Thesis

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Comparative study of biosecurity among cattle farms in Austria

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Abstract

Biosecurity is an essential component of modern cattle farming, preventing the introduction and spread of infectious disease which has not only an impact on animal health, but also on farm productivity and economic sustainability.

This thesis evaluates biosecurity measures on Austrian dairy and beef farms using the Biocheck.UGent survey, which is a risk-based tool designed to quantify biosecurity practices.

The results of the survey were analyzed and compared to the world average to identify strengths, weaknesses and areas for improvement.

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1. Introduction

The aim of this thesis is to discuss the importance of biosecurity in today's modern cattle farming and the approach of preventing infectious disease which has an impact on animal health, productivity and economic sustainability. Despite the known importance of biosecurity, the implementation on farms is still not self-evident. That is why the following chapters will give an insight in the topic to gain an understanding of what is biosecurity and the different fields it will be used for. Effective biosecurity involves external risks, such as the introduction of pathogens and internal risks, which includes the spread of disease within the farm. The focus will be on cattle management as the later parts discuss biosecurity levels of dairy and beef cattle farms in Austria. A conducted survey by Biocheck.UGent provided the data of the farms which then will be compared to the world average. The risk-based assessment tool was designed to quantify biosecurity measures which provides the opportunity to compare the gained data, as the evaluation uses the same survey.

The findings will contribute to a better understanding of how biosecurity measures are adopted and valued on farms as well as their impact on reducing the risk of infectious disease transmission.

2. Literature review

To build knowledge about the upcoming topic the literature review will focus on the definition of biosecurity and the critical management practice which will prevent the introduction and spread of infectious diseases between and within cattle farms. The reviewed articles give an understanding of biosecurity, their aim, implementation and challenges as well as the most important diseases related to the topic.

2.1. The concept of biosecurity

The aim of biosecurity in general is to prevent the introduction and transmission of diseases, which can have a significant impact on the health of animals and humans as well as an economic impact on the farms and the production chain. Biosecurity contains two components which are Bioexclusion and Biocontainment. Bioexclusion describes the measures taken to prevent the introduction of infectious pathogens on the farm via external sources whereas biocontainment is about measures to prevent the spreading within the farm and from the farm to others [1].

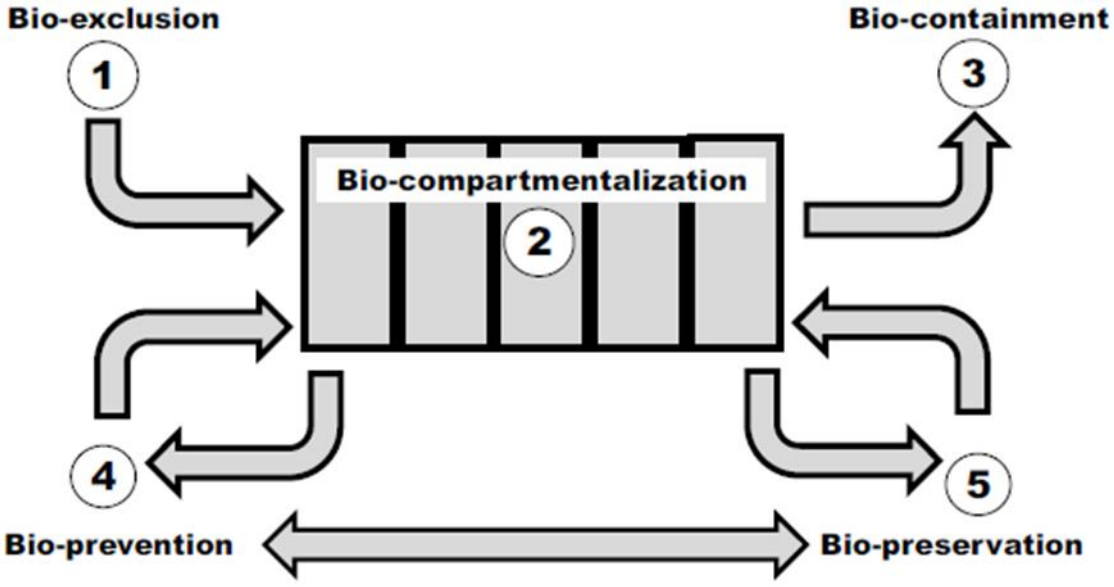


Figure 1 – Bio-compartmentalization

As seen in the picture **(Figure 1)** Biocontainment is the prevention of the spreading from an infected farm to another, but was also described in the publication of Maunsell and Donovan where it is referred as „the outcome of all actions aimed at controlling the spread of infectious agents (or diseases) within and between groups of animals once the agent is present on the operation"[2].

The practical aspect of the implementation of biosecurity on cattle farms is described in several studies and aims at reducing the transmission of diseases. Procedures like quarantine for new or returning animals, the use of disinfection and protective clothes like boots and gloves for farm workers and visitors. People and vehicles who move between farms are also to mention due to the fact that they can take an important part in disease transmission [3, 4].

Despite the positive impact of biosecurity their implementation is still not guaranteed and often insufficient across farms. This does not count for all aspects as described that on Belgian veal farms measures such as „all in all out" systems were well implemented, while other biosecurity measures such as quarantine or the disinfection of equipment were less implemented [3]. Another study described similar circumstances on finish farms, as the farmers found it satisfactory even though the actual implementation of biosecurity was low, especially in smaller farms [4]. These findings may reveal a discrepancy between awareness and actual practice, as farmers may prefer certain aspect over others based on their experience or knowledge.

There are several factors which influence the level of biosecurity like the size of the farm, their economic strength or the lack of standardization in general. The implementation of certain measures as described by Brennan and Cristley depend on the cost as well as the knowledge about the evidence of the efficacy of certain practices [5]. This for example may count for practices like disinfecting vehicles and equipment, even though it is a recommended practice. The lack of immediate benefit and time-consuming practice may prohibit farmers from such implementations.

External services are an integral part of the biosecurity protocol, but make their implementation like transport logistics or calf-rearing operation more difficult. A study from 2007 describes that large dairy farms often rely on external sources for feed, labor and replacement animals and therefore increase the risk for possible disease transmission and infection [6]. Biosecurity protocols may therefore be harder to implement due to the dependency on external sources.

The customization of biosecurity is also mentioned in several papers due to the specific risks each farm faces. This risk depends on the size, the geographical location as well as the disease prevalence. It describes one example of risk assessment with the identification of the most significant hazards on a farm and the following implementation according to the outcome as specific protocol [7].

Johnes disease or bovine viral diarrhea virus (BVDV) are known diseases related to biosecurity and plans who are prioritizing the movement on and between farms of infected animals or the cleaning and disinfection process of the equipment and the facilities may provide a significant impact on biosecurity [7, 8].

Hazard Analyses and Critical Control Point (HACCP) system has the same principal as the risk-based approach and has been adapted for biosecurity planning on farms. „The strength of the HACCP system is its flexibility of implementation through improvement of suboptimal control methods. Important critical control points to be included in a biosecurity and biocontainment plan for dairy farms should be identified" [6].

The transmission via indirect routes like vehicles, contaminated equipment or wildlife is a huge risk from the viewpoint of biosecurity. The ability to survive for enteric pathogens in environmental conditions is described in a study and therefore it underlines the importance of controlling environmental contaminations to prevent disease [5].

„Specific risk factors include the atmospheric conditions (temperature, humidity, wind chill, ventilation, air quality, and so forth); housing (individual calf hutches, enclosed group pens, dispersal on pasture); the physical environment (calving area, bedding, other animals, cleaning protocols, and so forth); stocking density; general hygiene and hygiene related to feeding practices; and miscellaneous stresses due to handling, surgery transportation, and the like" [5].

External vectors play also an important part in the introduction of disease as carriers like rats and birds point out that not only controlling the direct contact between animals but also the indirect routes of transmission [6].

Biosecurity plays especially a role in countries which have national disease controls or eradication programs. Diseases like BVDV or bovine herpesvirus 1 (BoHV-1) are prime examples of the dependency and consistency of measures to make sure it will not be reintroduced again after their eradication efforts [8].

This shows not only the need for biosecurity, but that it is a constant process which is adapting and changing over time dependent on the diseases, landscape, environment etc.

Even though biosecurity is seen as an essential part of disease prevention there are further research needed to implement these measures. The lack of standardization turns out to be one of the major problems since different farm sizes and environments require different focuses and therefore leading to inconsistency. The cost aspect is also a field which may need further research as it turns out to be a significant factor in the implementation and adoption of such measures. The educational point of view should also not be underestimated for farmers as well as veterinarians to further increase the knowledge and sense for biosecurity [4, 9].

2.2.Disease related to biosecurity in cattle

The major disease regarding biosecurity on cattle farms will be categorized by age groups, neonatal, young, and adult, as well as the organ system the disease will affect like respiratory, gastrointestinal, reproductive, and general systemic infections.

