuous
1-50	1	5	0	6
51-200	15	24	6	33
201-500	18	14	6	29
501-1000	2	1	0	3
>1000	2	0	0	2

Table 5b *Small and large herd sizes versus type of production in different barns*

Number of purchased animals	Quarantine barn		Finishing barn	
	Batch rearing	Continuous	Batch rearing	Continuous
1-200	16	29	6	39
>200	22	15	6	34

4.1.2 Purchase and housing of animals

The majority of the farms purchased weaned calves older than two months old (table 6). Nonetheless, 18 farms in total purchased calves younger than three weeks old (not weaned) of which seven only purchased animals of this age. Twenty-two farms bought not weaned calves older than three weeks of age. However, 13 of the farms that purchased the calves older than two months old, also bought animals of younger age. Two of these 13 farms bought animals of three different ages: younger than three weeks (not weaned), older than three weeks (not weaned) and older than two months (weaned). In total 23 farms bought calves of varying ages (25%). Most commonly the farms in the study purchased calves from dairy farms (table 7).

Table 6 *What is the average age of the animals purchased? Response rate 97% (91/94)*

Average age of animals	Number of farms	% of farms
Not weaned, < 3 wks	18	19.8%
Not weaned, > 3wks	22	24.2%
Weaned, 3wks-2 months	13	14.3%
Weaned, > 2 months	64	70.3%

Table 7 *The calves that are purchased originates from. Response rate 98% (92/94)*

Type of farm	Number of farms	% of farms
Dairy herd	59	64.1%
Beef herd	9	9.8%
Both	24	26.1%

The majority of the farms bought the animals directly from other farms; mainly through oral farm-to-farm agreements, but considerable percentage of the farms also purchased animals through slaughterhouse agents (table 8). Almost 31% of the farms used different purchase channels (28 farms). Twelve of the farms that used slaughterhouse agents also bought animals directly from farms through farm-to-farm agreements, oral or written. Eleven farms used both slaughterhouse agents and bought calves directly from farms but without farm-to-farm agreements.

Table 8 *How are the animals purchased? Response rate 96% (90/94)*

Type of purchase	Number of farms	% of farms
Slaughterhouse agents	39	43.3%
Directly from farms, oral farm-to-farm agreement	44	48.9%
Directly from farms, written farm-to-farm agreement	14	15.6%
Directly from farms, no farm-to-farm agreement	21	23.3%
Other	3	3.3%

The majority of the herds participating in this study, purchased their animals from two to five farms (table 9). Since the question about how many farms they purchase animals from was a freehand question (i.e. not a tick in the box-question), the answers have been put into reasonable intervals.

Not everyone who used slaughterhouse agents answered the question about which company they do business with. However those who did answer mentioned the following companies: SLS (HKScan, 24 farms), Dahlbergs slakteri (two farms), Dahlsjöfors slakteri (four farms), KLS Ugglarps (seven farms), Skövde slakteri (six farms), Närkes slakteri (one farm) and Våkön AB (two farms).

Table 9 *Origin of the calves: the number of farms the participating herds are collecting calves from.*

Number of farms the calves are collected from	Number of answers (participating herds) (n=77)	% of answers (participating herds)
1-2 farms	11	14.3%
2-5 farms	57	74.0%
5-10 farms	5	6.5%
10-20 farms	2	2.6%
> 20 farms	2	2.6%

Table 10 shows whether the farm picks up the animals themselves or get them delivered to their farm. The answers are quite evenly proportioned; nevertheless there were slightly few more farms, which collect the calves themselves compared to getting them delivered.

Table 10 *How do you collect the animals? Response rate 97% (91/94)*

Pick up or delivery	Number of farms	% of farms
Pick up by my self	35	38.5%
Get them delivered	31	34.1%
Both	25	27.5%

Table 11 shows if the farms that pick up the animals themselves mix calves from different farms in the truck and if calves of different origin are mixed at arrival on the farm. Table 4 shows that the majority of farms, which pick up the calves themselves, do not mix animals from different farms in their transport vehicles. On the other hand, it seems like most of the farms mix calves from different farm when they arrive on their farm.

Table 11 *Mixing of animals of different origin at pick-up or at arrival on the farm (only farms which collect calves themselves)*

	Animals are mixed in transport vehicle		Animals are mixed at arrival on the farm	
Answer	Number of farms (n=64)	% of farms	Number of farms (n=90)	% of farms
Yes	17	26.6%	57	60.6%
No	40	62.5%	12	12.8%
Sometimes	7	10.9%	21	22.3%

Table 12 shows whether the farms keep their animals on pasture or not, and if so during what periods of the year. There was an equal number of farms which did not have their animals on pasture at all as the ones keeping them on pasture during the spring/summer months (approximately 44% and 43% respectively). However, of those farms that did not keep their animals on pasture at any time of the year, were mainly farms with calves and/or young bulls. Only two farms with heifers did not let them on pastures and one of these did not house any cattle during pasture season and the other never kept dairy breeds on pasture only suckler cows and their calves (if they had type of production too). Seventeen of the farms, which had answered that they kept some of the animals on pasture, had added comments that specified that only the heifers, steers ,or only the suckler cows with their calves and not the young bulls were kept on pasture.

Table 12 *Are the animals kept on pasture? Response rate 93% (87/94)*

Are animals kept on pasture?	Number of farms	% of farms
Yes all animals are on pasture throughout the year	1	1.1%
Yes all animals but only during grazing season (spring-summer months)	9	10.3%
Yes some of the animals are on pasture throughout the year	6	6.9%
Yes some of the animals are on pasture during grazing season (spring and summer months)	37	42.5%
No, no animals on pasture	38	43.7%

4.1.3 Disease occurrence

For the majority of the herds the calves usually got sick between two to four weeks after arrival (table 13). A few of those who had animals that got sick "later" had commented on how much later the animals became ill. The answers ranged from anywhere between 4 weeks to eight months after arrival and particular seasons (late fall/early winter) were also given.

Table 13 *Period of time after arrival during which the animals become sick*

Period when animals get sick	Number of farms (n=82)	% of farms
0-2 weeks after arrival	24	29.3%
2-4 weeks after arrival	41	50.0%
Later	19	23.2%

Most of the farms did not seem to have a problem with diarrhea among the animals in the quarantine barns (table 14), but one farm acknowledged that 50% of the animals in the quarantine barns got diarrhea. The majority of the farms recognized that more than "practically none" but less than 25% of the calves got cough/pneumonia in the quarantine barns (table 14), but one farm admitted that about 75% of the calves in their quarantine barn got cough/pneumonia.

Most of the farms did not acknowledge any larger health problem in the quarantine barns (table 14). However, a few comments to this part of the question were made, in which different health issues were mentioned. Twelve farmers reported that ringworm was a health issue in the quarantine barns and six stated that lameness was a problem, but most of the comments were concerning cough/pneumonia.

Table 14 *Proportion of calves in the quarantine barns with diseases*

Proportion of animals	Diarrhea		Cough/pneumonia		Other larger health problems	
	Number of farms (n=83)	% of farms	Number of farms (n=82)	% of farms	Number of farms (n=58)	% of farms
Practically none of the animals	55	66.3%	22	26.8%	47	81.0%
0%<*<25%	18	21.7%	29	35.4%	4	6.9%
Circa 25%-practically all of the animals	10	12.0%	31	37.8%	7	12.1%

Almost none of the farms had problems with diarrhea in the finishing barns (table 15). Nevertheless, at one farm about 75% of the animals got diarrhea. Regarding cough/pneumonia in the finishing barns, the majority of the farms did not have any problem with respiratory disorders in these barns (table 15). When it came to larger health problems in the productions barns, the prevalence varied a little between farms (table 15), but the majority did not have big problems. The most common types of health problems mentioned were ringworm, lameness and limping.

Table 15 *Proportion of calves in finishing barns with diseases*

Proportion of animals	Diarrhea		Cough/pheumonia		Other larger health problems	
	Number of farms (n=80)	% of farms	Number of farms (n=80)	% of farms	Number of farms (n=63)	% of farms
Practically none of the animals	73	91.3%	54	67.5%	38	60.3%
0%<*<25%	4	5.0%	17	21.3%	16	25.4%
Circa 25%-practically all of the animals	3	3.8%	9	11.3%	9	14.3%

The majority of the farms had treated about 1-5% of the calves in the quarantine barn with antibiotics in the past year (table 16). The largest proportion of farms treated about 1-5% of the animals in the finishing barn the past year (table 16). No farm treated more than 20% of the animals in the finishing barn.

