Welfare Aspects of Beef Production in Sweden and Comparative Analysis with Major Beef-Exporting Countries

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Welfare aspects of Beef Production in Sweden and Comparative Analysis with Major Beef-Exporting Countries

Välfärdsaspekter inom Nötköttsproduktion i Sverige och Jämförande Analys med de Främsta Nötköttsexporterande Länderna

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Abstract

The welfare of livestock animals is crucial not only for their well-being but also for the profitability of the system, as it leads to healthier, more productive animals. Therefore, producers can benefit from focusing more on animal welfare, as investments in this area yield increased profitability in the long term. Animal welfare has long been a cornerstone of Swedish beef production and from the Swedish food industry perspective, there is a lack of compilation and update regarding various welfare aspects concerning beef production. This study aimed to investigate welfare aspects of Swedish beef production and compare them with major beef-exporting countries for Sweden Ireland, Germany, and Brazil. The comparative analysis conducted in this study aimed to refine our understanding of the substantial variations in standards between Swedish beef production and these major beef-exporting countries. This study is based on a comprehensive literature review, examining welfare aspects such as animal handling, housing, pasture access, anaesthesia during surgical interventions, antibiotic use, and transportation. Additionally, several interviews were conducted with Axfood in Sweden and their beef suppliers in Ireland.

The interviews revealed distinct practices between Sweden and Ireland in beef production, with grazing being crucial for Irish beef production, allowing cattle to graze eight to nine months of the year. In contrast, while pasture-based beef production is common in Sweden, it is not to the same extent due to climate characteristics. Interviewees also emphasized the profitability challenges in beef production, which are likely to persist in the coming years. Based on the data accessed, Sweden had regulations covering all investigated aspects included in the legislation, with some extended in certifications. Ireland and Germany seemed to lack detailed legislation for most aspects, although most beef producers were certified by standards higher than the legislation. Brazil's animal welfare legislation outlined basic requirements but lacked specific regulations covered in this thesis. Certification for Brazilian beef producers had more detailed rules, but the extent of certification among producers was unclear. Sweden was the only country including space allowance in national legislation, while others included it in certifications. Only Sweden mandated pasture access in legislation, although Ireland implied it as a common practice. Germany and Ireland didn't require anaesthesia for castration or dehorning of calves below a certain age, while Brazilian regulations for anaesthesia was not clear. Transportation time was similar for EU countries, and the allowed age for transporting calves was similar among EU countries, except for Germany’s certification, which prohibited transporting calves younger than four weeks. Sweden reported the lowest use of antibiotics for production animals.

Based on the information accessed, this study concludes that Swedish legislation is more restricted and presents more detailed animal welfare standards for beef production compared to the major beef-producing countries investigated in this thesis. However, other factors such as welfare aspects included in certifications are also considered in order to broaden the perspective. To make information regarding animal welfare legislation and certificates for countries exporting to Sweden more accessible to consumers and actors on the food market, it could be beneficial to conduct a platform which presents and compares these topics.

Keywords: animal welfare, animal welfare certification, beef cattle, beef production, behaviour, management system, Swedish agriculture

Sammanfattning

Välfärden för livsmedelsproducerande djur är relevant både för djurens välbefinnande och för lönsamheten i produktionen, eftersom en god djurvälfärd resulterar i friskare djur med högre produktivitet. Det betyder att det kan vara fördelaktigt för producenter att fokusera ännu mer på djurvälfärd, vilket kan leda till ökad lönsamhet för produktionen på lång sikt. Inom svensk nötköttsproduktion har djurvälfärd länge varit en viktig aspekt och den svenska livsmedelsindustrin saknar en sammanställning och uppdatering gällande välfärdsaspekter inom nötköttsproduktion. Syftet med den här studien är att undersöka utvalda välfärdsaspekter inom svensk nötköttsproduktion och jämföra med Irland, Tyskland och Brasilien, som är de framstående exporterande länderna av nötkött till Sverige. Den jämförande analysen som genomfördes i den här studien syftade till att förbättra förståelsen för de betydande skillnaderna mellan svensk nötköttsproduktion och de framstående exporterande länderna av nötkött. Studien baseras på en omfattande litteraturgenomgång där välfärdsaspekter som undersöktes inkluderade djurhantering, inhysning och skötsel, tillgång till bete, bedövning vid operativa ingrepp, användning av antibiotika och transport. Utöver litteraturgenomgången genomfördes även intervjuer med Axfood i Sverige och deras nötköttsleverantörer i Irland.

Resultaten från intervjuerna visade att Sverige och Irland har olika metoder för nötköttsproduktion. Betet är en stor del av den irländska nötköttsproduktionen, nötkreaturen betar åtta till nio månader om året. I Sverige är det vanligt med betesbaserad nötköttsproduktion, men på grund av det kallare klimatet är djuren inte ute på bete lika stor del av året som på Irland. Intervjupersonerna poängterade även kommande utmaningar med lönsamhet inom nötköttsproduktionen. Enligt materialet som kunnat användas har Sverige lagstiftade regler för alla djurvälfärsaspekter som inkluderas i studien, vissa av dem är utökade i certifieringar. Irland och Tyskland verkar inte ha någon detaljerad lagstiftning för de flesta inkluderade aspekterna, däremot är en stor andel av nötköttsproducenterna certifierade enligt certifieringar som har högre krav än lagstiftningen. Djurskyddslagstiftningen i Brasilien omfattar grundläggande krav för djurens välbefinnande, men det finns inga specifika regler för de flesta av aspekterna som ingår i denna uppsats. I certifieringen som vissa brasilianska nötköttsproducenter innehar finns det en del regler som är mer specifika, men det är oklart hur stor del av producenterna som är certifierade. Sverige verkar vara det enda landet som har måttbestämmelser för utrymme i den nationella lagstiftningen, de andra länderna inkluderar det i sina certifieringar. Vidare är det bara Sverige som har ett beteskrav, däremot är det en vedertagen praxis i Irland. Det är bara Sverige som kräver bedövning vid all kastration eller avhorning av kalvar, de andra länderna har krav beroende på ålder förutom Brasilien som inte verkar ha några tydliga regler kring bedövning vid ingreppen. Den godkända transporttiden är liknande för EU-länderna, likaså åldersgränsen för transport av kalvar med undantag för Tysklands certifiering, som förbjuder transport av kalvar yngre än fyra veckor. Enligt rapporter om antibiotikaanvändning för livsmedelsproducerande djur var Sverige det land med lägst användning för produktionsdjur.