2.2.1. Neonatal calves

Respiratory disease plays a major role in neonatal susceptibility with the likes of Bovine Respiratory Disease Complex (BRDC) being a leading cause for morbidity as well as mortality. BRDC is characterized by multiple viral and bacterial pathogens including Bovine Respiratory Syncytial virus (BRSV) Bovine viral Diarrhea virus (BVDV) Bovine herpesvirus (IBR) and Mycoplasma species [10].

To prevent the spreading of such diseases, studies turn out the importance of vaccination, high quality colostrum intake and the isolation of infected animals [11].

From a gastrointestinal point of view, diarrheal diseases are the most significant health risk for neonatal calves due to dehydration and mortality rate up to 25% [5].

„The major infectious causes of neonatal calf diarrhea include rotavirus, coronavirus, cryptosporidia, coccidia, various strains of *Escherichia coli*, and *Salmonella spp.*" [2].

„Similar to rotavirus and coronavirus infection, the incidence of infection with cryptosporidia often approaches 100% in the first month of life. Infection often occurs concurrently with rotavirus and coronavirus infections, and a respiratory form may occur" [5].

The biosecurity measures to be implemented are cleaning the calving environments, managing the colostrum intake and again isolating symptomatic calves [9].

Bovine viral diarrhea virus is especially important to mention in neonatal calves as it can lead to persistently infected (PI) calves, which become lifelong carriers and spreaders of the virus [2].

„Persistently infected cattle are the most important reservoir of virus; they shed high amounts of virus and are the most efficient sources of horizontal transmission to susceptible cattle" [2].

„BVDV biosecurity program must include the identification and removal of persistently infected animals, BVDV screening of incoming animals and their calves, and a comprehensive vaccination program [7,8,25,57]. Persistently infected cattle do not mount an effective immune response against the virus and are capable of shedding large amounts of the virus into the environment through multiple routes" [10].

2.2.2. Young cattle (Post weaning)

Young cattle are also susceptible to BRDC due to the increased exposure by the weaning process which often comes with stress, transportation and the formation of new groups [10].

„The major infectious causes of respiratory disease in calves are bacterial and include various *mycoplasma species, Pasteurella multocida*, and, less often, *Mannheimia haemolytica* and *Histophilus somni* [30–33]. Bovine respiratory syncytial virus has been associated with outbreaks of dairy calf pneumonia [30,31], but other viral respiratory pathogens seem to play a minor role in respiratory disease in modern calf husbandry systems" [2].

To lower the incident, measures like stress reduction, keeping high hygienic standard in transportation and housing are described by Gordon and Plumer [11].

Infectious Bovine Keratoconjunctivitis, also called pinkeye, is caused by Moraxella Bovis and affects young cattle. The disease occurs especially during the warmer months as the population of flies is the highest [2].

The biosecurity measures taken in place are fly controls, reducing environmental irritants like dust and isolating infected animals to prevent the spreading of the disease [5].

2.2.3. Adult cattle

BRDC also occurs in adult cattle, but is not as common as in young calves and is mostly down to stress situations and poor ventilation [10].

As shown in a study respiratory disease can be prevented by proper ventilation, routine vaccination and monitoring environmental stressors [11].

„For many dairy cattle producers, the adult cow gastrointestinal pathogens of highest concern include *Mycobacterium paratuberculosis* (*M. avium subsp. paratuberculosis*, the cause of Johne's disease) and *Salmonella spp*. These pathogens therefore form the basis for much of the biosecurity discussion that follows" [11].

The gastrointestinal tract is affected by Johns Disease, caused by *Mycobacterium avium subspecies paratuberculosis*. It is a chronic disease which typically becomes symptomatic in adult cattle even though the infection often occurs during the neonatal period [7].

Biosecurity measures implemented are isolation of infected animals, controlling the environmental contamination and managing of the manure [2].

Salmonella enterica, which is also a zoonotic bacterium is also of major concern as it causes gastrointestinal symptoms and systemic illness in adult cattle. The pathogen is shed via feces, which leads to the contamination of the environment as well as the feed sources [7].

Biosecurity measures include the isolation of infected animals, minimizing environmental contamination and maintaining a high standard relating to feed and water hygiene [9].

Leptospirosis is an important pathogen affecting the reproductive tract and leading to abortion, reproduction issues as well as systemic illness in humans due to its zoonotic potential [2].

Biosecurity measures to limit the disease are vaccination, managing water sources, and keep trac of the wildlife exclusion.

Veterinarians as well as farm advisors are essential for the implementation of biosecurity. As seen in a study in Ireland, they found that the recommendation of veterinarians focused on economic reasons as the advisors highlighted the animal health benefit. Communication seems to be key for an effective implementation, as the opposite hinders an effective implementation of biosecurity protocols [12].

„This study has highlighted education and communication gaps between groups of service providers to dairy farmers, and between these providers and the farmers" [12].

In conclusion effective biosecurity in cattle farming depends not only on the general aspect, but on the age groups and the disease. Therefore, the measure may vary between neonatal calves and adults and may have different significancy depending on the type of farm.

3. Materials and methods

The survey used from the Biocheck.UGent system is a risk based tool designed to assess and quantify on-farm biosecurity [13, 14].

The system does not focus on specific diseases, but on the evaluation of general biosecurity practices, highlighting measures which have a significant impact to prevent the spread of infectious diseases. The survey is structured into two main categories covering internal and external biosecurity and these two contain further subcategories which include various questions.

Most questions are designed to offer either two or three response options with each option scoring zero points for failed or improper implementation, to one point, representing full implementation of the measures asked. It is important to mention that the scoring is influenced by a weight factor (Figure 2 and 3) representing the importance for each question and each topic. For example, the subcategory “Purchase and Reproduction” is calculated by a weight factor of 39% and the subcategory “Vermin control and others” is only adjusted by a weight of 13%. This means that purchase and reproduction is a more significant factor related to biosecurity in comparison to Vermin control and other animals.

The weight factors assigned are influenced by their relative contribution to disease transmission risk which is determined by expert consensus.

This specific approach is designed to offer a fully risk adjusted score that gives an insight in the overall importance of different biosecurity measures. The given scores range from zero, representing a complete absence of biosecurity measures, to 100, representing the full implementation of all recommended measures. The average score of the internal and external biosecurity category offers a total score representing the overall biosecurity [14].

Dairy cattle

External Biosecurity	Weight (%)	Internal Biosecurity	Weight (%)
Purchase and reproduction	39	Health management	29
Transport and carcass removal	17	Calving management	20
Feed and water	10	Calf management	21
Visitors and farmworkers	20	Dairy management	13
Vermin control and other animals	14	Adult cattle management	7
		Working organisation and equipment	10

Figure 2 – Weight factor for dairy cattle

Beef cattle

External Biosecurity	Weight (%)	Internal Biosecurity	Weight (%)
Purchase and reproduction	41	Health management	33
Transport and carcass removal	18	Calving management	22
Feed and water	9	Calf management	25
Visitors and farmworkers	19	Adult cattle management	10
Vermin control and other animals	13	Working organisation and equipment	10

Figure 3 – Weight factor for beef cattle

For the following data twenty farms consisting of 10 dairy farms and 10 beef farms were asked to fill out the survey. The following data and the scores given by Biocheck.UGent were further processed in excel to better present the outcome of the survey. To categorize the following data functions were used to calculate different numbers and generate the specific charts to visualize the findings. Quartiles were used for the maximum and minimum scores to rule out extreme values which would have a significant influence on such a small sample. The surveys were used to classify the status, but further farms must be examined to get more representative numbers. That is why the interquartile range represents the core distribution and is less likely to be distorted by outliers.

4. Results and discussion

4.1.Dairy Cattle

As for the evaluation of the dairy cattle we divide the results into internal and external biosecurity.

4.1.1. External Biosecurity

External biosecurity measures are essential for preventing pathogens from entering the farm which include the following categories. Purchase and Reproduction, Transport and Carcass Removal, Feed and Water, Visitors and Farmworkers and Vermin Control and Other Animals.

4.1.1.1. Purchase and Reproduction

The scores shown in **Figure 4** vary significantly from as low as 24,25 representing the 1. Quartile to as high as 72,25 representing the 3. Quartile , resulting in a mean value of 45,2. The world average is 78. The maximum and minimum values in the text is representing the quartiles. This scheme is also used for all the other subcategories. This section contains questions about the purchase of different groups, the process including protocols and questions about quarantine and hygiene related to the different cattles purchased. This wide range implies that the farm

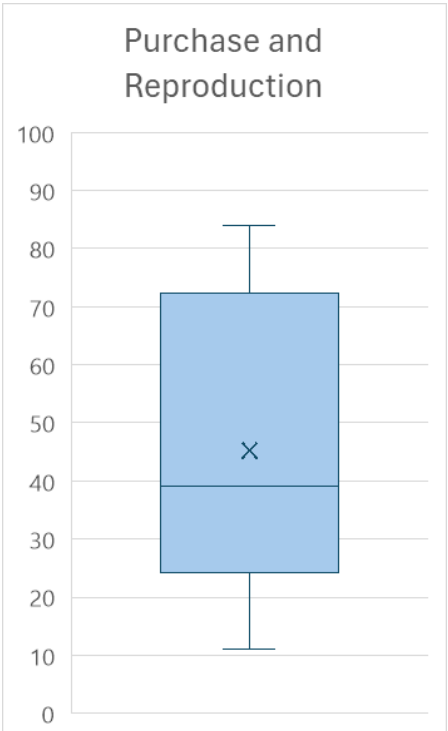


Figure 4. The statistical analyzis of the Purchase and reproduction scores. The minimum was 11, the median was 39 and the maximum was 84. The maximum and minimum score in the Figures is representing the lowest and highest score, not the quartile.

may differ widely in terms of biosecurity protocols of purchasing animals as well as the screening of pathogens or quarantine measures.