Table 16 *Proportion of animals treated with antibiotics in the past year in the quarantine and finishing barns*

	Quarantine barns		Finishing barns	
Proportion of animals	Number of farms (n=85)	% of farms	Number of farms (n=91)	% of farms
None	9	10.6%	20	22.0%
1-5%	38	44.7%	61	67.0%
5-10%	16	18.8%	6	6.6%
10-20%	15	17.6%	4	4.4%
20-50%	6	7.1%	0	0.0%
More than 50%	1	1.2%	0	0.0%

Most of the farms had a mortality of 1-2% in the quarantine and finishing barns during the last three years (table 18), but one farm had a mortality higher than 10% in the quarantine barns.

Table 18 *Mortality during the last three years in the quarantine and finishing barns*

	Quarantine barns		Finishing barns	
Mortality	Number of farms (n=85)	% of farms	Number of farms (n=91)	% of farms
None	10	11.8%	9	10.0%
1-2%	51	60.0%	63	70.0%
3-5%	20	23.5%	14	15.6%
6-10%	3	3.5%	4	4.4%
More than 10%	1	1.2%	0	0.0%

4.1.4 Control measures

The most common preventive measure was “control of rodents/small birds” (table 19). On second and third place were the “voluntary salmonella control program” and “sweeping the feeding area”. No farms had rules about staff and visitors having to shower before entering the barns. Four farms did not fill in any type of preventive measure. It is not clear if these farms just decided not to answer the question or if they actually do not perform any disease preventing measures on their farms.

Table 20 shows the number of preventive measures performed per farm. Seventeen different preventive measures were available to choose from, but no farm did more than twelve preventive measures. The largest proportion of farms did six different preventive measures.

Some of the farms left comments regarding other preventive measures they performed on their farms. These were mainly related to routines regarding visitors, equipment, cleaning and feeding, but did not fit into any pre-specified category.

Table 19 *Preventing measures performed on the farms*

Type of preventive measure	Number of farms (n=90)	% of farms
Control of rodents/small birds	83	92.2%
Part of the voluntary salmonella control program	74	82.2%
Sweeping the feeding area	73	81.1%
Preventing feed from manure contamination	72	80.0%
Hand washing with soap, hot water and towels is possible in the barns	61	67.8%
Making sure that the animals have eaten all the feed in the feeding area before any new feed is given	54	60.0%
Separate barn sections for animals of different ages	53	58.9%
Cleaning of pens/barns after every animal group/ animal round	46	51.1%
Hand disinfectant is available	34	37.8%
All visitors have to put on clean overalls/protective clothing and shoes before entering the barns	32	35.6%
Do not allow visitors on the farm	17	18.9%
24h waiting period for people who visited another farm	16	17.8%
Change of boots/shoes between different barns	9	10.0%
Footbaths with disinfectants, between barns/sections	5	5.6%
Change of clothes between barns	1	1.1%
All personnel has to shower before entering the barns	0	0.0%
All visitors have to shower before entrance into the barns is allowed	0	0.0%

Table 20 *The number of farms that performed one or more preventive measurements*

Number of preventive measures	Number of farms	% of farms
1	3	3.3%
2	1	1.1%
3	4	4.4%
4	6	6.7%
5	10	11.1%
6	17	18.9%
7	13	14.4%
8	9	10.0%
9	9	10.0%
10	7	7.8%
11	9	10.0%
12	2	2.2%

The majority of farms stated that the vehicle, which is used to transport animals to the slaughterhouse, is cleaned when arriving at their farm (table 21). Almost equal number of farms stated that the slaughter vehicle is always empty as the number of farms that stated that *sometimes* the slaughter vehicle is empty of animals. The majority admitted that they allow the driver of the slaughter vehicle to enter the barns when retrieving the animals.

Table 21 *Status of vehicle used to pick up animals for slaughter: cleanliness, empty at arrival, permissions for the driver*

Answer	Vehicle cleaned		Vehicle empty		Driver is allowed to enter barns	
	Number of farms (n=88)	% of farms	Number of farms (n=89)	% of farms	Number of farms (n=89)	% of farms
Yes	70	79.5%	40	44.9%	70	78.7%
No	2	2.3%	6	6.7%	9	10.1%
Sometimes	16	18.2%	43	48.3%	10	11.2%

The majority of the farmers stated that the vehicle used to transport animals purchased through slaughterhouses agents, have been cleaned before arriving at the farm (table 22), however a large proportion did not know whether it was cleaned or not. Comments mainly stated that the vehicle had been cleaned before picking up animals but it visited many different farms before arriving on their farm to deliver the animals. Table 23 shows whether the vehicle is carrying only animals intended for their farm when arriving on their farm and if the driver is allowed to enter the barns when dropping off animals. For the majority of the farms, the vehicle only carried animals which were supposed to be delivered to their farm. On a more positive matter, half of the farms never let the driver of the vehicle enter the barns when delivering the animals. The response rates were quite low, probably because not all farms used slaughterhouse agents. Comments regarding the driver in most cases stated that that the driver was only allowed to enter if it was necessary.

Table 22 *Cleanliness of the vehicle for animals purchased through slaughterhouse agents*

Answer	Number of farms (n=57)	% of farms
Yes	28	49.1%
No	8	14.0%
Do not know	21	36.8%

Table 23 *Vehicle for animals purchased through slaughterhouse agents: animals destined for different farms mixed together, permissions for the driver*

Answer	Animals of different origin, mixed together in the vehicle		Driver is allowed to enter the barns	
	Number of farms (n=59)	% of farms	Number of farms (n=59)	% of farms
Yes	26	44.1%	23	39.0%
No	17	28.8%	31	52.5%
Sometimes	16	27.1%	5	8.5%

Table 24 displays the results regarding cleaning and cleaning procedures in the quarantine and finishing barns. The majority of farmers cleaned the quarantine barns and the finishing barns at least once a year. However, it was also rather common to clean the quarantine barns between every batch. Answers for "other interval" differed a lot and were ranging between once per year to six times a year. Also one farm mucked out between every batch and used high-pressure washer once every six months.

Table 24 *Cleaning intervals in the quarantine and finishing barns*

Cleaning interval	Quarantine barn		Finishing barn	
	Number of farms (n=84)	% of farms	Number of farms (n=89)	% of farms
Between each batch	33	39.3%	7	7.9%
At least once every six moths	8	9.5%	8	9.0%
At least once a year	35	41.7%	60	67.4%
Other interval	7	8.3%	10	11.2%
Never	1	1.2%	4	4.5%

Table 25 shows what types of cleaning routines the farms were using in the quarantine and finishing barns. Most farms used high-pressure washer with hot water or disinfectants to clean their quarantine barns. Sixty-seven percent of farms used more than one way of cleaning, with the most common combination being high-pressure washer with hot water and disinfectant. Thirthy-three percent only used one type of cleaning routine. There were eight farms which only "dry cleaned" their quarantine barns.

Regarding the finishing barns, most of the farms used high-pressure washer with hot water (table 25). Almost 51% of the farms used more than one type of cleaning, with the most common combination being high-pressure washer with hot water and disinfectant. The number of farms that only did one type of cleaning measure was 43 (49%). Thirteen farms only "dry cleaned" the finishing barn.

Table 25 *Cleaning routines performed in the quarantine and finishing barns*

Cleaning routine	Quarantine barn		Finishing barn	
	Number of farms (n=84)	% of farms	Number of farms (n=87)	% of farms
Dry cleaning (manure removal, scraping, sweeping)	30	35.7%	30	34.5%
Wet cleaning (manure removal, scraping, scouring)	6	7.1%	6	6.9%
High pressure washer, cold water	30	35.7%	31	35.6%
High pressure washer, hot water	44	52.4%	44	50.6%
Disinfectant	44	52.4%	32	36.8%
Other	0	0.0%	0	0.0%

Table 26 shows that the majority of farms removed all animals from the quarantine barns before cleaning them. However, that is not the case regarding the finishing barns. Most farms did not seem to empty the finishing barns before cleaning them.