Slutsatsen är att Sverige har den striktaste djurskyddslagstiftningen jämfört med de inkluderade länderna, enligt det material som kunnat användas. För att underlätta jämförelsen av välfärdsaspekter för länder som exporterar till Sverige skulle det kunna vara fördelaktigt att skapa en plattform som inkluderar såväl lagstiftning som certifieringar.

Sökord: beteende, djurvälfärd, djurvälfärdscertifiering, managementsystem, nötkreatur, nötköttsproduktion, svenskt lantbruk

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Abbreviations

ANI	Animal Needs Index
BVD	Bovine Viral Diarrhoea
CBPA	Coordination of Good Agricultural Practices
HFAC	Humane Farm Animal Care
SBLAS	Sustainable Beef and Lamb Assurance Scheme
SFS	Svensk Författningssamling
SJVFS	Statens Jordbruksverks Föreskrifter
SLU	Swedish University of Agricultural Sciences
WHO	World Health Organisation

1. Introduction

The welfare of livestock animals is relevant not only for the sake of the animals but also for the system profitability, nevertheless it is an ethical and legal commitment for farmers. Healthy animals which have adequate welfare status produce better, live longer, and have higher efficiency overall (Dawkins 2016). Therefore, producers can benefit from focusing even more on the welfare of their animals, thus the investments will return as increased profitability for the system in the long-term.

Additionally, there is also an increasing demand from the consumers for animal derived products that prioritize animal welfare standards (Lusk 2011). Consumers are becoming more aware of what they consume, and animal welfare activists are advocating for the rights of production animals. This is a significant factor when it comes to developing animal welfare standards. Thus, it is important to distinguish standards created by private farmers- or animal welfare organizations and the legislation (Lundmark et al. 2018). According to the study by Lundmark et al. (2018) the private standards that have been developed are great tools to improve animal welfare, but they must be implemented under the existing legislation. Further, the government and policymakers need to consider the overall perspective in order to enable a positive application of private standards.

For beef production, the Swedish environment is highly beneficial with the large areas of pasture and arable land that may only be suited for this type of production, which includes grazing and silage production (Jamieson & Hessle 2021). Although Sweden has great conditions for beef production, almost half of the consumed beef is imported (Svenskt Kött 2023). Swedish beef production cannot compete with imported beef from an economic perspective as producing beef in Sweden costs more than other countries, which could be due to the higher standards (Ahmed et al. 2020). Still, according to the same authors, for some consumers, the price of the beef is an important factor which leads to choosing the imported beef (Ahmed et al. 2020).

According to von Keyserlingk et al. (2009), the welfare standards can be divided in three main aspects; animal functioning, affective states and natural living. The functioning of production animals is about health status and productive parameters like disease occurrence and growth rate. Affective state covers the animal well-being, in other words, mental health (e.g. pain assessment). And finally, the aspect of natural living aims for the animal's ability to perform natural behaviours (e.g. grazing as a natural behaviour for ruminants). Those three aspects of welfare standards of course overlap each other. For example, access to pasture is an

opportunity to fulfil the natural living of cattle, and it could have a positive effect on the health status (Washburn et al. 2002). However, pasture access comes with some risks which can include heat-stress and parasite infection. These physical conditions affect both the health and functioning as well as the affective state of the animals (von Keyserlingk et al. 2009).

1.1 Purpose and hypothesis

From the Swedish food industry perspective, there is a lack of compilation and updating regarding various welfare aspects concerning beef production. This information is crucial in understanding the substantial variations of standards in Swedish beef production compared to the major beef-exporting countries, which export to Sweden and other European countries. We hypothesise that there are likely differences concerning welfare aspects for beef production in Sweden compared to Ireland, Germany and Brazil and that Sweden presents higher standards and regulations. Therefore, this study aimed to investigate the welfare aspects of Swedish beef production and compare them with those of the major beef-exporting countries. Additionally, the study will bring more understanding about the differences in the welfare of global beef production and hopefully create a discussion on how to improve it.

2. Material and Methods

The study was grounded in a comprehensive combined literature review and data collection analysis from available online documents, focusing on welfare aspects within beef production in Sweden, Ireland, Brazil, and Germany. The decision on the selected countries was based on Axfood's information regarding some main exporting countries for beef. Aspects investigated were animal handling, housing and management, access to pasture, anaesthesia during surgical interventions, use of antibiotics and transportation. Additionally, legislation and regulations related to welfare-certified products were explored through available online documents. In complement to this, the study conducted empirical investigations, including interviews with Axfood in Sweden and their beef suppliers in Ireland.

2.1 Literature review and data collection

For the literature review, academic databases like Web of Science, PubMed and Google Scholar were used to find relevant articles, reports, studies, and official publications. A systematic approach was adopted to review the material. Keywords used for searching in databases were beef production, animal welfare, animal welfare certifications, behaviour, management system, housing, antibiotic use, surgical intervention, beef cattle, Swedish agriculture, and international comparison.

The data collection regarding beef production in Sweden and major beef-exporting countries included material from government reports, agricultural organizations, and industry publications. Official statistics from the Swedish Board of Agriculture were crucial in providing detailed insights into domestic beef production practices, trends, and economic aspects.

2.2 Interview

In addition to the literature review and data collection about legislation and regulations, three semi-structured interviews were conducted with Axfood in Sweden and their beef suppliers in Ireland. Axfood is a leading retail company in Sweden, and this thesis is a collaboration between the Swedish University of Agricultural Sciences (SLU) and Axfood. The interviews aimed to obtain qualitative insights about Axfood’s sourcing strategies, consumer preferences, and the initiatives they take to develop sustainability and welfare of the beef market.

All interviews took place on video calls using Zoom Meetings software. The interviews were recorded, and afterwards, they were transcribed. The interview with Axfood in Sweden was essential for proposing and developing the main topics of the literature review.

2.3 Data analysis

A comparison of key aspects of beef production in Sweden and major beef-exporting countries was conducted with a quantitative analysis. Published statistically analysed data was used to identify differences, similarities and trends in production practices, market dynamics and efficiency. To enable a refined understanding of which factors are correlated to the competitiveness and sustainability of Swedish beef production compared to major beef-exporting countries, this thesis synthesized literature review with empirical data from the interviews.

2.4 Limitation

There were several factors which may have limited the literature review, and the availability of published material is one of them. Limitations also involved potential biases in the available data. The limitations affected the reliability and generalizability of data used for the review. It is possible that variations in methodology among studies involved in this literature review could also have an impact on generalizability.

Some delimitations were made before the start of the project. The delimitations included language of the findings, only published studies in Swedish and English could be used for the literature review. However, since documents regarding legislation and welfare certificates of the included countries was essential for the thesis, it was necessary to use the tool Google Translate for translating publications which were not available in English. The use of Google Translate could have limited the understanding of some material, due to the possible errors of the translation.