4.1.1.2. Transport and carcass removal

The scores in **Figure 5** vary from 39,5 to 52, leading to a mean value of 46,3 with the world average representing 48. Questions about the access of vehicles, animals in the vehicle or disinfection process. The lower numbers may also be the result of the carcass storage space, which often was not properly looked at and represents an area in which significant improvement could be made.

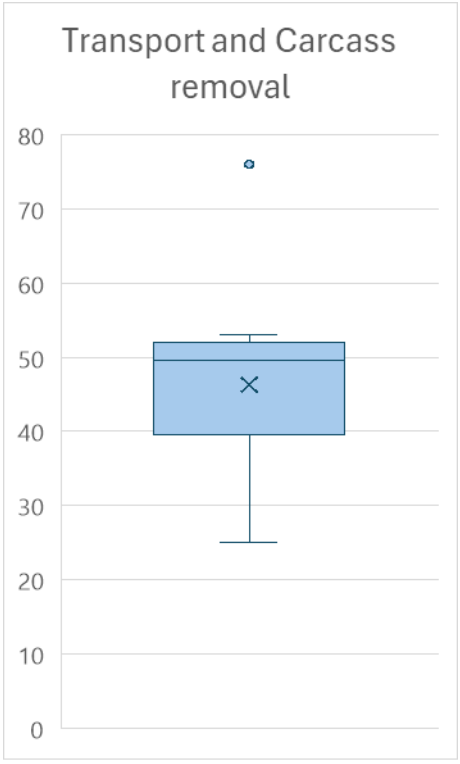


Figure 5. The statistical analyzis of the Transport and Carcass removal scores. The minimum was 25, the median was 49,5 and the maximum was 76.

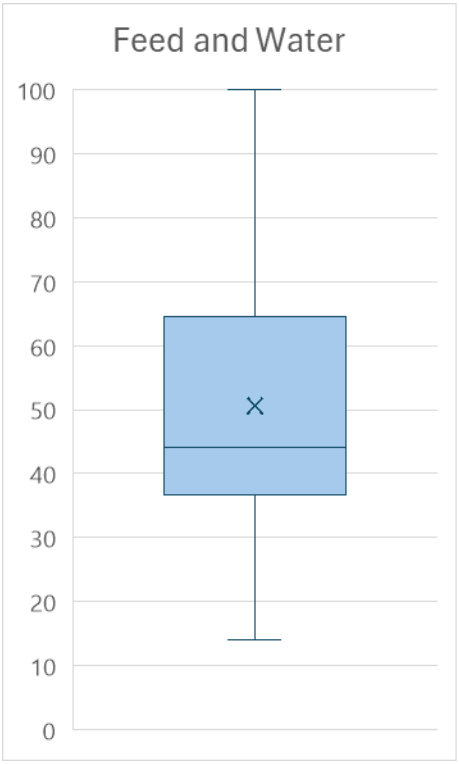
4.1.1.3. Feed and Water

Scores in **Figure 6** range from 36,75 to 64,5 which provides a mean value of 50,6 with the world average at 58. Scores of 100 may be an outlier and does not represent the median with the standard deviation at 24. Questions asked are about feed storage, utensils used for food, quality of food, drinking water etc.

The higher scores may represent a more frequent control of food and water hygiene. Lower grading farms may have a higher risk for feed and water contamination which indicates another potential area to make improvements.

4.1.1.4. Visitors and Farmworkers

This section shown by **Figure 7** evaluates the access control of workers and visitors and therefore the prevention of external contamination. The scores vary again between 41,75 and 71,25 with the mean value at 56,7 and the world average at 69. This section asked about clothing and changing protocols including veterinarians, visitors orhoof trimmers. The score represents a focus on the control of human access to the farms. Low scoring farms could increase their biosecurity by managing their protocols.



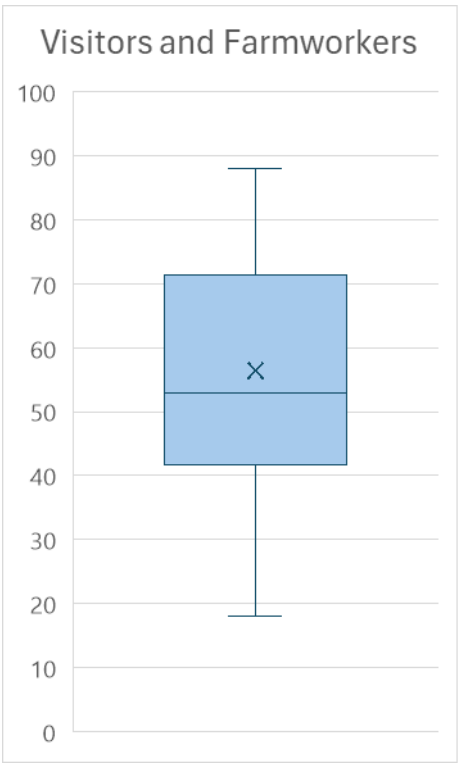


Figure 6. The statistical analyzis of the Feed and Water scores. The minimum was 14, the median was 44 and the maximum was 100.

Figure 7. The statistical analyzis of the Visitors and Farmworkers scores. The minimum was 18, the median was 53 and the maximum was 88.

4.1.1.5. Vermin control and other animals

Scores in **Figure 8** vary from 36,25 to 52,75 with the mean value at 44,4 and the world average also 64. The asked questions were about rodent, bird or insect control programs, access of cattle to natural water or contact with other animals outside of the farm. Higher scores represent that measures for the control of vermin like traps or physical barriers were implemented as for the lower scoring farms these measures are not sufficient, leading to an increased risk of disease transmission from wild animals or vermin.

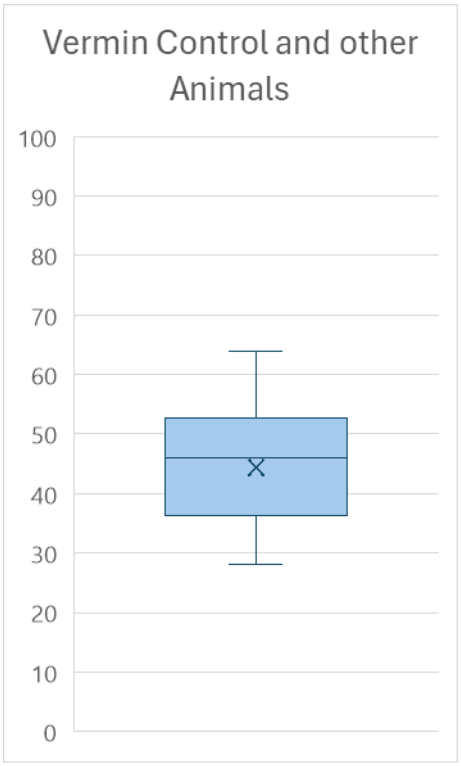


Figure 8. The statistical analyzis of the Vermin Control and other Animals scores. The minimum was 28, the median was 46 and the maximum was 64.

4.1.1.6. Subtotal external biosecurity

The subtotal score in **Figure 9** for external biosecurity is between 34,5 and 61,5, leading to a mean value of 48 in comparison to a world average of 67.

The standard deviation for the subtotal external biosecurity is 15,2, but still shows that the value is beneath the world average which indicates room for improvement in external biosecurity in general.