Table 26 *Preparations before cleaning – animal removal from the quarantine and finishing barns*

Answer	Quarantine barn		Finishing barn	
	Number of farms (n=84)	% of farms	Number of farms (n=89)	% of farms
Yes	69	82.1%	20	22.5%
No	13	15.5%	63	70.8%
Sometimes	2	2.4%	6	6.7%

4.1.5 Statistical analysis –possible links between different disease control factors

4.1.5.1 Antibiotic treatment

The association between level of cough/pneumonia and antibiotic treatment in the quarantine barns is shown in table 27, showing that farms with cases of cough/pneumonia in the quarantine barns also treated calves in the quarantine barns more often with antibiotics. However, it is not known what the calves have been treated against. There was, however, no significant association between pneumonia and antibiotic treatment in the finishing barns.

Table 27 *Number of farms with cough/pneumonia versus antibiotic treatment in quarantine (p< 0.001) and finishing barns (p=0.19)*

	Antibiotic treatment					
	Quarantine barn			Finishing barn		
Disease	0%	1-5%	>5%	0%	1-5%	>5%
No Cough/Pneumonia	7	15	0	15	35	4
Cough/Pneumonia	2	21	37	3	19	4

Table 28 shows that there was a significant association between antibiotic treatment and mortality in the quarantine barn but not in the finishing barn. The table shows that farms with higher antibiotic treatment also have higher mortality among the calves in the quarantine barn ($p<0.01$).

Table 28 *Number of farms, which have treated animals with antibiotics versus the mortality in the quarantine (p< 0.001) and finishing barns (p =0.106)*

	Quarantine barn		Finishing barn	
Disease	No mortality	Mortality of 1% and above	No mortality	Mortality of 1% and above
No antibiotic treatment	5	4	4	16
Antibiotic treatment of 1% and more	5	71	5	65

4.1.5.2 Biosecurity measures

Table 29 shows that farms with few biosecurity measures had more diarrhea than farms that applied several measures. However, this only shows the number of preventive measures not what type of preventive measures, which are performed. There was however no significant association between cough/pneumonia and number of biosecurity measures.

Table 29 *Number of farms with diarrhea (p=0.003) and cough/pneumonia (p=0.1646) in the quarantine barns versus number of biosecurity measures performed*

	Diseases in quarantine barns			
Biosecurity measures	No diarrhea	Diarrhea	No Cough/Pneumonia	Cough/Pneumonia
1-5	11	11	5	15
6-9	26	17	9	34
>9	17	0	8	10

4.1.5.3 Number of purchased animals

Table 30 shows that the majority of farms with which purchase both less or more than 200 animals have had cases of cough/pneumonia and diarrhea in the quarantine barns. However, there are also a quite large number of farms with herds of less than 200 animals, which did not have any cases of cough/pneumonia. There were a significant association between herd size and cough/pneumonia in the quarantine barns, i.e. with a larger the herd size (more the 200 purchased animals) there were more cases of cough/pneumonia among the animals in the quarantine barn ($p<0.05$). The majority of farms did not have any diarrhea in the quarantine barn nor the finishing barn. However, there was no significant association between herd size and cases of diarrhea.

There was a significant association between herd size and cases of diarrhea in the finishing barns ($p<0.05$), which shows that farms, which purchase less the 200 animals per year have more cases of diarrhea. Although, the majority did not have any cases of diarrhea in the finishing barns,

Table 30 *Herd sizes versus disease prevalence in the past 12 months, in both the quarantine and the finishing barns The number of farms of smaller and larger herd size (more or less than 200 purchased animals per year) with or without cases of cough/pneumonia or diarrhea in the quarantine and finishing barns.*

	Diseases							
	Quarantine barn				Finishing barn			
Herd size	No cough /pneumonia [1]	Cough/ pneumonia[1]	No diarrhea [2]	Diarrhea [2]	No cough/ pneumonia[3]	Cough/ pneumonia[3]	No diarrhea [4]	Diarrhea [4]
1-200	17	24	27	15	30	12	35	6
>200	5	32	27	11	21	13	34	0

1: p =0.011; ***2:*** p =0.634; ***3:*** p=0.464; ***4:*** p =0.029; Herd size = number of purchased animals per year

There was a significant difference in biosecurity performance between farms that bought more than 200 calves per year and farms that bought less than 200 calves per year (table 31). Smaller herds perform less biosecurity measures than larger herds.

Table 31 *Number of purchased animals versus number of biosecurity measures (p=0.0444)*

	Number of purchased animals	
Biosecurity measures	1-200	>200
1-5	18	6
6-9	20	25
>9	9	10

4.1.5.4 Other factors though no statistical association

Tables 32 to 35 show the association between factors like type of purchase and antibiotic treatment, diarrhea and antibiotic treatment, biosecurity measures and antibiotic treatment as well as biosecurity and diseases. Although none of the statistical tests of these factors showed any significant results it seems as if the majority of farms, which have treated more than five percent of the calves in the quarantine barns, had bought these calves directly from other farms. Also in table 34 it seems like the majority of those who treated their animals with antibiotics used between 6-9 different biosecurity measures. However, since no statistically significant associations were found, these results might be due to chance alone.

Table 32 *Type of purchase versus antibiotic treatment in quarantine and finishing barns (Quarantine barns: Chi2=0.6688, p= 0.7158; Finishing barns: Chi^2=0.8647, p=0.6490)*

	Antibiotic treatment in quarantine barns			Antibiotic treatment in finishing barns		
Type of purchase	No animals treated with antibiotics	1-5%	>5%	No animals treated with antibiotics	1-5%	>5%
Slaughterhouse agents	2	4	7	5	10	1
Directly from farms	5	21	24	11	34	6

Table 33 *Number of farms with diarrhea versus antibiotic treatment in the quarantine and finishing barns (Quarantine barns: Chi^2=3.07, p=0.2154; Finishing barns: Chi^2=0.3239, p=0.8505)*

	Antibiotic treatment in quarantine barns			Antibiotic treatment in finishing barns		
Disease	No animals treated with antibiotics	1-5 %	>5%	No animals treated with antibiotics	1-5 %	>5%
No Diarrhea	7	26	22	17	48	8
Diarrhea	1	11	16	1	5	1

Table 34 *Preventive biosecurity measures versus antibiotic treatment in quarantine and finishing barns. (Quarantine barns: Chi^2=2.804, p=0.5911; Finishing barns: Chi^2=4.972, p=0.2902)*

	Antibiotic treatment in quarantine barns			Antibiotic treatment in finishing barns		
Number of measures	No animals treated with antibiotics	1-5%	>5%	No animals treated with antibiotics	1-5%	>5%
1-5	4	11	8	7	16	1
6-9	3	18	22	10	17	7
>9	2	9	7	3	13	2

Table 35 *Number of farms with diarrhea and cough/pneumonia in the finishing barns versus number of biosecurity measures (Diarrhea: Chi^2= 1.772, p=0.4123; Cough/Pneumonia: Chi^2=1.259, p=0.5329)*

	Diseases in finishing barns			
Number of measures	No Diarrhea	Diarrhea	No cough Pneumonia	Cough/Pneumonia
1-5	15	3	11	8
6-9	41	3	31	12
>9	16	1	11	6

4.2 Interviews

4.2.1 Anders Persdal, Buska Åkeri AB

Buska Åkeri AB picks up and delivers animals for Lövsta Kött and Faringe Kött & slakt in the Uppsala area. They collect and deliver about 1000 cattle every year, which includes suckler calves, weaned dairy calves and pregnant heifers. They collect and deliver animals to and from about 75 farms in average. To deliver animals to one farm they have to pick up animals from about three different farms. They might have to deliver to several farms during one trip, e.g. when one farm wants bulls and the other heifers. This happens especially during fall. The truck is cleaned before picking up animals and after delivery. Disinfectant is not used every time the truck is cleaned. When cleaning the trucks they use hot water and the disinfectant is Virkon.

The company employs four drivers and these drivers have taken the animals transport course, which is held by TYA. Buska Åkeri do not have any special biosecurity rules for their drivers except for that the vehicle, clothes and shoes should be clean. The company's CEO did not know what other biosecurity measures could be performed on their part. Animals from different farms might be mixed together in the truck if one farm only delivers e.g. two or three calves, since they want to fill the vehicle to its maximum. It is not really possible to check whether the

drivers follow the rules or not; it can only be assumed that they do. When it comes to the slaughterhouse agent's role as a vector for diseases, Buska Åkeri have never been a part of a conscious contamination. The drivers make sure that they do not collect and deliver animals that show clear signs of illness. However, if calves with ringworm are going to be delivered to a farm that already has ringworm they will transport these, but if the receiving farm is free from ringworm they will not collect and deliver these calves.