Delimitations also included time range; published material, except legislation, before the year of 2000 was not considered as applicable since the literature review aimed to be based on current information.

3. Welfare Strategies of Axfood

Several interviews were conducted in the section about Axfood's sustainability and animal welfare strategies. These interviews provided insights into the distinct beef market scenarios in Europe. The sections below were based on answers from the interviews, along with relevant references. The interviewees were both representatives from Axfood in Sweden and beef suppliers in Ireland. The interviews aimed to gain insights into the beef market and Axfood's strategies aimed at ensuring the welfare of beef cattle regarding commercialized products. The main questions were about the overall beef market, which welfare certificates are accepted and the future of beef production within the European Union (EU). The questions can be found in Appendix 1 & 2. Before the interviews, the student prepared the questions based on previous background on the topic and with the supervisor's support. The interviewee received the questions a few days before the interview to prepare and discuss the answers with colleagues. The answers are limited by confidential material; however, public data was included.

3.1 Axfood in Sweden

Participants in the first interview were the student author and a sustainability innovator at Axfood. The interview lasted for 40 minutes and was recorded after consent from the interviewee. The recording was used to transcribe the information from the interview, which is presented along with relevant references below. The interview was held in Swedish, and the material was translated to English afterwards. Some questions could not be answered directly; in this case, the student was advised on where to find information about the topic.

3.1.1 Import and consumption of beef

More than half of the consumed beef is produced in Sweden. According to Jordbruksverket (2022a), 55.8% of beef consumed originates from Sweden. Axfood aims for a higher share than the average percentage of self-sufficiency. The direct beef consumption in Sweden is 11.5 kg per person and year (Jordbruksverket 2022b). Axfood imports most of the beef from Ireland, but they also import from Germany, South America, France, Denmark, and New Zeeland.

3.1.2 Accepted certificates

Axfood accepts several different certificates regarding welfare aspects for beef production, but exactly which certificates are accepted is a confidential information.

The certifications are demanded for all imported beef but not yet for beef which is produced within Sweden, since the national legislation regarding animal welfare is already extended compared to other countries in EU. One of the aspects included is use of antibiotics. Axfood strives to restrict the use of antibiotics in international beef production by demanding careful use for all beef, including imported beef. The certifications that Axfood accepts are often brought up in the countries. Some certificates may be developed in one country and adopted by other countries as well. Before approving the certificate, Axfood assesses the requirements included. The audits on farms are made by an independent third- party, who then issues a certificate. It is the supplier who guarantees the compliance of the certificate.

3.1.3 Prospects of future beef production

According to a study which is mentioned in the interview, conducted by the Swedish label "Från Sverige", the consumption of products originating from Sweden has increased the past few years (Från Sverige 2024). The products which seem to be most important for consumers to buy from Sweden is egg, milk, chicken, beef and pork (Från Sverige 2024). This shows that the consumers prioritize Swedish products, welfare aspects may be an influencing factor. Axfood strives for a high percentage of Swedish and organic beef on the market. The selection is based on which commodity has the highest sustainability; welfare standards included.

"If Sweden would lower their welfare standards to become more competitive internationally from an economic perspective, it is not certain that Swedish beef would be the most sustainable choice anymore."

- *Sustainability Innovator, Axfood*

Since Axfood is a relatively small buyer from most international suppliers, they cannot request much regarding the aspects included in certifications. It is different in Sweden where Axfood is one of the largest operators and therefore they can demand more from the certifications. At the time it is only the imported beef that needs to be certified, the national label "Från Sverige" is enough for beef produced in Sweden. The goal for Axfood is to request a certification for all beef, including Sweden, by the year of 2025. The certification that will hopefully be implemented is "IP Nöt & Mjölk Grundcertifiering" by Sigill Quality System. Implementation of the certification is under investigation at the moment.

The year of 2023 was a rough year for Swedish farmers and there are probably more to come. Climate change makes it harder to produce food and the profitability for farmers decreases. Although Sweden has great potential to produce beef compared to many other countries, one limiting factor for many Swedish farmers is the generational shift.

“We believe that there is a future for Swedish beef but it will be tough.”

- *Sustainability Innovator, Axfood*

3.2 Axfood’s Beef Suppliers in Ireland

The following section is based on two interviews with different actors on the Irish beef market and they are all connected to Axfood. The participants for the first interview were the student author and a managing director for food safety in Ireland. For the second interview with actors on the Irish beef market, there were three participants except the student. All of them were representatives from Bord Bia, Irish Food Board. Both interviews lasted for around 40 minutes and were recorded after consent from the participants. The recordings were only used for compilation of the data afterwards.

3.2.1 Import and consumption of beef

Ireland is a major exporter of beef due to its large herd. Around 90% of all Irish beef is exported, which means 490 000 ton every year. Axfood imported 4500 ton of beef from Ireland last year. Due to the large production, Ireland imports very little beef from other parts of the world. Last year, the number for imported beef was 32 000 ton, of which 28 000 ton came from the UK or Northern Ireland. The remaining amount most likely originates from South America. The direct beef consumption in Ireland is 18.5 kg per person and year.

3.2.2 Accepted certificates

The Bord Bia Quality Assurance Scheme is the most widely accepted scheme. It is extended over the EU legislation. Beef producers who comply with the Quality Assurance Scheme receives a bonus. However, 95% of all beef produced in Ireland is certified, which means that most producers receive this bonus for their beef.

“If it wasn’t certified, it wouldn’t get into the supermarket.”

- *Managing Director, Food Safety*

“A lot of the major factories in Ireland won’t accept beef without certificate. It’s more like the farms who don’t have the certificate get a penalty for that, because the bonus is very common.”

- *Representative, Bord Bia*

The standards of Bord Bia Quality Assurance Scheme are continuously revised and updated. There is an ongoing revision to improve the standards where welfare

aspects are included. Beef producers following the standard get inspected on farm every 18 months and all animals are tagged to ensure the traceability. The tags are checked at the slaughterhouse where the animals are identified and inspected by veterinary inspectors.

“If you don’t treat the animal right, the animal isn’t happy and the animal doesn’t grow.”

- *Managing Director, Food Safety*

Animal transportation is not an issue within Ireland due to the short distances between farms and slaughterhouses. However, the duration of transportation is recorded.

“Most animals are not transported more than an hour, it is a small country”

- *Representative, Bord Bia*

3.2.3 Prospects of future beef production

Animal welfare is becoming a bigger priority for consumers and some people are consuming less beef. The welfare standards need to keep improving. Additionally, Ireland is following a target to reduce the carbon footprint with 25% by the year of 2030, compared to 2021. One way to reduce the carbon footprint could be to slaughter cattle at a younger age, the goal is 22 months instead of the current average age which is 26 months.