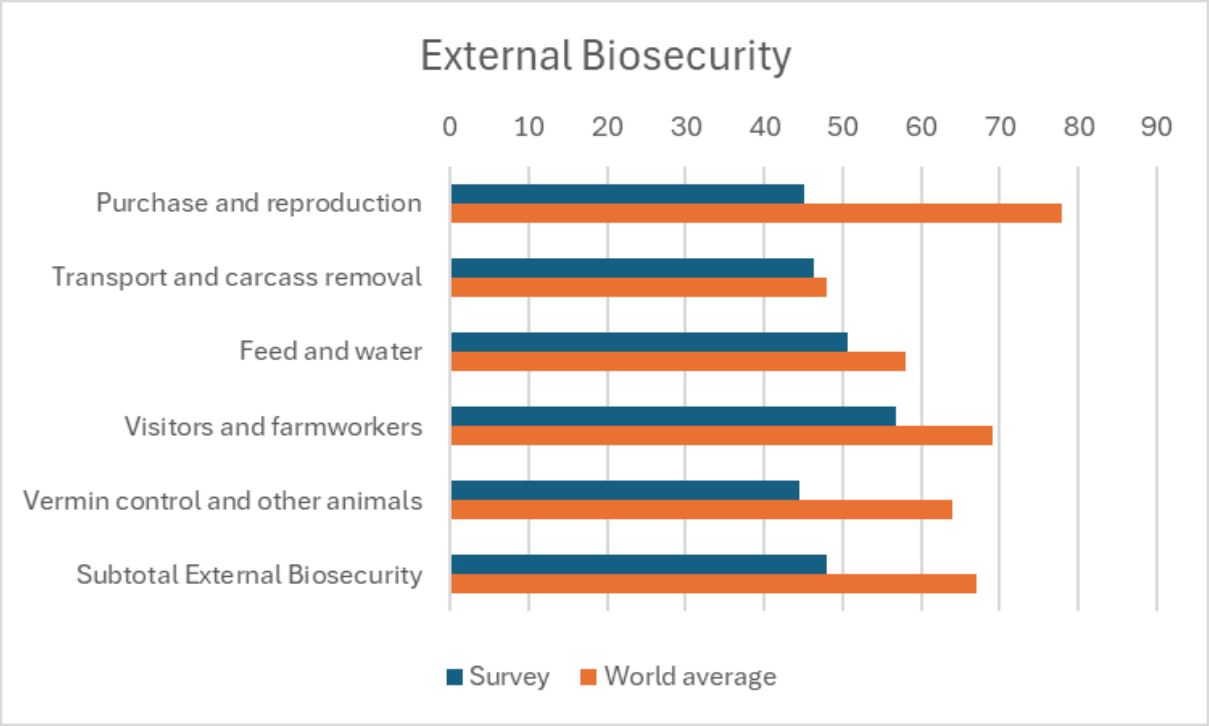


Figure 9. The statistical analyzis of the subtotal External Biosecurity. The minimum was 25, the median was 48,5 and the maximum was 68.

4.1.2. Internal Biosecurity measures

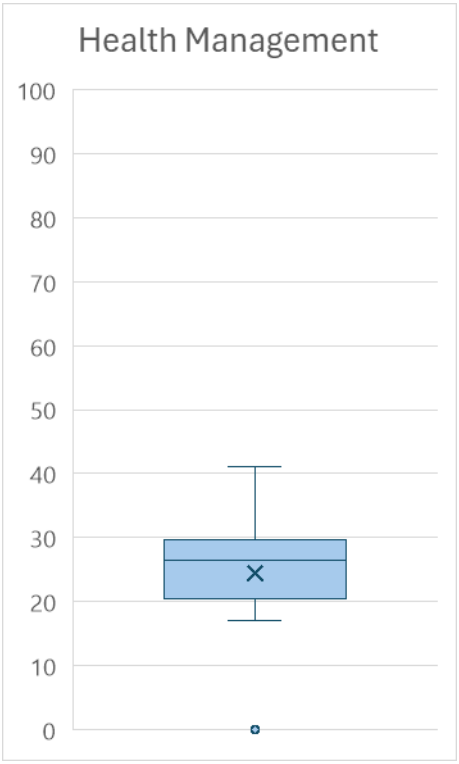
The internal Biosecurity measures focus on the spread of pathogens within the farm which includes the following categories: health Management, Calving Management, Calf Management, Dairy Management, Adult Cattle Management and Working Organization and equipment.

4.1.2.1. Health management

Scores in **Figure 10** range from 20,5 to 29,75 leading to a mean value of 24,5 and a world average of 34. The calculation includes the highest weight facto3 (29%) of the internal biosecurity category. These values include the separation of sick cattle, the equipment used, vaccination protocols or isolation measures. These values are beneath the world average as well.

4.1.2.2. Calving management

The range representing the management of calvings as seen in **Figure 11** is between 23,25 and 52,5 and a mean value of 38,3. The world average is 33 which is slightly below. A good score implies proper management regarding the maternity pen, separation and isolation of the calves and testing in case of abortions.



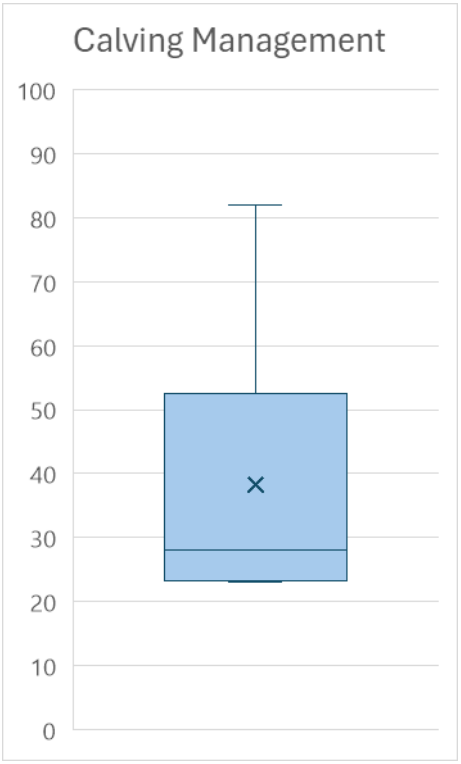


Figure 10. The statistical analyzis of the Health Management scores. The minimum was 0, the median was 26,5 and the maximum was 41.

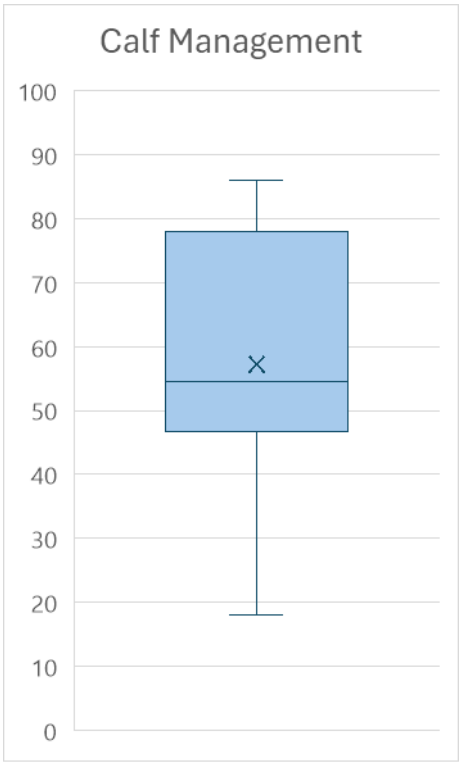
Figure 11. The statistical analyzis of the Calving Management scores. The minimum was 23, the median was 28 and the maximum was 82.

4.1.2.3. Calf management

Calf management scores in **Figure 12** between 46,75 and 78 leading to a mean value of 57,2 and a world average of 45. Calf management includes the administration and quality of colostrum, the housing, feeding of calves and is calculated with a weight factor of 21, which is the second highest factor in the internal biosecurity category.

4.1.2.4. Dairy management

This section as seen in **Figure 13** scores between 44,25 and 69 leading to a mean value of 58 and a world average of 47. The topics covered in this section are the milking process including the number of milkings per cow per day, teat cup liners, disinfection or bacterial examination of the udder.



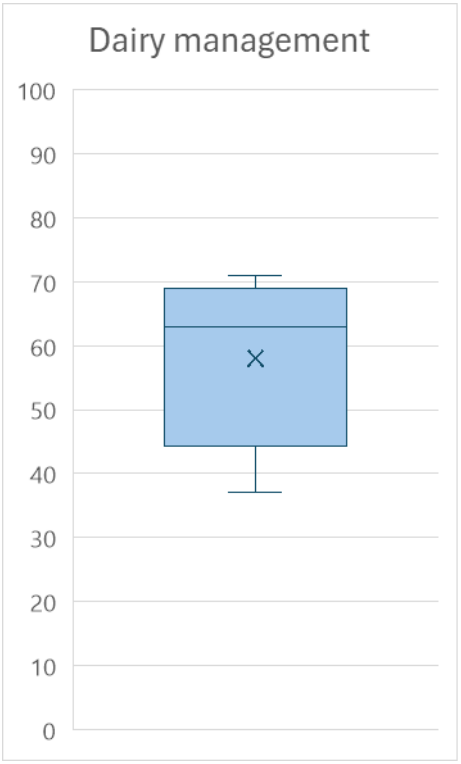


Figure 12. The statistical analyzis of the Calf Management scores. The minimum was 18, the median was 54,5 and the maximum was 86.