According to Buska Åkeri, the most difficult part of disease control and biosecurity is that a livestock truck will never be 100% clean. There will always be some pathogens left. During the winter, when it can be minus 25 degrees, hopefully the cold will kill the pathogens. When it comes to health declaration of animals (appendix 2, question 16), the CEO of Buska Åkeri thinks it is possible but that it depends on the cost and if the money can be brought back in the other end, i.e. in the growth of the calves etc. It should also be possible to only collect and deliver calves which are known to be free from RS-virus, but it is necessary to know which farms is virus free.

4.2.2 Jakob Danielsson and Kristher Svensson, SLS HKScan/ HKScan Agri Sweden

SLS (now they have changed name to HKScan Agri) conveys about 50 000 animals every year to and from approximately 3 000 farms in Sweden (numbers from 2013). Generally animals delivered to one farm originate from about five other farms. It is not common that they convey and deliver animals to several farms during the same drive; mostly they go to only one farm. The transportation vehicles are cleaned after delivery with water and detergent as well as disinfected with Virkon S.

SLS/HKScan Agri has contracts with 30 trucking companies, and the drivers are governed by orders from SLS. The drivers have to follow current laws and regulations, and the drivers have to take the TYA animal transportation course or an equivalent course. They have to be authorized to transport animals. SLS/HKScan Agri do random checks and control that the drivers follow the regulations, but government agencies are also conducting checks of the transport vehicles and drivers.

Except for cleaning the vehicles after delivery, SLS/HKScan Agri also tells the drivers not to enter the barns at the farms they are visiting, but sometimes it happens anyway. Nonetheless, SLS/HKScan Agri believes that it is very important that the drivers perform their assignments carefully to prevent spreading of diseases. Regarding the possibility to health declare animals (appendix 2, question 16), SLS/HKScan Agri thinks that it might be possible but that it probably depends on how much it will cost. On the other hand, they think it would be possible to have certain days when only calves free from BRSV is transported, although it also depends on the price.

4.2.3 Animal transportation course by TYA

Both the drivers of SLS and Buska Åkeri AB have to take the animal transportation course held by TYA. Jan Gardell at EnviroGard is managing the course for TYA. He explained via email the contents of the course which are concerning biosecurity. The course lasts for two days, and on the second day the section about biosecurity and transportation is taught. Following points are addressed during the course:

- Different diseases and how you can see it on the animals.
- Hygiene and boundaries to protect yourself as well as the barns from contagion.
- Quarantine regulations after someone have stayed abroad.
- Clothing hygiene and routines for change of clothing.
- Driving arrangements with respect to the health status of the herds.
- Cleaning/disinfection and the effects at different temperature conditions.
- To (rather) not enter the barns.
- Not having "the farmer on the load", i.e. the farmer should not enter the transportation vehicle.
- Information on the website to increase the knowledge.
- The importance to act and report suspicions.
- The conveyor becomes the "first suspect"
- Only transport healthy animals

Veterinarian Gunnar Johansson at SvDHV teaches this section of the course.

5. DISCUSSION

5.1 Biosecurity

The main reason for implementing biosecurity measures at farms with animal production is to prevent diseases from entering the farm and infect animals. Sick animals will cost money, both in treatment and due to reduced production (in the case of specialized beef farms, lower weight gains which results in higher feed costs). Also some diseases may be a threat towards the welfare and protection of animals.

The results from this study show a varying attitude among farmers concerning biosecurity. Some did up to 12 different preventive measures while others did only two or three. Close to 20% did six biosecurity measures. The majority of those performing biosecurity measures was a part of the voluntary salmonella program and used control measures against rodents and small birds. These are probably two of the easiest preventive measures to perform, thus so many did them. On the other hand rodents and small birds were specified in the same alternative in the questionnaire and they have to be controlled in different ways. Rodents can be controlled through mousetraps, poison or by cats. Small birds are much more difficult to control when the buildings are not as closed, as they are in the pig and poultry industry. There are often openings of the barns in the beef industry, which allows birds to fly through them. The third most common biosecurity measure was feed handling, e.g. removing old or left-over feed and making

sure that feed and manure have no contact. The feed handling is also a biosecurity measure quite easy to uphold since the calves have to be fed every day. It is therefore easy to notice and act quickly if the feed is handled incorrectly and if there is any risk of contamination.

The biosecurity measures, which had a low usage, were for example change of boots between barns (10%) and footbaths (6%). The boots are an important source of pathogens and may spread diseases between barns and farms. If not changing boots, it is important to make sure to clean the boots thoroughly before entering a barn, especially if going from the finishing barn or sections where sick animals are housed to the quarantine barns with young and more sensitive animals. Maybe an additional measure specifying cleaning the boots with water would have been better and clearer to the participants, and perhaps given another more "positive" response result compared to the statements about footbaths with disinfectants, clean clothes/shoes and switching shoes between the barns, which might not be as common in this type of production.

It was quite surprising that only 51% answered that they cleaned the boxes/barns between groups of animals. Especially when dealing with young sensitive animals like calves. A large number of the farms did only use one type of cleaning of both the quarantine and finishing barns, mainly hot high pressure water but some only did dry cleaning during which they only removed excessive manure and feed residues from the barns. Using high pressure water systems for cleaning may not necessarily be optimal, especially in barns that are not completely empty, because of the risk of spreading pathogens over a larger area and because many pathogens thrive in moist environments and may grow in ponding water (England, 1982: see Boone & Gerba, 2007; Goto *et al.*, 1986; Nicholson *et al.*, 2005; Cleer *et al.*, 2008). A combination of several cleaning methods, e.g. high pressure water, disinfectant and regular dry sweeping and scraping, would probably have the best effect on preventing pathogen growth and disease outbreaks. These are all common cleaning practices within the pig industry (Seaman & Fangman, 2001)

Regarding the cleaning of the barns 39% answered that they cleaned the quarantine barns after every batch and 42% only once a year. It is not known if all of those 42% have continuous production in their quarantine barns, but the answers in the questionnaire also indicate that not all farms followed the SJV rules about type of barn/production according to number of animals purchased per year. The results showed that smaller farms (less than 200 animals) more often had continuous production and larger farms (more than 200 animals) batch rearing system in the quarantine barns.

The results showed that not all farms followed the hygiene regulations (Jordbruksverket, 2015d), although they were rather new at the time of the study, which may explain the deviation. Less than 70% provided visitors/employees possibilities to wash their hands with warm water and soap and dry them off on towels and not even 40% had hand disinfectant available in the barns. The low percentage of farms that have implemented this is probably due to lack of knowledge about the new regulations. Clothes and shoes are also important for spreading disease, but barely 36% required that visitors use clean protective clothing and shoes. If visitors

are allowed to enter barns which shoes and clothes that have been contaminated with pathogens, there is a possibility of disease spreading. Quite similar results were shown in the Finish study by Sahlström *et al.* (2014), in which they discussed that even though washing hands is a well-known measure to prevent spread of diseases some of the Finish farmers did not wash their hands directly after work (did not tick the box). In the study by Nöremark *et al.* (2010) it was shown that only 23% of the cattle farmers required visitors to use protective clothing. In Finland, 51% of dairy farmers, 34% of the beef producers and 27% of suckler cow producers required protective clothing for visitors. The reason for the higher percentage in the current study compared to the study by Nöremark *et al*. (2010), 36% versus 23%, might be that beef farmers got more knowledge about the importance of clean, farm specific clothes to prevent introduction of pathogens than other farmers or maybe the difference is due to the difference in number of participants in the studies. Another possible explanation could be over-positive answers, i.e. farmers feel the expectations to perform biosecurity and answer that they do more measures than they actually perform. . On the other hand it could be that many of the participants in this study are clients of Gård & Djurhälsan and therefore have the knowledge about the importance of biosecurity. However, the numbers are still not high, and quite similar to the Finnish study, so there is room for improvement.