“It is going to be though, no question.”

- *Managing Director, Food Safety*

From some perspectives, dairy production seems to be more sustainable than beef production. This assessment depends on the production systems being very different. The main rule of dairy production is that the cow produces milk through its lifetime, and at the end the beef is used for human consumption. This aspect gives more variety to the dairy production which is beneficial from an environmental perspective. The suckler cows do not have the same purposes as dairy cows, but they may have a very important impact on the biodiversity since grazing is an important part of their productive life.

Beef production in Ireland has benefits compared to other countries, for example, grass-based beef production is a common practice. The cattle are out on pastures, grazing for eight to nine months. Grass is a sustainable and economic resource for cattle feed. The quality assurance scheme in Ireland mandates that the majority of the cattle's diet must be grass-based. While it is a common practice to maximise

grass content in the diet, the scheme does not explicitly require pasture access. This omission may be because pasture access is inherently a major component of the Irish beef production system. However, there is an additional grass-fed certification which assures 220 days of grazing and a minimum of 90% grass in the diet.

"The fact that there is no requirement for grazing in our scheme is just a consequence of our very different production systems compared to the EU. So, we don't need to put that sort of requirement to our scheme because we have a different system here. As soon as the weather allows it, animals are outside."

- *Representative, Bord Bia*

According to the beef suppliers in Ireland, this year it has become more complicated to export beef due to the new rules. Most of the beef must go through Great Britain before it is exported to other countries. All countries within EU have the same food safety regulations, but exporting to Sweden requires more administration due to the strict rules regarding salmonella.

4. Literature Review

4.1 Assessment and characterization of welfare aspects in Swedish beef production

When assessing beef cattle welfare on farms, we should consider several aspects in regard of the animal needs. An Animal Needs Index (ANI) published by Bartussek et al. (2000) presents various indicators which can be grouped into six categories as presented in Table 1. Some specific indicators such as grazing time, space allowance and anaesthesia for surgical interventions will differ among countries and their regulations.

Table 1. Indicators for assessing welfare in beef production.

Category	Welfare indicators
Locomotion	Space allowance, outdoor access, injurious protrusions, ease of locomotion, avoidance distance, grazing time (days per year).
Social interactions	Space allowance, housing - social groupings, proximity to other animals, calving method, weaning method, outdoor access, social grooming, grazing time (days per year).
Flooring	Type of floor, animal cleanliness, type of yard flooring, housing duration.
Environment	Natural light, artificial light, side openings, draughts, condensation, noise level, disinfection, alarms (fire), grazing time (days per year).
Stockpersonship	Access to water facilities, number of animals per drinker, frequency of cleaning water facilities, feed quality, feed refusal quality, cleanliness of calving facilities, lameness, animal body condition score (BCS), tail clipping, experience, background, time spent with animals, interest.
Husbandry management	Calving difficulty score, colostrum feeding relative to calf birth, choice of colostrum, cow and calf separation, housing duration, age of calves at weaning, pre-weaning - concentrates, disbudding age, disbudding with anaesthesia, castration age, castration with anaesthetic.

Adapted by (Lawrence et al. 2022)

In 1 Chapter. 1§ Animal Welfare Act (SFS 2018:1192) of Sweden it is stated that "The purpose of the law is to ensure a high level of animal welfare and promote animal well-being and the respect for animals". All of the legislation that is brought up has only one aim, to protect animals from unnecessary suffering and sickness.

According to 5§ Swedish Board of Agriculture's regulations on public control in the field of animal welfare (SJVFS 2022:13), it is the county administrative board which have been given the commission, by the government, to perform inspections

to secure the practical compliance of animal welfare legislation. The inspections are carried out with different intervals for each farm, depending on the risk assessment. There is a goal for all county administrative boards in Sweden regarding inspection, which strives for a minimum of 10% out of all farms with production animals every year should have a routine inspection (Jordbruksverket 2022c). Each year, the county administrative board carry out a risk assessment for producers within the county. 13§ Swedish Board of Agriculture's regulations on public control in the field of animal welfare (SJVFS 2022:13) defines aspects included in this assessment which are:

- Number of animals.
- Type of animals.
- Previous inspection results.
- Incoming information regarding insufficient compliance on farm and possible animal experiments.

4.1.1 Animal housing, management, and handling

A report from 2004 identified four different housing systems which are common for beef production in Sweden (Johnsson et al. 2004). They are stable with cubicles, stable with loose straw bedding, open windshield with bedding and outdoor access and outdoor housing with access to shelter under roof. The authors concluded that all systems have both advantages and disadvantages from a welfare perspective. It is more difficult to manage calving periods in production systems with cubicles since the dam needs to be moved to the calving area in time. The systems with outdoor housing and access to shelter under roof requires an appropriate climate, ground condition and a dense forest which provides natural protection from wind (Johnsson et al. 2004). However, the systems with outdoor housing and access to windshield or shelter under roof can be beneficial for the well-being of the animals. In Sweden, both heat- and cold stress can be a problem. Different housing systems have higher or lower risk of animals suffering from difficulties in thermoregulation. Cattle housed outdoors with access to shelter need to be provided with a dry and clean bedding, it is also recommended to have the calving period in the warmer season (Johnsson et al. 2004). Furthermore, the report highlights the importance of staff with competence.

Although improved animal welfare can be beneficial for the efficiency in beef production, it can also be costly for producers to fulfil these improvements (Ahmed et al. 2020). The study conducted in Sweden by Ahmed et al. (2020) concluded that an increase in space allowance decreases the profitability of beef production. The authors of the study did a follow-up where they investigated economic consequences of improving animal welfare in cow-calf operations (Ahmed et al.

2021). The results were similar to the first study, increased space allowance for calves does also have a negative impact on the profitability for cow-calf operations. However, the authors highlight the importance of further studies which take indirect consequences of improved welfare into consideration. They propose aspects regarding improved health and higher efficiency among the production animals as a possible outcome. To comprehensively understand the economic consequences of improving animal welfare in beef production it is important to include the indirect aspects as well.

Another following study by Ahmed et al. (2023) investigated economic consequences of efforts made on farm animal welfare in Swedish beef production. The same study took aspects such as husbandry and health management into account, comparing with the economic outcomes to get a conclusion if the farm animal welfare efforts are beneficial for the profitability. It was concluded that the farm animal welfare efforts do not entail any increased income for the farms. Although the authors highlighted the importance of indirect aspects in this study as well.