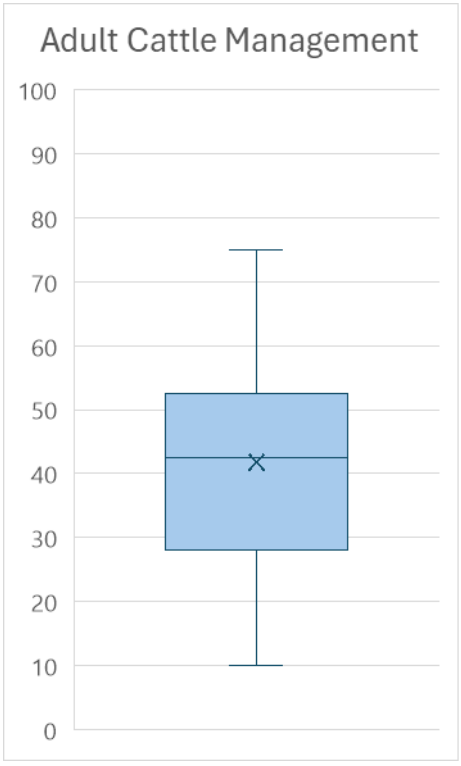
Figure 13. The statistical analyzis of the Dairy Management scores. The minimum was 37, the median was 63 and the maximum was 71.

4.1.2.5. Adult cattle management

Scores in **Figure 14** are between 28 and 52 leading to a main value of 41,8 and a world average of 44. Adult cattle management includes the cleaning and disinfection of the stable, the grouping and the application of footpaths.

4.1.2.6. Working organization and Equipment

This section as seen in **Figure 15** includes questions about the grouping according to age, the order of farm work, usage of specific boots, clothes, hand wash and shared materials between farms. The scores are between 27,75 and 55,5 leading to a mean value of 45,7 and a world average of 40.



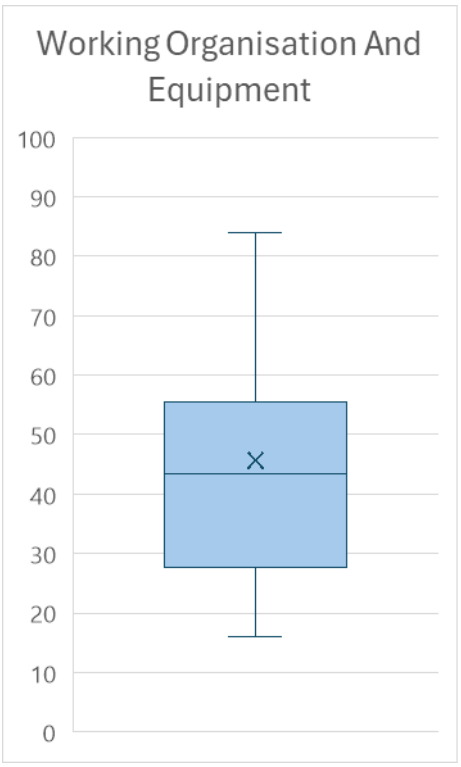


Figure 14. The statistical analyzis of the Adult Cattle Management scores. The minimum was 10, the median was 45 and the maximum was 75.

Figure 15. The statistical analyzis of the Working Organisation and Equipment scores. The minimum was 16, the median was 43,5 and the maximum was 84.

4.1.2.7. Subtotal internal biosecurity

The discussed values above lead to an internal biosecurity score as seen in **Figure 16** of 36,5 to 46,75 and a mean value of 41,8 in comparison to a world average score of 39.

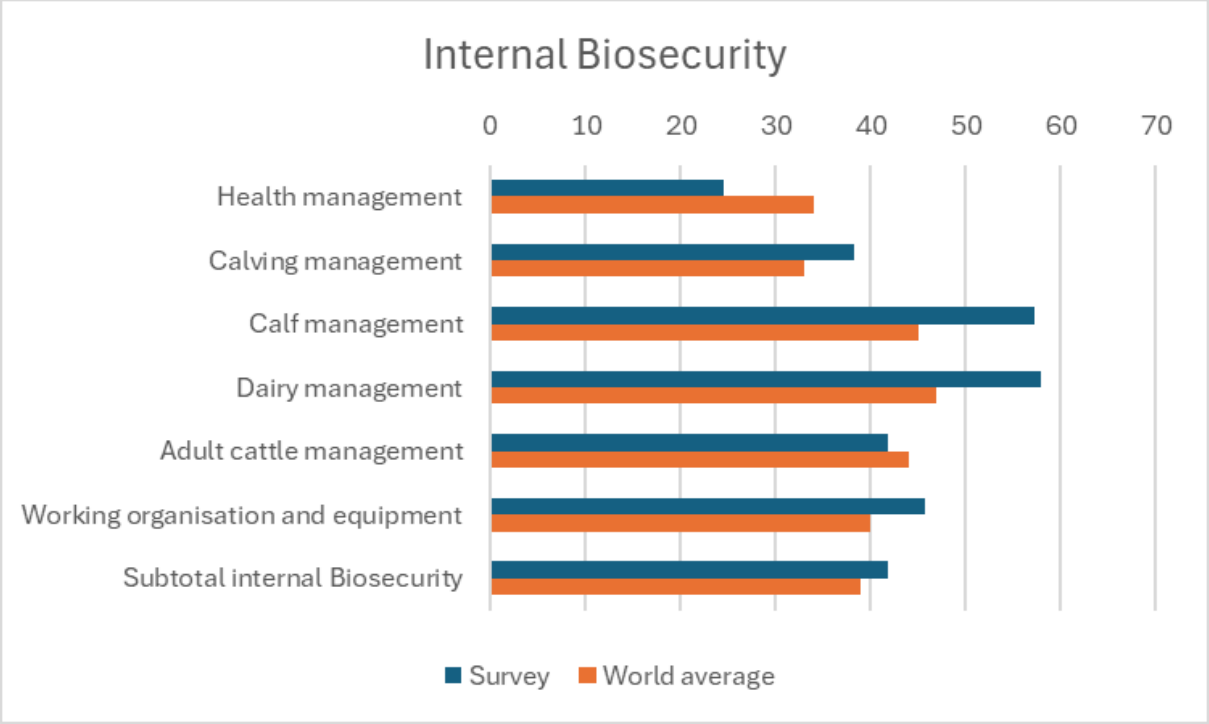


Figure 16. The statistical analyzis of the Subtotal Internal Biosecurity scores. The minimum was 13, the median was 41 and the maximum was 63.

Chart 1 *Min:* *33*
Median: *45*
Max: *62*

4.1.3. Total

The total score in **Figure 17** is between 36,25 and 51,75 and a mean value of 45 compared to the world average of 53.

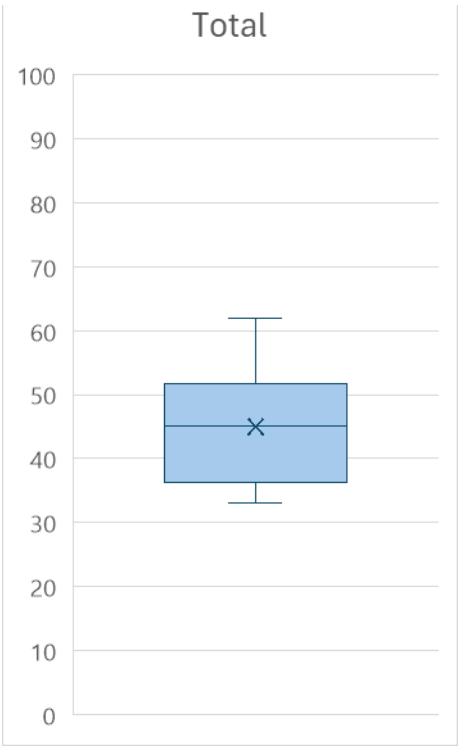


Figure 17. The statistical analyzis of the Total scores. The minimum was 33, the median was 45 and the maximum was 62.

4.2.Beef Cattle

The evaluation of beef cattle follows the same principles as dairy cattle and is build up the same to provide easier comparison and discussion.

4.2.1. External biosecurity

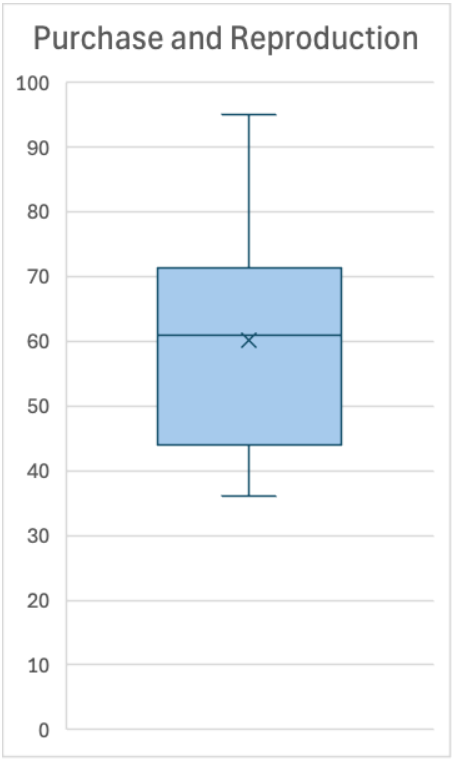
The subcategories of external biosecurity are the same as in dairy cattle, which means the topics and questions answered deal with the same topics. Therefore, the following data is presented in a shorter version and only compares the numbers with dairy cattle.