Answers regarding purchase and transportation of the calves showed that 74% of farms purchased calves from 2-5 farms. Several farms did purchase both directly from other farms and through slaughterhouse agents. Moving and trading animals between different farms opens up for many different potential entry points for animals pathogen introduction, hence increases the risk of widespread disease outbreaks (Jin *et al.*, 2009; Nöremark, 2010; Nöremark *et al.*, 2010). A majority (60.6%) of the farms mixed calves from different origins at arrival on the farm. This means that calves with different health status are mixed. Calves, which have not previously been exposed to disease and due to that might have a weak immune system, could consequently get severely ill by getting infected with pathogens from other calves that are carriers. Other possible routes of disease introduction are when the drivers of the transport vehicles are allowed to enter the barns. The results showed that several farms allowed the drivers to do so, even though, according to the interview with SLS, the drivers should not enter the barns if not necessary. Perhaps all of those times were necessary, since it is conceivable that drivers that are retrieving bulls for slaughter might have to enter the barn and help the farmer to lead the bulls to the vehicle. Nonetheless, when handling young calves it should be possible to avoid it.

In Sweden there is a regulation that specifies that only calves up to eight weeks of age can be housed individually but they have to be kept in close range of each other so they can have eye contact and be able to touch one another (Jordbruksverket, 2014). If there is an animal health or safety issues they can be exempted from the latter part of the regulation, but only for a shorter period of time. This means that if the purchased calves are older than eight weeks of age they have to be kept in group housing at arrival on the new farm and younger calves can be housed individually but they still have to be able to touch other calves. Thus, there is a risk of disease transmission when calves from different farms are housed together. Some calves might be

carriers of disease but not showing symptoms and therefore posing a risk of infecting other calves.

According to the results most farmers purchase their calves both directly from other farms and through slaughterhouse agents. Almost all farms that answered the questionnaire purchased dairy calves. Since there is a negative trend within the Swedish dairy industry (the number of dairy farms are declining) there will be fewer farms to purchase calves from. This might have both a positive and negative effect on the calf health. Fewer dairy farms may result in larger dairy farms that may be able to provide dairy calves for beef producing farms, which in turn could result in the possibility to purchase more calves from a few specific farms instead of many. Hence, it may be easier to keep a good biosecurity on the beef farm and further on a good calf health. On the other hand, fewer farms might lead to a lack of dairy calves and therefore the producer may have to purchase calves from many different farms instead, which results in an increased need for good biosecurity and healthy calves on both the farm which are selling the calves and on the farm purchasing the calves. If there would be a disease outbreak, it will be more difficult and costly to trace the source of the disease if the producer has purchased calves from many different farms.

Regarding disease prevalence, diarrhea does not seem to be a big health issue in either quarantine or finishing barns, which may be as expected with the age range of animals in these operations. However, cough/pneumonia, on the other hand, seems to be more common, especially in the quarantine barns, although the reported proportion of calves with symptoms of respiratory issues was still not very high. These results are not consistent with current reports on calf health. Hegrestad (2010), Gulliksen *et al.* (2009b) and Svensson *et al.* (2006) all have reported that respiratory disease is the most common issue for young calves and Hegrestad (2010) also saw that lameness is more common in older animals, maybe due to bulls often fighting each other. In this questionnaire, lameness/limping is a health issue mentioned to occur both in quarantine and finishing barns. Svensson *et al.* (2006) and Gulliksen *et al.* (2009b) reported that even though pneumonia is the most common cause of mortality in total, enteritis is the most common cause of mortality in younger calves (in Svensson's study younger than 31 days old). Roy (1990) has reported that mortality due to enteric diseases are highest during the first 14 days of age and respiratory disease will appear at 6-8 weeks of age or older. One explanation for the somewhat different results in questionnaire compared to what has been found in the literature may be that our frequencies are self-reported and affected by the individual farmer's own perception of calf health issues. They may miss some signs of disease and not all animals show clinical signs of disease even though they are carriers (Nöremark, 2010). It is also possible that the sample of farms was better than the average, because they were clients of the SvDHV and therefore might have been given good tools to prevent disease outbreaks within their herds. An important explanation for the lower rate of enteric disease is that the farms usually purchase calves older than 2 weeks of age and then the risk of diarrhea is much less and the calves may have built up an immune response against the most common pathogens already when they arrive. It could also be that people define diarrhea differently and it is not always easy to detect.

The majority of the farms treated 1-5% of their calves with antibiotics and had a mortality of 1-2% in both the quarantine barn and the finishing barn. Svensson et al. (2006) showed that Swedish dairy farms had a mortality of 3.1% in calves younger than 91 days, and a Norwegian study showed a mortality of 3% among dairy calves (Gulliksen *et al.*, 2009b). The Swedish study showed that 26% of the participating farms had no mortality and 47% had a mortality of less than 2% (Svensson *et al.*, 2006). The current study found that 60% of the herds had a mortality of 1-2% in the quarantine barns, while 11.8% had no mortality and 23.5% had a mortality of 3-5% in the quarantine barn. These numbers in the finishing barns was 70, 10 and 15.6%, respectively. However, these Swedish and Norwegian studies covered dairy calves in dairy operations, and cannot really be compared with the current study because differences in age distributions and management routines with the specialized beef rearing units as in this study.

The questionnaire did not provide information about the types of antibiotics that are used on the farms nor what diseases have been treated, but there was a significant association between antibiotic treatment and cases of cough/pneumonia in the quarantine barns (farms which had cases of cough/pneumonia have had antibiotic treatment of calves during the past year). However, it is not known if it was pneumonia which had been treated. Nevertheless, in the report from SvDHV by Hegrestad (2010) it was observed that penicillin is the first-line therapy for respiratory infections. Even though respiratory disease in calves in many cases have a viral origin it may be multifactorial and the calves can carry both a viral and a bacterial infection (Allen *et al.*, 1991; Stortz *et al.*, 2000; Giovannini *et al.*, 2013). Hegrestad's report showed no significant correlation between high antibiotic treatment and high mortality, however in the present study a significant correlation between antibiotic treatment and mortality in the quarantine barns was found. On the other hand, a correlation does not show if there is a causal association between high and low antibiotic treatment and mortality rates. Still, it does show that farms which have a mortality of above one percent in the quarantine barns also treats the calves in those barns with antibiotics.

There was a significant correlation between cases of diarrhea and the number of preventive measures in quarantine barns, i.e. less cases of diarrhea with more biosecurity measures. However, it does not show what types of biosecurity measures were performed. Although, diarrheic pathogens is often spread when calves get in contact with contaminated manure, hence good cleaning of barns, clothes and equipment and preventing contaminated feed probably would reduce the risk of diarrhea spreading among calves.

The statistical analysis showed some significant correlations between herd size and disease prevalence. Respiratory disease in the quarantine barns was more common for farms that purchased more than 200 animals per year than for smaller producers, while diarrheic issues in finishing barns was more common for smaller herds. A possible explanation is that it is more difficult to observe a sick calf when retrieving maybe 50 calves at one time compared to a smaller producer, which might purchase ten calves at one time, and therefore they might not separate the sick calves from the others before putting them in the quarantine barns. Another

explanation could be that the lager herds might have a higher stocking density which makes it easier for the respiratory pathogens to spread. The correlation regarding diarrhea in finishing barns might be due to that smaller farms tend to do fewer biosecurity measures than larger farms. The results show that both large and small size farms tend to clean the finishing barns less often than the quarantine barns, and some even never cleaned them. Even though older animals should have a stronger immune system it does not mean that they are immune to all diseases. Moving animals between s and rearranging new animal groups is a stressful experience, which may reduce the immune response.

Both the current study, and the study by Nöremark *et al.* (2010) and the Finish study by Sahlström *et al.* (2014), have shown that farm size have a positive effect on the number of biosecurity measures performed, i.e. larger farms perform more biosecurity measures compared to smaller farms. Sahlström *et al.* (2104) discusses the possibility that a larger farm can afford to perform more measures like to build separate and efficient quarantine barns. They also mention that large farms may see a disease outbreak as more disastrous than a smaller farm, and thus are more willing to take necessary precautions.