According to 9§ Swedish Board of Agriculture regulations and general advice regarding cattle husbandry (SJVFS 2019:18), the individual space allowance for housing with fully slatted flooring is:

- 1.9 m^2 for juveniles weighing 400 kg max;
- 2.3 m^2 for 600 kg max;
- 2.6 m^2 for 600 kg and above

For loose housing which is not fully slatted the space allowance is:

- 4.8 m^2 for suckler cows,
- 3.7 m^2 for juveniles weighing 400 kg max;
- 4.4 m^2 for 600 kg max;
- 4.8 m^2 for 600 kg and above

It is also stated by 16§ Swedish Board of Agriculture regulations and general advice regarding cattle husbandry (SJVFS 2019:18) that all cattle must be held in loose housing systems. According to 13§ Swedish Board of Agriculture regulations and general advice regarding cattle husbandry (SJVFS 2019:18), Calves older than eight weeks of age must be held in groups.

Regarding the allowed flooring for Swedish beef production 16§ Swedish Board of Agriculture regulations and general advice regarding cattle husbandry (SJVFS

2019:18) states that fully slatted floors are only allowed in thermally insulated stables for:

- Calves >one month, juveniles and adult male cattle, if there is rubber flooring or other yielding material. Other, solid material is only allowed for calves >four months, juveniles and adult male cattle in stables that were built before June 30, 2010.
- Exception for juveniles and adult male cattle – where slatted floor in any material combined with solid floor is allowed.
- Exception for juveniles and adult cattle – where slatted rubber floor combined with solid rubber floor is allowed.

Even though there are far more beef farms than dairy farms in Sweden, 60% of the consumed beef originates from the dairy production (Jordbruksverket 2022d). If everything goes right, all dairy cows will eventually be slaughtered and become a part of the beef market. The bull calves and some heifers of dairy production are either raised on the farm or sold to a beef producer, only a small proportion are sold to breeding companies (Eriksson et al. 2020). The purebred dairy cattle which are raised for beef production do not have the same prerequisites as beef cattle (Eriksson et al. 2020). Growth and carcass weight is significantly lower for purebred dairy cattle which leads to decreased profitability (Eriksson et al. 2020).

Except for the economic aspect it may also be more difficult to fulfil the welfare aspect for purebred dairy cattle in beef production, due to the regulations regarding transportation (Hessle & Jamiesson 2020). According to 20 § Swedish Board of Agriculture's regulations and general advice regarding transportation of live animals (SJVFS 2019:7) it is accepted to transport calves from two weeks of age. It is also stated in 21§ Swedish Board of Agriculture's regulations and general advice regarding transportation of live animals (SJVFS 2019:7) that cattle should not be transported within 28 days before calving and 21 days after calving.

The allowed transportation time for cattle in Sweden according to 13§ Swedish Board of Agriculture's regulations and general advice regarding transportation of live animals (SJVFS 2019:7) is eight hours maximum for animals transported to the slaughterhouse.

4.1.2 Access to pasture

Sweden has great conditions for pasture-based animal production and the pastures are important resources for beef producers due to the high economic value (Jamieson & Hessle 2021). The same authors investigated challenges and opportunities for semi-natural pasture grazing in Sweden, and the overall

conclusion was that producers need higher profitability to be able to implement management methods of grassland utilization. The authors also reported that grazing can present challenges for the animal welfare because of parasites on the pastures and complication of nutritional management as well as the supervision of animals. According to Högberg et al. (2019) gastrointestinal nematodes, which is a common issue regarding parasites on pastures, reduces growth and has an impact on behaviour and activity in cattle. However, the opportunities of pasture access are substantial for the welfare of ruminants (Jamieson & Hessle 2021). Further, the study highlighted aspects such as natural behaviour and also an additional value for the final product.

In Sweden it is mandatory by law for all cattle except bulls and calves to have pasture access during parts of the grazing period (SJVFS 2019:18). The exception for bulls' results in a share of 25.9% of all cattle in Sweden which do not have pasture access during their lifetime (Hessle et al. 2021). According to Chapter 6. Swedish Board of Agriculture regulations and general advice regarding cattle husbandry (SJVFS 2019:18), the length of the grazing period depends on climate zone of the country. For example, the required number of days on pasture is ranging from 30 in northern Sweden to 120 in the south. Depending on the weather in the southern parts of Sweden, the grazing period can start from April 1 and last until October 31.

4.1.3 Anaesthesia during surgical interventions

Sweden has a detailed animal welfare legislation which regulates and prevents surgical interventions without pain management. A survey was conducted to investigate the existing opinions of Scandinavian cattle veterinarians concerning use of pain relief (Thomsen et al. 2010). The results showed that Scandinavian cattle veterinarians have a positive attitude against use of pain relief for surgical interventions.

A common practice in Sweden is dehorning of calves, it is implemented both for the safety of animals and handlers. The method for dehorning young calves which have started developing horns is burning with a hot iron. Local anaesthesia, anti-inflammatory and sedation are methods included in the pain management. The first mentioned is obligatory according to 4 Chapter. 2§ Animal Welfare Act (SFS 2018:1192) of Sweden, while the two other additional methods are commonly used at farms in Sweden. There is an exception for an alternative method for dehorning of adult cattle which developed horns at a later stage, then amputation is used.

For castration, the allowed methods in Sweden are surgical and anaesthesia must be administered according to 4 Chapter. 2§ Animal Welfare Act (SFS 2018:1192).

4.1.4 Use of antibiotics

According to the European Medicines Agency (2022), Sweden has been the leading country of all EU members since the reports started regarding use of antibiotics in animal production. In Sweden it is forbidden by 5§ Swedish Board of Agriculture's regulations and general guidelines on veterinarians' prescriptions of medicines, animal keepers' registration of information and surgical interventions that animal keepers may perform (SJVFS 2023:21), to use antibiotics for anything other than veterinary medical reasons, and if the veterinarian assesses that the treatment will have sufficient effect. In many other countries, antibiotics are used for stimulating growth in animals and as a preventative against disease (European Medicines Agency 2022). The preventative use of antibiotics has been banned in Sweden since 1986, this decision made Sweden the first country in the world restricting the use of antibiotics (Wierup et al. 2021). Within EU a similar legislation regarding use of antibiotics took place in 2006, many countries outside EU still do not have any regulations about the topic (Wierup et al. 2021).

Björkman et al. (2021) conducted a qualitative study in Sweden where different stakeholders connected to animal production were interviewed. The same study investigated methods for retaining a restrictive use of antibiotics, it was focused on poultry but also included an overall perspective of the animal production as a whole. According to the study by Björkman et al. (2021), veterinarians along with farmers seem to agree about the importance of health management in animal productions to limit further antimicrobial resistance. Furthermore, the study also concluded that biosecurity, daily routines as well as prevention and early detection of infection are crucial factors for containing healthy animals. It is also highlighted that due to the extensive health management, Sweden cannot compete economically on the international food market (Björkman et al. 2021).