4.2.1.1. Purchase and Reproduction

The scores **Figure 18** vary from 44 to 71,25, resulting in a mean value of 60,2. The world average is 65. On this category dairy scored 45,2 to a world average of 78. The score for beef cattle is significantly lower compared to dairy.

4.2.1.2. Transport and carcass removal

The scores in **Figure 19** vary from 38 to 54,25, leading to a mean value of 47,2 with the world average representing 55. For dairy the mean value with 45,2 is nearly the same with a world average of 48 slightly lower compared to beef cattle.



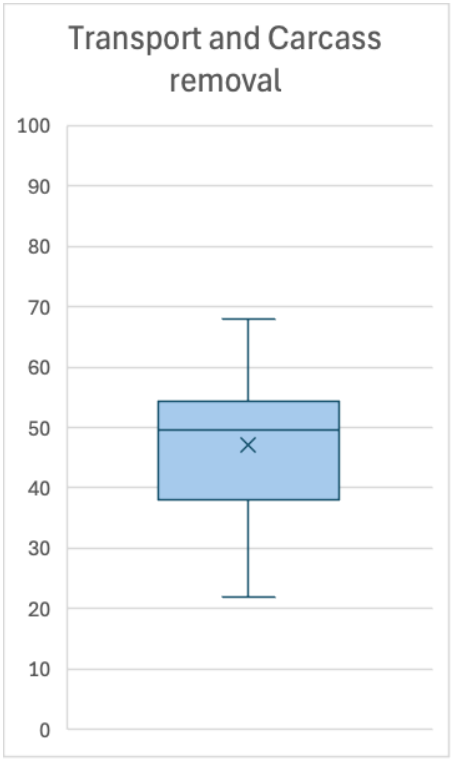


Figure 18. The statistical analyzis of the Purchase and Reproduction scores. The minimum was 36, the median was 61 and the maximum was 95.

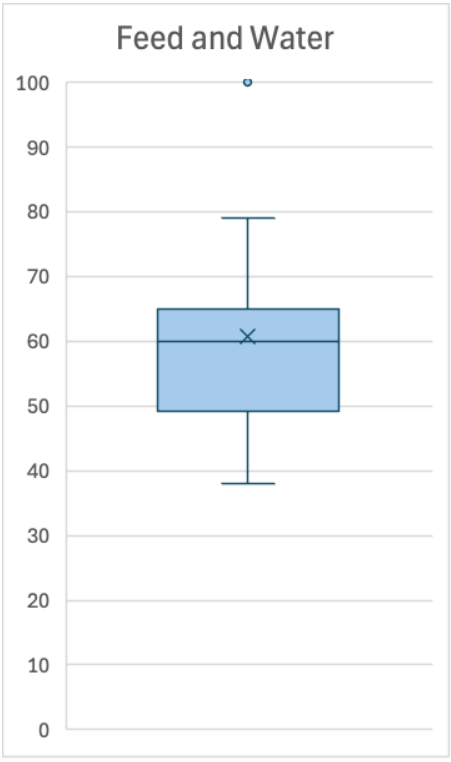
Figure 19. The statistical analyzis of the Transport and Carcass removal scores. The minimum was 22, the median was 49,5 and the maximum was 68.

4.2.1.3. Feed and Water

Scores in **Figure 20** range from 49,25 to 65 which provides a mean value of 60,8 with the world average at 52. The world average for dairy is 58 and the mean value of the survey is 50,6.

4.2.1.4. Visitors and Farmworkers

The scores in **Figure 21** vary again between 42,5 and 74 with the mean value at 59,6 and the world average at 68. Dairy scores a mean value of 56,7 and an world average of 69. These numbers are close to each other, which concludes that there is no significant difference in biosecurity protocols between beef and dairy farms.



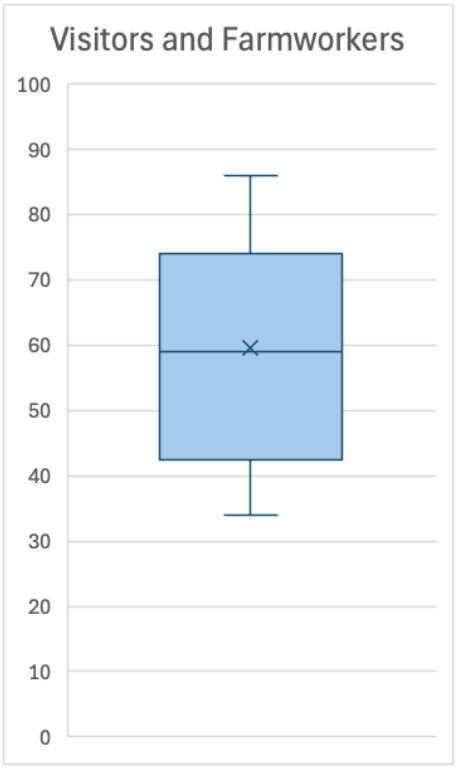


Figure 20. The statistical analyzis of the Feed and Water scores. The minimum was 38, the median was 60 and the maximum was 100.

Figure 21. The statistical analyzis of the Visitors and Farmworkers scores. The minimum was 34, the median was 59 and the maximum was 86.

4.2.1.5. Vermin control and other animals

Scores in **Figure 22** vary from 45 to 63 with the mean value at 53,5 and the world average also 61. Dairy scores with a mean value of 44,4 and a world average of 64. The world average is similar as the Austrian numbers show greater differences.

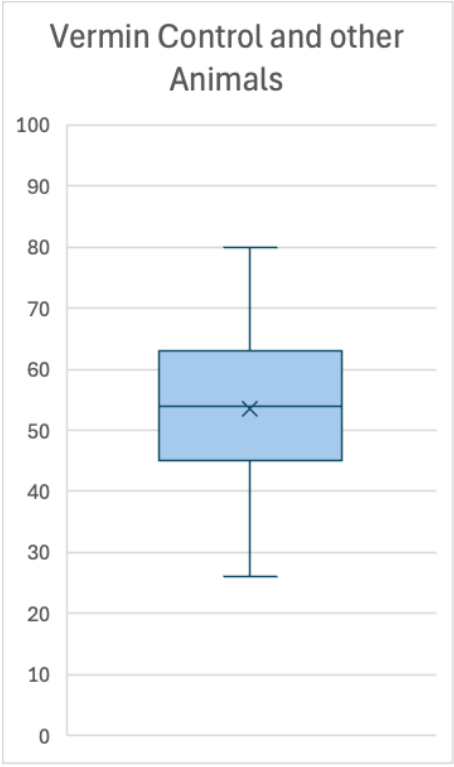


Figure 22. The statistical analyzis of the Vermin Control and other Animals scores. The minimum was 26, the median was 54 and the maximum was 80.

4.2.1.6. Subtotal external biosecurity

The subtotal score as seen in **Figure 23** consists of the subcategories for external biosecurity and is between 48 and 67 leading to a mean value of 56,8 in comparison to a world average of 62.

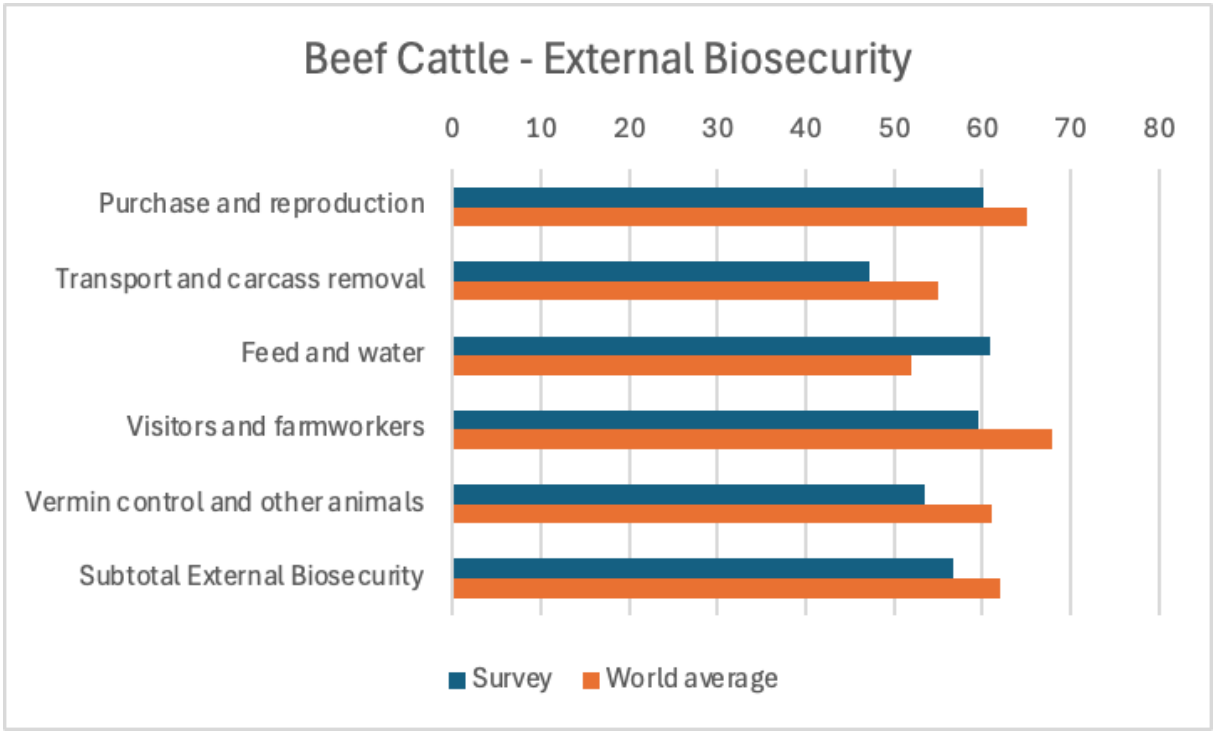


Figure 23. The statistical analyzis of the Subtotal External Biosecurity scores. The minimum was 40, the median was 57,5 and the maximum was 75.