Although no animal purchase would be the best prevention of pathogen introduction it is not possible for the specialized beef production farms that were the target for this study. Purchasing calves is what their production is built on. This means that it is very important to purchase calves in good general condition, which are healthy and not carriers of disease. Thus it would be good if a producer, which purchases calves, would observe them before purchasing them. However, this is not always possible, especially if they purchase them through a slaughterhouse agent. When purchasing through farm-to-farm agreement, infection pressure might be lower due to smaller number of calves delivered each time (lower stockning density), therefore the producer have a lower risk of calves becoming sick. Nonetheless, with farm-to-farm agreements it might be more difficult to plan when calves will arrive (they may be delivered when the calf producer has a few calves ready) hence it will be more difficult to keep batch production because of too small or uneven calf groups and at delivery at irregular intervals. When purchasing very young calves, these calves will not be as good at readjusting to the new environment and maybe a new type of feed. This put higher demands on the specialized beef producer, since they could get problems with diseases and treatment rates. However, buying young unweaned calves could be advantageous (if they are healthy), because these calves are still given milk and may still carry the immunity from the colostrum, which has been shown to be advantageous (Davis & Drackley, 1998; see: Johnson *et al.* 2007). Also the specialized beef producer has the chance to plan the feed regime throughout the production cycle and will not have to expose the calves to a sudden change in feed when they are already exposed to other stressful changes (new pathogens, new animals, new environment). Hence, the move and change in environment will hopefully not have as big effect on the feed intake and health in these calves, therefore they might have a better growth increase in the beginning compared to older calves. In the current study, the age of the calves purchased varied, and a few farms purchased both weaned and non-weaned calves.

The results from the questionnaire did not show any increased disease prevalence at farms purchasing calves through slaughterhouse agents. Purchasing through slaughterhouse agents could mean a higher infection pressure, since the producer buys more calves at one time and the calves might origin from several different farms that have been brought up in different ways and are used to different feeds and stocking rates. On the other hand, it is an uncomplicated way of purchase and requires less labor from the producer (in terms of purchasing process). Also, it is important to the mediating slaughterhouse company to only deliver healthy calves. Interviews with slaughterhouse companies showed that they think it is possible to only pick up and convey animals from farms that are free from BRSV. This is what the larger project "Risk factors for disease in Swedish feedlot calves and preventive measures" is studying. The results from this questionnaire showed that the majority of the farms which purchased calves directly from other farms, mainly purchased from one to five farms. This probably would mean that it should not be that difficult for most of the farmers to demand to purchase from herds which are free from BRSV, if there are enough dairy herds which are free from BRSV.

Vaccinating calves, against e.g. BRSV, is a possible preventive measure of the spread of diseases although, as mentioned in the literature review, it is not without issues, such as limited efficacy in some cases. In addition, a big vaccination program costs a lot of money and a large number of animals have to be vaccinated which demands good logistics and big vaccine reserves (Breeze, 2004). Since it has been shown that it is possible to manage and eradicate infectious diseases with proper measures, like it was done with BVDV (Greiser-Wilke *et al.*, 2003; Hult & Lindberg, 2005), it should be possible to implement such a voluntary program also for other common calf diseases. This requires, however, that a majority of farms participate and that only healthy, non-carrying calves are purchased and delivered at a farm. A calf that has not been exposed to a certain pathogen will not have built up an immune response against it, and it will thus be very sensitive to an infection and possibly at high risk of mortality, so mixing calves from herds free of the infection with calves from herds with the infection is not advisable. However, if a producer would only purchase calves from e.g. a BRSV free farm (i.e. no calves have been exposed to the virus, no calves will carry the virus and no calves will shed the virus) it could reduce the risk of a pneumonia outbreak and thus limit the treatment costs and reduce mortality within the herd. Nevertheless, even such a farm need to perform good and effective biosecurity to become totally free of BRSV.

As mentioned above the results from this study do show similarities to the previous Swedish study by Svensson *et al* (2006) and the Finish study by Sahlström *et al*. (2014), i.e. cattle farmers do perform a few biosecurity measures but it seems like they could become better (especially when comparing them to pig producers). They do perform the "easy" ones like rodent control, feed sweeping, participate in Salmonella control program and removing feed contaminated by manure. However, as in the two other studies specialized beef producer need to improve washing routines and enforce protective clothing and farm specific boots for visitors. Also using correct and clean equipment (shovels, brooms specific for one barn) is important.

Nonetheless, the question is how to make the farmers want to improve their biosecurity? As seen in Denmark, although there is a regulation which requires large herds have to implement a farm specific biosecurity plan, few farms actually have done it (Kristensen & Jacobsen, 2011). The same seem to have happened in Sweden regarding the new hygiene regulations. Maybe implementing new laws are not the answer, rather show the farmers the importance of improved biosecurity and motivate them to change their perspective. Pig and poultry farmers seem to look at biosecurity more seriously. Perhaps it is easier for them to keep up a good biosecurity since their animals are more contained compared to calves and young cattle. However, it should be possible to improve biosecurity (without having to change housing systems too much) and to motivate farmers without forcing them, both in specialized beef herd and in dairy herds, which are the deliverers of the calves. It has been done with the voluntary Salmonella and BVDV programs, e.g. through economic compensations and education.

5.2 Sources of error

When the answers from the participating farmers had been evaluated a few sources of error have been documented. Regarding the questionnaire there were a few issues with the formulation of the questions. It seems like a few farmers had difficulties in understanding the questions regarding the different types of vehicles, e.g. regarding the cleanliness of the vehicle, which deliver calves to the specialized beef farm. Since the vehicle carries calves when delivering it is of course not clean when delivering the calves at the farm and producers who do not collect the calves themselves do not always know if it has been cleaned before calves entered it. They might not even be able to get that information. The questions should have been clearer and perhaps more specific.

Regarding the questions about diseases, the way of ranking disease prevalence (especially diarrhea) was not optimal and should undoubtedly have been asked in a different way Diarrhea is a big problem among young calves, according to several studies and SVA, and therefore it would be expected that there would be a higher incidence of diarrhea at these type of farms. Perhaps these farms did not have problems with diarrhea, since they are clients of Gård & Djurhälsan. Maybe the producers do not notice if one calf has diarrhea if its health state otherwise is good (i.e. eating, drinking, not lethargic) or they classify diarrhea differently (what one farmer classify as diarrhea might another one not classify as such). But since many producers buy young, unweaned calves, which are sensitive to disease, it would be reasonable for diarrhea incidence to be higher.

Instead of using open questions, intervals had been better to use from the beginning, e.g. number of animals purchased and number of farms which they purchased calves from. Perhaps the questions would have been answered correctly and the results would have been easier to process.

When entering the results from paper questionnaires into Netigate, it was sometimes difficult to read and evaluate the answers if there were written comments. Some producers had chosen several alternatives when only one was to be made, some wrote the alternative as a note on the

side but did not put a cross in the box. Therefore, it was difficult to decide if to regard it as a correctly answered question (since it was not easy to understand what they actually wanted to answer) or if to ignore and not use the answer at all.

6. CONCLUSION

The results from the questionnaire showed that Swedish farms with specialized beef production did not perform many biosecurity measures. The three most common ones were rodent and bird control, participating in the voluntary Salmonella control program and sweeping the feed area. However, larger farms performed more biosecurity measures compared to smaller farms. A low percentage of farms had, at that time, implemented the new regulations on hygiene in barns and for visitor, with special regards to washing possibilities and the use of protective clothing and boots. According to the questionnaire not all farms followed the regulations with respect to number of purchased animals and housing. It seemed as if some farms should have housing for batch-wise production but did not.

Disease prevalence and mortality rates were relatively low, especially in the finishing barns, although the participating farms seemed to have more problems with cough/pneumonia among their calves than with diarrhea. There was no difference in disease prevalence between different types of purchase, but diseases were more common in larger herds than in small herds. Antibiotic treatment was more common in quarantine barns than in finishing barns, so that part of the production would be targeted if the goal were to reduce antibiotic use further. However, number of biosecurity measures or type of calf purchase was not related to use of antibiotic treatments, so actions to reduce use of antibiotics need to target other areas

The results show that there is room for improvement when it comes to biosecurity in the specialized beef production, but the question is how to motivate the farmers to do it.

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Personal messages

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APPENDIX 1

Questionnaire

Information

Hej,

Detta är en enkät som riktar sig till djurägare som bedriver specialiserad nötköttsproduktion, det vill säga med mellankalv-, och/eller ungnötsuppfödning. Vi är intresserade av svar från gårdar oavsett besättningsstorlek. Enkäten tar ca 10 minuter att besvara och avser att ta reda på hur smittskyddet ser ut på gårdar med specialiserad nötköttsproduktion. Frågorna är uppdelade i frågor om mottagningsstallet för sig och frågor om produktionsstallarna för sig samt separata frågor om slaktbilen och livdjursbilen. Observera detta när du svarar på frågorna om det enskilda stallet eller fordonet. Enkätsvaren kommer att vara till hjälp för att förbättra det förbyggande smittskyddsarbetet och för att minska spridningen av smittsamma sjukdomar inom nötköttsproduktionen.