Restricted use of antibiotics requires improved health management, which means that healthy animals will not need the antibiotics. Health and animal welfare are closely related, since the wellbeing of animals is based on their physical condition. Since the banning of antibiotics for growth promotion the year of 1986, Sweden has been a role model for health management in animal production (Grundin et al. 2020). The extensive work with health management has led to eradication of many severe diseases like bovine viral diarrhoea (BVD), which still is a problem for other countries (Grundin et al. 2020).

According to the Swedish Government (2020), Sweden has a detailed strategy regarding the combating of antibiotic resistance. The strategy includes seven different objectives:

- Increased knowledge through enhanced surveillance
- Continued strong preventive measures
- Responsible use of antibiotics
- Increased knowledge for preventing and managing bacterial infections and antibiotic resistance with new methods
- Improved awareness and understanding in society of antibiotic resistance and counter measures
- Supporting structures and systems
- Leadership within the EU and international cooperation

It is stated by the Swedish Government (2020) that; "The need for antibiotics in animals is reduced through efficient disease control, good farm management, biosecurity and sound animal husbandry." This statement goes in line with former reviewed publications in Sweden regarding antimicrobial resistance. Most of the antibiotics used in Sweden are received individually for production animals, treatment on group level has decreased drastically over the past years (Swedish Government 2020).

The World Health Organization (WHO) stands behind the concept One Health, which describes the relation of health between humans, animals, plants and the environment (WHO 2024). According to WHO (2024), One Health has an important role in combating antimicrobial resistance.

4.2 Welfare certification in Sweden

4.2.1 KRAV

The Swedish certification KRAV is a complement to the Animal Welfare Act of Sweden, which includes even more detailed regulations regarding animal welfare (KRAV 2024a). "KRAV" is simply translated to "Demand", which is a short summary of what the certification stands for. Except exceeding the Swedish laws of animal welfare, KRAV also requires higher standards than the EU Organic certification (KRAV 2024a). The vision of the certification is, among other things, to strive for animal production systems which enables natural behaviours and thus, improves the welfare of production animals.

Except animal welfare, KRAV also demands high standards in reducing environmental impact, increasing biodiversity, improved working conditions and sustainable agriculture (KRAV 2023a).

KRAV hires independent certification companies for performing inspections on certified producers (KRAV 2023b). The inspections can take place with or without prior notice, at least once a year. For animal production, there are more unannounced inspections and 30% of all certified animal productions shall have an extra inspection every year (KRAV 2023b). If the inspector notices abbreviations, the producer must correct and come up with a plan to prevent it from happening again (KRAV 2023b). KRAV implies three stages of abbreviations, slight, major and suspension (KRAV 2023b).

KRAV has regulations regarding transportation. The animals must be held in the same groupings before transportation, thus it lowers the stress response and improves the welfare (KRAV 2024b). Furthermore, most certificates come with more requirements of documentation and KRAV is no exception. For example, all certified beef producers must have a documented strategy of health management for preventing health issues in the animals (KRAV 2024c). It is also required, according to KRAV (2024c), to document the period of outdoor- and pasture access.

In addition, the regulations regarding pasture access are extended for KRAV-certified beef producers (KRAV 2024d). All cattle older than six months are required access to pasture the majority of the day during grazing season (KRAV 2024d). Calves must have outdoor access during grazing season from four months of age (KRAV 2024d). According to KRAV (2024d) the calves need a shelter in the pen and the outdoor access is only required for part of the day. Additionally, it is demanded for adult cattle to have outdoor access, with no requirement for grazing on pasture, for part of the day during two months before grazing season in spring, and two months after grazing season in the autumn.

According to KRAV, castration on bull calves is only allowed within eight weeks of age (KRAV 2024e). The certification also demands use of local anaesthesia and anti-inflammatory and recommends sedation, to reduce the pain response in the calves.

Regarding dehorning, the certification demands that the procedure is performed with a hot iron on calves before eight weeks of age (KRAV 2024e). Exceptions can only be made if a calf is developing horns later or, for adult cattle, due to safety for both animals and handlers (KRAV 2024e). The regulation regarding pain

management is the same as for castration, it is a requirement to use both local anaesthesia and anti-inflammatory during the dehorning procedure (KRAV 2024e).

4.2.2 Svenskt Sigill and IP Nöt & Mjölk Grundcertifiering

Svenskt Sigill is a Swedish certification which includes many different aspects of food production (Svenskt Sigill 2023a). It covers aspects like animal welfare, biodiversity and environmental impact. Svenskt Sigill only certifies Swedish products which are farmed, born, raised, produced, slaughtered, processed, and packaged in Sweden (Svenskt Sigill 2023b). In other words, the whole production chain needs to take place in Sweden. The certification has created three optional add-on certifications, which include climate, beef from semi-natural pastures and working conditions. The optional add-ons are additional to the basic certification, which means that the requirements are extended for specific aspects (Svenskt Sigill 2023a).

The inspections are carried out on farm by an independent auditor every other year and in addition, certified producers compile their production by themselves every other year which is also verified by the auditor (Svenskt Sigill 2023c). Serious abbreviations lead to suspension from the certification, slight abbreviations will require correction by the producer within 28 days and follow up by the auditor (Svenskt Sigill 2023c).

The certification Svenskt Sigill addresses requirements beyond the Animal Welfare Act of Sweden, including prohibition of fully slatted flooring (Svenskt Sigill 2023d). Another beneficial prerequisite regarding animal welfare for cattle is the demand for grooming brushes (Svenskt Sigill 2023d).

According to the additional Sigill certification “Beef from semi-natural pastures”, the majority of pasture used for cattle grazing must be defined as semi-natural pasture and the grazing season needs to be documented (Sigill 2022).

The Sigill Quality System also has a basic certification which is based on the Swedish Animal Welfare Act, it is called IP *Nöt & Mjölk Grundcertifiering* which is translated to IP Beef & Dairy basic certification (Sigill 2020). This certification ensures that producers are inspected every other year, in addition to the standards of animal welfare inspections by the county board (Sigill 2020).

4.3 Welfare legislation and certifications of major beef-exporting countries

4.3.1 Ireland

The Animal Health and Welfare Act (2013) of Ireland contains general guidelines for the welfare and protection of animals. Animals should be treated with respect, and the housing must be adequate to avoid discomfort and injury. If it is found that a producer is not following the rules of the Animal Health and Welfare Act (2013), depending on the severity, they will firstly be obliged to comply and could also be forced to pay the penalty. Producers who do not comply with the rules after this, or if it is a severe case, could get banned from handling animals.