4.2.2. Internal Biosecurity measures

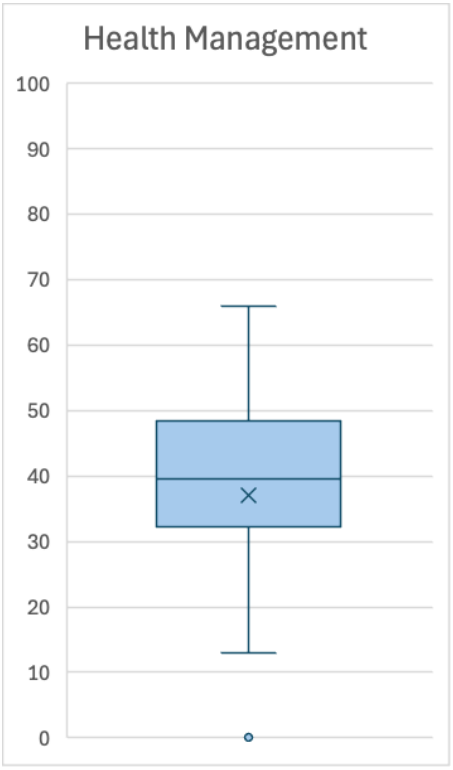
The internal Biosecurity measures again focus on the following subcategories: Health Management, Calving Management, Calf Management, Adult Cattle Management and Working Organization and Equipment.

4.2.2.1. Health management

Scores in **Figure24** range from 32,25 to 48,5 leading to a mean value of 37 and a world average of 44. The world average for dairy is 10 points less at 34 with the mean value also significantly lower at 24,5.

4.2.2.2. Calving management

The range representing the management of calvings in **Figure 25** is between 26,25 and 42,25 and a mean value of 32,6. The world average is 36. These numbers match the mean value of 38,2 and the world average of 33 as there are no big differences between the scores.



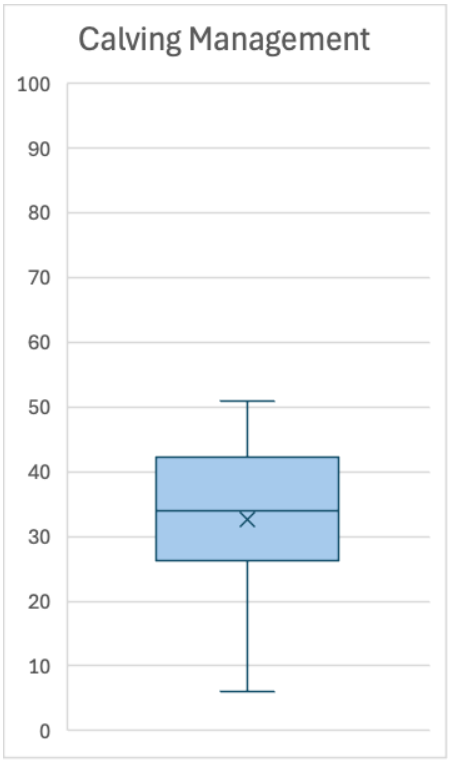


Figure 24. The statistical analyzis of the Health Management scores. The minimum was 0, the median was 39,5 and the maximum was 66.

Figure 25. The statistical analyzis of the Calving Management scores. The minimum was 6, the median was 34 and the maximum was 51.

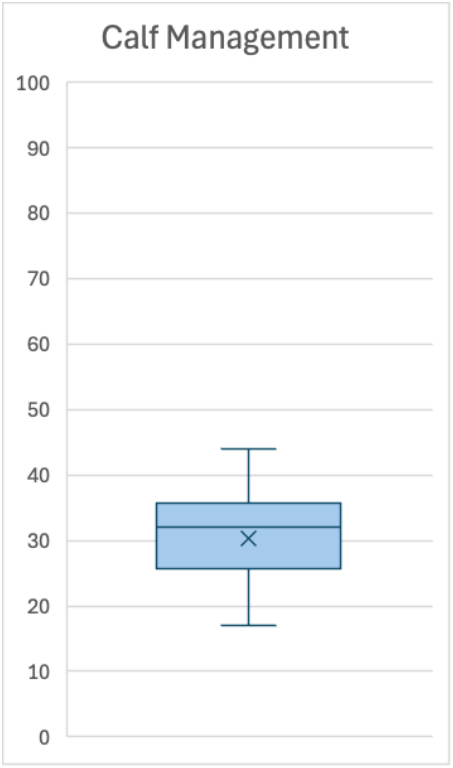
4.2.2.3. Calf management

Calf management in **Figure 26** scores between 25,75 and 35,75 leading to a mean value of 30,4 and a world average of 39.

With a world average of 57,2 and a mean value of 45 for dairy cattle the scores show a significant difference.

4.2.2.4. Adult cattle management

Scores in **Figure 27** are between 0 and 29,5 leading to a main value of 17,4 and a world average of 35. For dairy the mean value is at 41,8 and the world average at 44 leading to a score difference of several points.



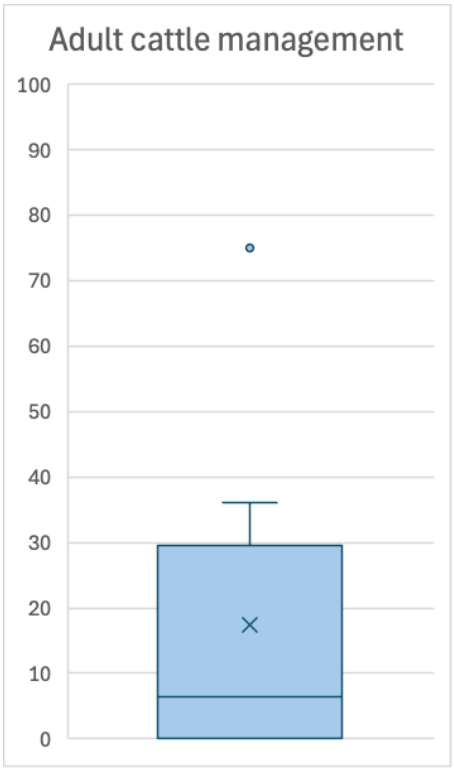


Figure 26. The statistical analyzis of the Calf Management scores. The minimum was 17, the median was 32 and the maximum was 44.

Figure 27. The statistical analyzis of the Adult Cattle Management scores. The minimum was 0, the median was 6,5 and the maximum was 75.

4.2.2.5. Working organization and Equipment

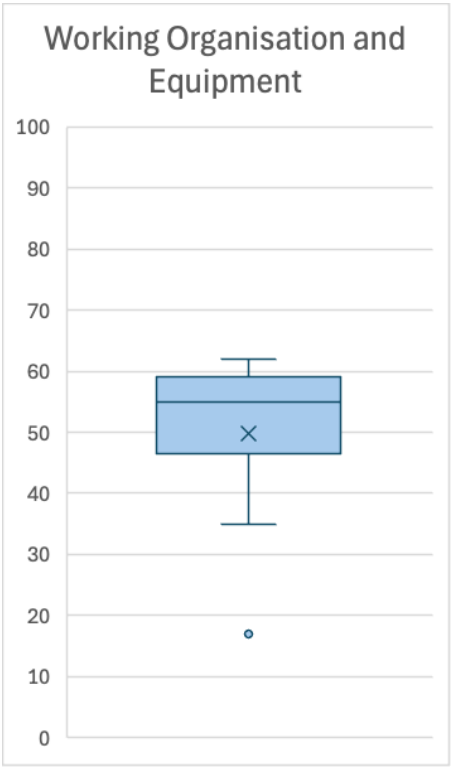
The scores in **Figure 28** are between 46,5 and 59 leading to a mean value of 49,8 and a world average of 45. Dairy cattle scores less in both numbers with the mean value at 45,7 and the world average at 40.

4.2.2.6. Subtotal internal biosecurity

The discussed values in **Figure 29** lead to an internal biosecurity score of 26,75 to 39,75 and a mean value of 33,6 in comparison to a world average score of 40.

4.2.3. Total

The total score in **Figure 30** is between 40 and 49,75 and a mean value of 45,6 compared to the world average of 52.