Enkätsvaren kommer att hanteras konfidentiellt och svar kommer inte att kunna härledas till enskilda gårdar. Det finns inga rätt eller fel svar, fyll bara i de alternativ som du tycker bäst motsvarar gården där du arbetar.

OBS! Denna enkät riktar sig endast till uppfödare av mellankalv och ungnöt (ungtjur,stut,kviga).

Stort tack för din medverkan! Om du anger ditt PPN (sista frågan) så kommer vi skicka ut resultatet av enkäten till dig.

1. **I vilket län ligger gården?**
A. GÅRDEN OCH BAKGRUND

□ Blekinge

□ Dalarna

□ Gotland

□ Gävleborg

□ Halland

□ Jämtland

□ Jönköping

□ Kalmar

□ Kronoberg

□ Norrbotten

□ Skåne

□ Stockholm

□ Södermanland

□ Uppsala

□ Värmland

□ Västmanland

□ Västernorrland

□ Västerbotten

□ Västra Götaland

□ Örebro

□ Östergötland

2. Vilken typ av specialiserad nötköttsproduktion bedrivs på gården? (Ange ett eller flera alternativ.)
A. GÅRDEN OCH BAKGRUND

□ Mellankalv

□ Ungtjur

□ Stut

□ Kviga

3. Finns någon annan typ av animalieproduktion på gården? (ex. mjölkproduktion, dikoproduktion, fjäderfäproduktion, slaktsvinsproduktion)

A. GÅRDEN OCH BAKGRUND

☐ Ja

☐ Nej

Om ja, ange vilken/vilka:

4. Vilken är den huvudsakliga typen av uppfödning i mottagningsstallen på gården? (Ange ett eller flera alternativ.)

A. GÅRDEN OCH BAKGRUND

☐ Omgångsuppfödning (all in-all out)

☐ Kontinuerlig

☐ Har inget mottagningsstall, köper in dikalvar som sätts in i produktionsstallet

☐ Annat

Annat, ange vilken/vilka:

5. Om gården har omgångsuppfödning, hur många djur stallas i så fall in per omgång?

A. GÅRDEN OCH BAKGRUND

6. Vilken är den huvudsakliga typen av uppfödning i produktionsstallen på gården? (Ange ett eller flera alternativ.)

A. GÅRDEN OCH BAKGRUND

☐ Omgångsuppfödning (all in-all out)

☐ Kontinuerlig

☐ Annat

Annat, ange vilken/vilka:

7. Hur många kalvar har köpts in de senaste 12 månaderna?

A. GÅRDEN OCH BAKGRUND

8. . Hur gamla är djuren i genomsnitt när de köps in? (Ange ett eller flera alternativ.)
B. INKÖP OCH INHYSNING AV DJUR

□ Ej avvanda kalvar, yngre än 3 veckor

□ Ej avvanda kalvar, äldre än 3 veckor

□ Avvanda kalvar, 3 veckor till 2 månader gamla

□ Avvanda kalvar, äldre än 2 månader

Plats för eventuell kommentar:

9. Kalvarna som köps in kommer ifrån:
B. INKÖP OCH INHYSNING AV DJUR

☐ Mjölkbesättning

☐ Köttbesättning

☐ Både och

10. Vad har medelslaktåldern varit de senaste 12 månaderna? (Om flera sorters uppfödning bedrivs var tydlig med om slaktvikten gäller mellankalv, ungtjur, stut eller kviga)
B. INKÖP OCH INHYSNING AV DJUR

11. Vad har medelslaktvikten varit de senaste 12 månaderna?
B. INKÖP OCH INHYSNING AV DJUR

12. Hur köps djuren in? (Ange ett eller flera alternativ.)
B. INKÖP OCH INHYSNING AV DJUR

☐ Via livdjursförmedlare

☐ Direkt från gårdar via muntligt mellangårdsavtal

☐ Direkt från gårdar via skriftligt mellangårdsavtal

☐ Direkt från gårdar, inga mellangårdsavtal

☐ Annat

Annat, ange hur:

13. Vid inköp direkt från gård, hur många olika gårdar (i genomsnitt) köps kalvarna in ifrån? (OBS! frågan avser inte inköp via livdjursförmedlare)

B. INKÖP OCH INHYSNING AV DJUR

14. Vid inköp via livdjursförmedlare, vilken/vilka livdjursförmedlare anlitas?

B. INKÖP OCH INHYSNING AV DJUR

Ange företagsnamnet:

☐ Vill ej ange

15. Hur ofta köper ni in kalvar till gården? (t.ex. var femte vecka)

B. INKÖP OCH INHYSNING AV DJUR

16. Hämtar du djuren själv eller levereras de till gården?

B. INKÖP OCH INHYSNING AV DJUR

☐ Hämtar själv

☐ Får dem levererade till gården

☐ Både och

Om de leveras till dig är det via livdjurstransport eller är det säljaren som kör djuren till dig?

17. Om du hämtar djuren själv, blandas djur från flera gårdar i transporten?

B. INKÖP OCH INHYSNING AV DJUR

☐ Ja

☐ Nej

☐ Ibland

18. Blandas djur från olika gårdar vid ankomst till gården?

B. INKÖP OCH INHYSNING AV DJUR

☐ Ja

☐ Nej

☐ Ibland

19. Hålls alla eller en viss andel av djuren på bete hela eller delar av året? (Ange ett eller flera alternativ.)

B. INKÖP OCH INHYSNING AV DJUR

☐ Ja, alla djur går på bete under hela året

☐ Ja, alla djur men bara under betessäsong (vår-sommarmånaderna)

☐ Ja vissa av djuren får gå på bete under hela året

☐ Ja vissa av djuren får gå på bete under betessäsong(vår-sommarmånaderna)

☐ Nej, inga djur går på bete

Plats för eventuell kommentar:

20. Om djuren blir sjuka, när är den vanligaste tidpunkten i förhållande till ankomst till gården?

C. SMITTOR OCH SMITTSKYDD

☐ 0-2 veckor efter ankomst

☐ 2-4 veckor efter ankomst

☐ Senare

Senare, ange genomsnittlig tid efter ankomst:

21. Hur stor andel av djuren i mottagningsstallen drabbas av:

C. SMITTOR OCH SMITTSKYDD

	Så gott som inga		Cirka 1/4		Cirka 1/2		Cirka 3/4		I stort sett alla
Diarré	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hosta/Lunginflammation	☐	☐	☐	☐	☐	☐	☐	☐	☐
Annat större hälsoproblem	☐	☐	☐	☐	☐	☐	☐	☐	☐

Annat större hälsoproblem, ange vilket (t.ex. ringorm, hältor, klövspalt):

Plats för eventuell kommentar:

22. Hur stor andel av djuren i mottagningsstallen har behövt behandlas med antibiotika under det senaste året?

C. SMITTOR OCH SMITTSKYDD

☐ Inga

☐ 1-5 %

☐ 5-10 %

☐ 10-20 %

☐ 20-50 %

☐ Mer än 50 %

Plats för eventuell kommentar:

23. Hur hög har dödligheten varit i genomsnitt de senaste tre åren i mottagningstallen?

C. SMITTOR OCH SMITTSKYDD

☐ Ingen

☐ Enstaka, 1-2 %

☐ 3-5 %

☐ 6-10 %

☐ Mer än 10 %

Plats för eventuell kommentar:

24. Hur stor andel av djuren i produktionsstallen drabbas av:

C. SMITTOR OCH SMITTSKYDD

	Så gott som inga		Cirka 1/4		Cirka 1/2		Cirka 3/4		I stort sett alla
Diarré	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hosta/Lunginflammation	☐	☐	☐	☐	☐	☐	☐	☐	☐
Annat större hälsoproblem	☐	☐	☐	☐	☐	☐	☐	☐	☐

Annat större hälsoproblem, ange vilket (t.ex. ringorm, hältor, klövspalt):

Plats för eventuell kommentar:

25. Hur stor andel av djuren i produktionsstallen har behövt behandlas med antibiotika under det senaste året?

C. SMITTOR OCH SMITTSKYDD

☐ Inga

☐ 1-5 %

☐ 5-10 %

☐ 10-20 %

☐ 20-50 %

☐ Mer än 50 %

Plats för eventuell kommentar:

26. Hur hög har dödligheten varit i genomsnitt de senaste tre åren i produktionsstallen?

C. SMITTOR OCH SMITTSKYDD

☐ Ingen

☐ Enstaka,1-2 %

☐ 3-5 %

☐ 6-10 %

☐ Mer än 10 %

Plats för eventuell kommentar:

27. Utförs förebyggande åtgärder i besättningen för att förhindra att smitta sprids till eller från gården? I så fall vilka? (Ange ett eller flera alternativ.)