Bord Bia – Irish Food Board

The Irish Food Board has created certifications for food safety, which is implemented all around Ireland for around 95% of the beef producers (Bord Bia 2017). The Bord Bia certifications cover all aspects of the food chain, and there is a specific certificate for each producer category. For beef producers, the certification Sustainable Beef and Lamb Assurance Scheme (SBLAS) is implemented. The certification is based on the legislation of the EU but extended in some aspects.

SBLAS inspections are carried out with maximum intervals of 18 months (Bord Bia 2017). It is independent auditors who perform the farm inspections, to ensure a high level of reliability (Bord Bia 2017). If the auditor assesses that a producer is not following specific rules according to the SBLAS, then they are required to correct the deficiencies in management and follow up with the auditor (Bord Bia 2017). Severe non-compliance findings will lead to suspension from the certification.

According to SBLAS, the recommended space allowance for cattle weighing up to 600 kg is 2.2 m^2 when housed in fully slatted sheds. It's important to note that the scheme does not prescribe specific housing systems or flooring, but it does emphasize that the housing system should be designed to prevent injury and contamination of animals.

For transportation duration, there is no limitation that exceeds the EU legislation of eight hours (Council of the European Union 2005), but according to the interviews, this is not an issue in Ireland since the cattle transportation distances are usually short due to the small area of the country.

It is a common practice in Ireland to feed cattle almost exclusively with forage (Bord Bia 2017). SBLAS demands grass-based diets for all cattle, which means that more than 50% of the diet must be forage (Bord Bia 2017). Pasture access is not addressed as a demand for SBLAS but the culture of Irish beef production often includes grazing animals.

According to SBLAS, calves over eight weeks of age must not be housed individually, and before that they are required direct contact with other calves (Bord Bia 2017). Castration is only justified after considering demands of the current market (Bord Bia 2017). The use of burdizzo clamp is a method for castration which stops the blood flow to the testicles which are either reabsorbed by the body or surgically removed (Stafford & Mellor 2005a), this method should only be used before six months of age (Bord Bia 2017). Rubber ring is a method where the blood flow is stopped, resulting in necrosis where the testicles fall off (Stafford & Mellor 2005a), this is only allowed for SBLAS certified calves younger than one week. Pain management for castration is only a recommendation and no requirement for the certification (Bord Bia 2017).

Animal caretakers are allowed to perform dehorning of calves using a hot iron before four weeks of age, animals above that age must be dehorned by a veterinarian (Bord Bia 2017). Local anaesthetic is required for calves older than two weeks and animals older than four weeks are required pain relief such as anaesthesia and analgesia (Bord Bia 2017).

All beef producers certified with SBLAS must conduct an animal health plan to prevent disease and improve animal health and welfare, this is checked during inspection (Bord Bia 2017).

Regarding the use of antibiotics for production animals in Ireland, it is not allowed for routine use (Department of Agriculture, Food and the Marine 2022). The antibiotics has to be prescribed from a veterinarian and use as growth promotors is prohibited.

4.3.2 Germany

The animal welfare legislation for beef production in Germany is structured with an Animal Welfare Act and the Animal Welfare Farm Animal Husbandry Ordinance. In the ordinance there are regulations regarding husbandry for calves younger than six months but there does not seem to exist other specific regulations for cattle older than that.

2§ of the Animal Welfare Act (2006) of Germany states the basic principles of animal husbandry, including caring, locomotion and experience in handlers. According to 5§ of the Animal Welfare Act (2006) of Germany, there is no requirement of pain management for dehorning calves under six weeks of age and for castrating calves under four weeks of age, older calves are required local anaesthesia for the intervention.

The Animal Welfare Ordinance of Germany contains some more specific information of the basic principle in the Animal Welfare Act, further it contains regulations for calves. 5§ of the Animal Welfare Ordinance states that calves should not be tied up, further 9§ declares that calves older than eight weeks must be held in groups.

Germany does not seem to have any legislation regarding pasture access for cattle, approximately one out of three cattle have outdoor access during the grazing season (Federal Ministry of Food and Agriculture 2023). Further, in the southern part of the country, it is common with permanently restrained animals. The allowed time of transporting animals to slaughterhouses is the same as for the EU legislation, which is eight hours (Council of the European Union 2005).

Regarding the use of antibiotics in animal production, it is prohibited to use it as growth promotors (Federal Ministry of Food and Agriculture 2010). Germany's overall strategy for decreasing the antimicrobial resistance is presented by the Federal Ministry of Food and Agriculture (2010) and includes improved management, stricter legislation, and research about alternative methods.

QS – Quality Scheme for Food

In Germany, the largest operator for certifications regarding food safety is the QS quality scheme, covering around 85% of all beef producers in Germany (QS 2024a). The certification provides standards from producer to supermarket and was created in 2001. All producers certified by QS are inspected regularly by independent auditors (QS 2024a). The intervals of the inspections are based on assessment of risk, producers who perform well at inspections have lower risk than producers with insufficient compliance (QS 2024a). According to QS (2024a), all inspectors are evaluated to ensure reliable and equal food safety inspections. The inspectors must also take courses in order to remain updated regarding food safety aspects addressed during the inspections.

The QS has compiled requirements which are extended over the legislation, among the topics is animal welfare aspects listed (QS 2023). Producers certified by QS

must accept monitoring for use of antibiotics (QS 2023). Space allowance is specified for cattle weighing more than 400 kg, the minimum is 2.2 m^2 for each animal (QS 2023). There are no requirements for specific housing systems or flooring, but there are general requirements which states that the housing system should be designed to prevent injury and contamination of animals. At slaughter level, data such as respiratory health, organ health and joint health is recorded in a diagnostic database (QS 2023).

Calves should not be tied up and if they are housed separately, direct contact with other calves is a requirement (QS 2024b). Anaesthesia is not required for dehorning of calves younger than six weeks of age, if sedation is provided (QS 2024b). However, anti-inflammatory drugs should be used for pain relief after the intervention. The certification counteracts transportation of newly born calves, and it is forbidden to transport cattle who have gone through at least 90% of pregnancy or if the calving took place closer in time than seven days (QS 2024b). According to the certificate, calves younger than four weeks should not be transported within Germany.