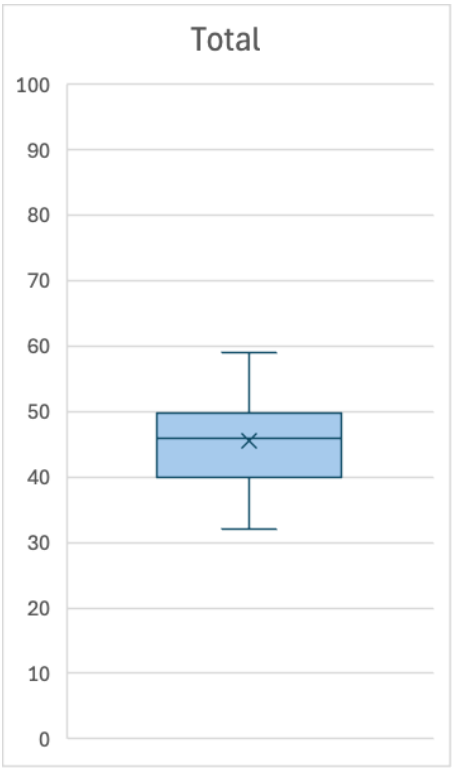


Figure 28. The statistical analyzis of the Working Organisation and Equipment scores. The minimum was 17, the median was 55 and the maximum was 62.

Figure 30. The statistical analyzis of the Total scores. The minimum was 32, the median was 46 and the maximum was 59.

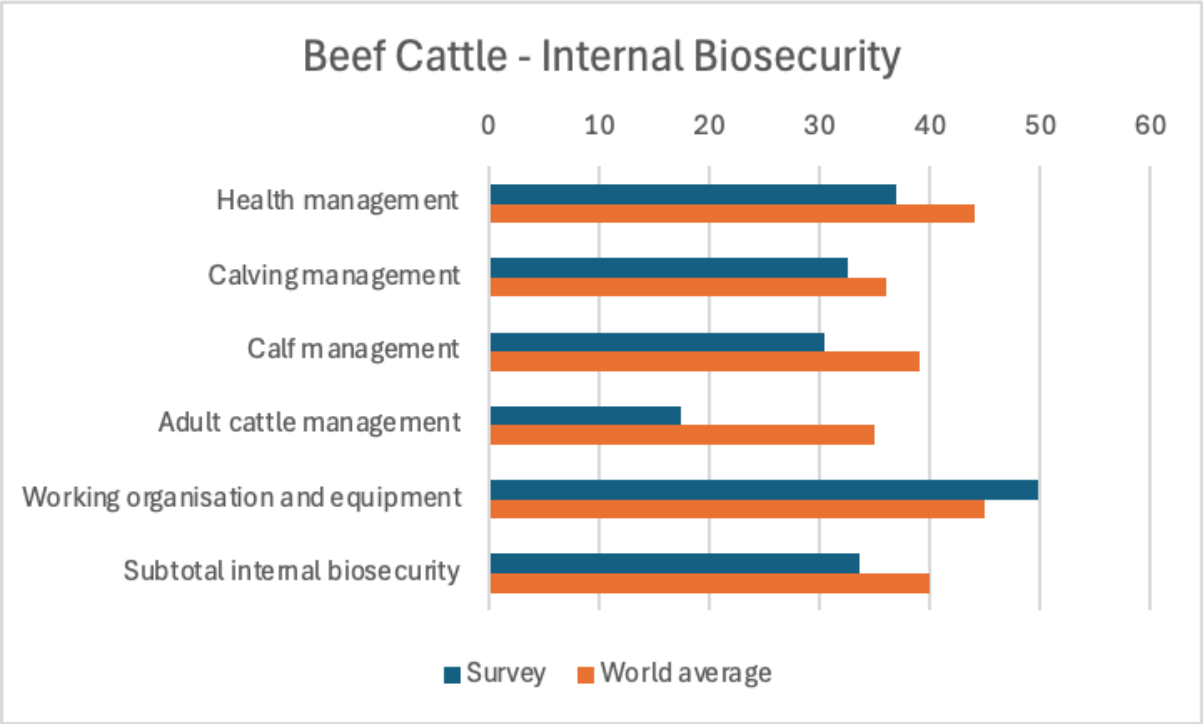


Figure 29. The statistical analyzis of the Subtotal Internal Biosecurity scores. The minimum was 23, the median was 36,5 and the maximum was 42.

4.3.Discussion

The overall score of 45 for dairy and 45,6 for beef is close to the global score of 53 for dairy and 52 for beef cattle. However, the individual values that make up this result are quite different. Internal biosecurity scores at 41,8 for dairy compared to 33,6 for the survey, which is slightly higher than the global average of 39 for dairy, but with a world average of 52 lower than beef. External biosecurity scores 48 for dairy, significantly lower than the global score of 67., while the external score for beef is with 56,8 close to the world average of 62.

A study about dairy cattle in India using the same survey had an external biosecurity score of 45,4 which is slightly lower than the Austrian score of 48. Internal biosecurity result of 43,7 are slightly higher than the 41,8. The study also described the highest scoring subcategories as followed: “Among the different subcategories, the highest mean score was observed for ‘vermin control and other animals’ (63%), followed by ‘feed and water’ (61%), ‘transport and carcass

removal' (52.9%), and 'visitors and farm workers' (47.6%), and the lowest score was observed for 'purchase and reproduction' (30.6%)"(15).

In comparison the highest subcategory for external biosecurity reached in this study is „Visitors and Farmworkers (56,7%) followed by „Feed and Water" (50,6%), "Transport and Carcass Removal" (46,3%), "Purchase and Reproduction" (45,2%) and the lowest score representing „Vermin control and other Animals".

Internal subcategories were described in the study as "highest score was observed for 'adult cattle management' (76.6%), followed by 'dairy management' (55.1%), 'calving management' (42.4%), 'working organization and equipment' (41.9%), 'calf management' (41.6%), and the lowest score was observed for 'health management' (33.6%)."[15]

These subcategories are ordered in Austria differently again having „Dairy Management" (58%) as the highest subcategory, followed by „Calf Management" (57,2%), „Working Organization and Equipment" (45,7%), „Adult Cattle Management" (41,8%), „Calving Management" (38,3%) and „Health Management" (24,5%) which represents the lowest score.

A Further Study by Damiaans described his findings, which also vary from the Austrian survey. "As in beef farms, in dairy farms "purchase and reproduction" was the highest scoring subcategory in external biosecurity. In dairy farms, this high score was due to the fact that many farms did not purchase cattle. Farms that did purchase generally took few extra measures to limit the risks, similar to beef farms and resulting in a large range of scores from 25 to 100 points. The lowest scoring subcategory in ex- ternal biosecurity was"feed and water" with an average score of 45.9 points."[13]

5. Conclusions

This study concluded that measures on Austrian dairy and beef farms highlighting strengths as well as areas for improvement. Overall, the biosecurity scores -45 for dairy and 45,6 for beef – are slightly below global average of 53 and 52 with notable differences between subcategories. External biosecurity such as Transport and Carcass removal showed the greatest weaknesses, which may show the need for better protocols to manage the risk for the introduction of external pathogens through vehicles or animals.

Internal Biosecurity measured on dairy farms scored better especially in “Dairy Management” and “Calf Management”. However, the poor score of “Health Management” may highlight a lack in disease control practices above all the isolation of sick animals and hygiene. Same results were shown in beef cattle especially in “Adult Management” indicating a need for improvement in stable hygiene and grouping practices.

Compared to studies in other countries, Austrian farms showed mixed scores, performing better in some areas, but lack in other, especially external biosecurity. These results may reflect economical challenges, inconsistent practices and different levels of farmer awareness.

The different results showcasing that Biosecurity can still be improved. The subtotal scores and as a result their subcategories are different not only between the single farms but also between countries. Nevertheless, is the risk base scoring system a great way of evaluating the data as the result give an insight in the different fields of biosecurity and which areas may lack of proper biosecurity. Therefore, the weight factor provided in the evaluation of the survey plays an important factor as for example purchase and Reproduction has a far greater impact on the subtotal and total scores than for example vermin control and other animals.

To improve Biosecurity, Austrian farms need better education for farmers and support to implement the needed measures. Costs play also an important role, but this factor may differ geographically as the farm sector in western of Austria is much smaller than in the east. Future research should explore the economic impacts of biosecurity and develop solutions for different farm sizes and types.

6. Summary

This thesis is examining biosecurity in Austrian dairy and beef farms, focusing on on its role in preventing infectious disease and therefore improve animal health, productivity and economic sustainability.

The collected data with Biocheck.UGent provided an insight in both internal and external biosecurity practices, allowing for a detailed comparison with the global average.

The findings show that the examined farms score slightly below the global average. It also underlines the variability of biosecurity practices across farms, also influenced by factors like the size of the farm, economic stability as well as farmer awareness. By analyzing the strengths and weaknesses this research offers a foundation for future efforts to improve biosecurity practices and reduce the risk of disease transmission on Austrian cattle farms,

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