C. SMITTOR OCH SMITTSKYDD

☐ Med i frivilliga salmonellakontrollprogrammet

☐ Bekämpning av gnagare/småfåglar

☐ Separata stallavdelningar för djur i olika åldrar

☐ Rengöring av boxar/stall mellan varje djurgrupp/djuromgång

☐ Skobad med desinfektionsmedel, mellan olika stall/avdelningar

☐ Byte av stövlar/skor mellan olika stall

☐ Byte av kläder mellan olika stall

☐ 24 h karens för personer som varit på en annan gård

☐ All personal måste duscha innan inträde i stall

☐ Alla besökare måste duscha innan inträde i stall tillåts

☐ Alla besökare måste klä sig i rena skyddskläder/skor innan de får gå in i stallarna

☐ Tar inte emot besökare

☐ Det finns möjlighet till handtvätt (tvål, varmt vatten, handduk) i stallarna

☐ Det finns tillgång till desinfektionsmedel (alcogel) för händerna

☐ Är noga med att foder inte kommer i kontakt med gödsel

☐ Sopar foderbord

☐ Ser till att djuren ätit upp allt foder på foderbordet innan nytt foder ges

Annat som du gör:

28. Är slaktbilen rengjord vid ankomst till gården?

C. SMITTOR OCH SMITTSKYDD

☐ Ja

☐ Nej

☐ Ibland

Plats för eventuell kommentar:

29. Är slaktbilen tom vid ankomst till gården (d.v.s. inga djur från andra gårdar)?

C. SMITTOR OCH SMITTSKYDD

☐ Ja

☐ Nej

☐ Ibland

Plats för eventuell kommentar:

30. Får föraren av slaktbilen gå in i stallarna vid hämtning av djur till slakt?

C. SMITTOR OCH SMITTSKYDD

☐ Ja

☐ Nej

Plats för eventuell kommentar:

31. Är livdjursbilen rengjord vid ankomst till gården?

C. SMITTOR OCH SMITTSKYDD

☐ Ja

☐ Nej

☐ Vet ej

Plats för eventuell kommentar:

32. Transporterar livdjursbilen endast dina djur vid ankomst till gården (d.v.s. inga andra djur som ska till andra gårdar)?

C. SMITTOR OCH SMITTSKYDD

☐ Ja

☐ Nej

☐ Ibland

Plats för eventuell kommentar:

33. Får föraren av livdjursbilen gå in i stallarna vid lämning av djur till gården?

C. SMITTOR OCH SMITTSKYDD

☐ Ja

☐ Nej

☐ Ibland

Plats för eventuell kommentar:

34. Hur ofta utförs storrengöring av gårdens mottagningsstall?

C. SMITTOR OCH SMITTSKYDD

☐ Mellan varje omgång

☐ Minst en gång i halvåret

☐ Minst en gång per år

☐ Annat intervall

☐ Aldrig

Ange annat intervall:

35. Hur ofta utförs storrengöring av gårdens produktionsstall?

C. SMITTOR OCH SMITTSKYDD

☐ Mellan varje omgång

☐ Minst en gång i halvåret

☐ Minst en gång per år

☐ Annat intervall

☐ Aldrig

Ange annat intervall:

36. Hur rengörs mottagningsstallen vid storrengöring? (Ange ett eller flera alternativ.)

C. SMITTOR OCH SMITTSKYDD

☐ Torr rengöring (utgödsling/skrapning/sopning)

☐ Våt rengöring (utgödsling/skrapning/skurning)

☐ Högtryckstvätt, kallt vatten

☐ Högtryckstvätt, varmt vatten

☐ Desinfektionsmedel

☐ Annat

Annat, ange vilket/vilka:

37. Hur rengörs produktionsstallen vid storrengöring? (Ange ett eller flera alternativ.)

C. SMITTOR OCH SMITTSKYDD

☐ Torr rengöring (utgödsling/skrapning/sopning)

☐ Våt rengöring (utgödsling/skrapning/skurning)

☐ Högtryckstvätt, kallt vatten

☐ Högtryckstvätt, varmt vatten

☐ Desinfektionsmedel

☐ Annat

Annat, ange vilket/vilka:

38. Töms mottagningsstallen på samtliga djur innan rengöring?

C. SMITTOR OCH SMITTSKYDD

☐ Ja

☐ Nej

☐ Ibland

39. Töms produktionsstallen på samtliga djur innan rengöring?

C. SMITTOR OCH SMITTSKYDD

☐ Ja

☐ Nej

☐ Ibland

40. Ange gärna ditt produktionsplatsnummer:

Svaren kommer att hanteras konfidentiellt även om du anger ditt produktionsplatsnummer. Det är ger oss dock möjlighet att jämföra med data från t.ex. djurförflyttningsregister samt se regionala skillnader som inte överensstämmer med län. Dessutom kommer vi ha möjlighet att delge dig resultatet av denna studie.

41. Plats för eventuella kommentarer.

STORT TACK FÖR DIN MEDVERKAN!

Om du har några frågor kring studiens syfte eller utformning är du välkommen att kontakta

oss! Maria Wanhainen, agronomstudent
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APPENDIX 2

Interview questions to calf transporters

In Swedish

1. Hur många djur förmedlar ni per år i genomsnitt?
2. Hur många gårdar förmedlar ni till/från per år i genomsnitt?
3. Hur många gårdar hämtar ni i snitt ifrån för leverans till en gård?
4. Vid djurleverans, åker ni till flera olika gårdar under samma ”tur” och levererar djur?
5. Rengörs och desinfekteras livdjursbilen mellan hämtningarna/leveranserna?
6. Hur många chaufförer har ni i ert team och är det många som ”kommer och går”? Är det svårt att styra hur dessa jobbar?
7. Anlitar ni andra transportörer?
8. Vad har ni för regler som era chaufförer ska följa, både livdjursbilen och slaktbilen?
9. Vad har chaufförerna för utbildning vad gäller djur, smittor mm?
10. Hur kontrollerar ni att reglerna följs?
11. Vilka smittskyddsåtgärder utför ni?
12. Händer det att chaufförer går in i besättningar som de besöker?
13. Vad använder ni för metod för rengöring och desinfektion?
14. Hur viktig roll tror du att ni som livdjursförmedlare har när det kommer till smittutbrott och smittspridning på den här typen av gårdar?
15. Vad anser du vara den svåraste faktorn när det gäller förebyggande smittskyddsarbete?
16. Tror du att det skulle gå att få igenom att ”hälsodeklarera” djur och att bönder skulle vara villiga att betala extra för en sådan kalv? Att man t.ex. testar kalvar för att se att de fått bra råmjölk?
17. Skulle det gå att vissa dagar endast köra djur från gårdar som är fria från RS-virus? Man gjorde ju på liknande sätt inom BVDV-programmet.

In English

1. On average, how many animals do you collect and deliver every year?
2. On average, how many farms do you collect and deliver calves from and to every year?
3. On average, how many farms do you collect animals from for delivery to one single farm?
4. When delivering animals, do you visit several different farms to deliver animals during the same drive?
5. Is the transport vehicle cleaned and disinfected between pick-ups and deliveries?
6. How many drivers do you have in your team and how many is ” coming and going”? Is it difficult to control how these drivers are working?
7. Do you employ other conveyors?
8. What rules do your drivers have to follow, both drivers of the vehicle for the animals destined for the specialized beef farm and the drivers of the vehicle carrying animals going to the slaughterhouse?
9. What kind of education do your drivers have regarding animals, contagions etc.?
10. How do you check that the rules are followed?
11. What biosecurity measures do you perform?

12. Do drivers occasionally enter herds, which they are visiting?
13. What methods do you use for cleaning and disinfection?
14. How important do you think your role as a slaughterhouse agent is when it comes to disease outbreak and spread of diseases when visiting these type of farms?
15. What do you believe is the most difficult factor regarding preventive disease control?
16. Do you think it would be possible to implement a ”health declaration” for animals and that the farmers would be willing to pay extra for that type of calf? For example, to test if calves have gotten good colostrum?
17. Would it be possible, on certain days to only transport animals from farms, which are free from BRSV? They did something similar when implementing the BVDV program.