4.3.3 Brazil

The general legislation of Brazil prohibits actions of cruelty against animals. The Normative Instruction NO. 56 (2008) of the Brazilian Ministry of Agriculture and Livestock includes production animals. It states that producers need to have the appropriate competence for their production system, in order to fulfil the animal welfare requirements. Appropriate husbandry management which enables rest and protection for the animals are also included in the legislation. Most of the information concerning welfare of livestock animals, is addressed as recommendation rather than regulations and some points are highlighted below.

The Coordination of Good Agricultural Practices (CBPA) has the commission to encourage and educate producers about sustainable production to improve the animal welfare (Brazilian Ministry of Agriculture and Livestock 2024a). For cattle, the CBPA aims to support and train producers to improve production practices and sustainability (Brazilian Ministry of Agriculture and Livestock 2024b). This includes aspects such as husbandry management and reducing fear and injuries in production animals.

According to the Brazilian Ministry of Agriculture and Livestock (2022) it is the producers' responsibility to create an adequate well-being condition and allow the production animals to express their natural behaviours. The CBPA manual also mentions the five freedoms as basic principles for the animal welfare;

- Ensure conditions that prevent hunger, thirst and malnutrition;
- Ensure conditions that avoid fear and anguish;
- Ensure conditions that avoid physical and thermal discomfort;
- Ensure conditions that prevent pain, injuries and diseases;
- Ensuring conditions that allow for normal expressions of behaviour

Additionally, the Brazilian Ministry of Agriculture and Livestock mentions the importance of following recommendations from the World Animal Health Organisation except national legislation.

Regarding transportation, the Normative Instruction NO. 56 (2008) from the Brazilian Ministry of Agriculture and Livestock states that it should not cause the animals any unnecessary harm or stress. Further rules on transportation of production animals are presented by the Ministry of Infrastructure/National Traffic Council in Resolution NO. 791 (2020), but there does not seem to be any restrictions regarding duration of transportation. In the CBPA, which is a recommendation manual for good practices, it is recommended not to transport animals for more than 12 hours, and if so, they are required a break including unloading of transport for 18 hours (Brazilian Ministry of Agriculture and Livestock 2013). In the Ordinance NO. 365 (2021) issued by the Ministry of Agriculture and Livestock, it is stated that the period of fasting when transported to the slaughterhouse should not exceed 24 hour. The recommendations according to the manual for transporting of pregnant cattle is to avoid it within the last trimester and a week after calving. It is also not recommended to transport newborn calves with unhealed wounds from the umbilical cord (Brazilian Ministry of Agriculture and Livestock 2013).

In Brazil, different procedures are used for dehorning animals. The hot iron method is most commonly used but is only recommended for calves up to two months. Sedation is recommended but not mandatory for that method. For cattle older than two months, surgical dehorning is usually recommended, and by law, it is mandatory to be conducted by a veterinarian and with the use of local anaesthesia (Federal Council of Veterinary Medicine 2008). There are similar regulations for castration, where non-invasive methods for castration (e.g. burdizzo) does not demand anaesthesia, however, for any surgical intervention it is mandatory to use local anaesthesia.

Regarding space allowance, cattle should have an adequate living area which enables natural living (Brazilian Ministry of Agriculture and Livestock 2022). Further, antibiotics are prohibited as growth promotor in production animals (Brazilian Ministry of Agriculture and Livestock 1998).

Certified Humane Raised and Handled – Humane Farm Animal Care

In Brazil, some beef producers have qualified for the certification Certified Humane Raised and Handled which was raised by the organisation Humane Farm Animal Care (HFAC) in America. Every year, 10% of the certified producers get inspected by the HFAC (Humane Farm Animal Care 2020). If non-compliance is found at inspection of a beef producer, they have 30 days to correct it before getting suspended from the certification.

Cattle should be housed in such environment that they can move freely and rest without becoming overly contaminated (Humane Farm Animal Care 2023). The minimum space allowance for cattle weighing up to 545 kg housed in stables with fully slatted floor is 2.3 m^2 (Humane Farm Animal Care 2023).

The limit for transporting duration of cattle is eight hours (Humane Farm Animal Care 2023).

There is an additional marking of the certification, which is Grass-Fed System (Humane Farm Animal Care 2023). For the producers to be grass-fed qualified, the cattle need to be feed exclusively with grass and forage. They also need to have regular access to pasture (Humane Farm Animal Care 2023).

5. Discussion

The literature review within this thesis served as the foundation for understanding the current practices, challenges, and policy frameworks regarding beef-production in Sweden and major beef-exporting countries for Sweden. Each topic investigated is then discussed in this section. In Table 2 there is a legislation/recommendation comparison of the main aspects investigated, concerning welfare for beef cattle among the countries.

5.1 Animal housing, management and handling

The production systems with fully slatted flooring are common for finishing beef cattle internationally (Wechsler 2011). In Sweden, the legislation counteracts the use of concreted slats. Ireland, Germany and Brazil do not seem to have any legislation about housing or flooring, other than that it should not cause injury or more than reasonable contamination. Graunke et al. (2011) found that housing systems with fully slatted floors could benefit from using rubber flooring instead of concreted slats. The results of the study showed that rubber flooring has positive effects on animal behaviour as well as claw- and leg disorders. Thus, the welfare of beef cattle could be improved by using rubber- instead of concrete flooring in fully slatted systems. Another study showed that rubber flooring could improve the lying behaviour and thus also the animal welfare of beef cattle housed in fully slatted floor systems, but it cannot be compared to the improvement given by an additional straw bedding (Gygax et al. 2007).

In a study conducted with adult cattle, the animals could choose between different flooring, it was clear that they prefer straw bedding over slatted floors but the rubber slats also presented a higher grade than the concrete slats (Lowe et al. 2001).

The countries requirements regarding space allowance in the legislation and implemented certifications are similar (Table 2). The difference is that Sweden has applied those requirements in the national legislation, while the other countries only have such requirements as recommendation or as a demand in their certifications, which does not apply for all producers of the countries.

Table 2. Comparison of aspects in included countries.

Legislation/recommendation	Sweden	Germany	Ireland	Brazil
Space allowance[1]	2.3 m^2	2.2 m^2	2.2 m^2	2.3 m^2
Pasture access	Yes	No	Yes	No
Dehorning anaesthesia	Yes	No	No	No
Castration anaesthesia	Yes	No	No	No
Transporting age	2 weeks	4 weeks	2 weeks	-
Transporting time	8 hours	8 hours	8 hours	12 hours
Antibiotics[2] mg/PCU[3]	10.6	69.9	33.6	-

[1]For animals housed on fully slatted flooring, weighing 400-600kg. [2]European Medicines Agency (2022). [3]Population Correction Unit, includes animal population and average weight of animals at treatment (Radke 2017).

A study examined how different housing systems could impact tail tip alterations, concluding that space allowance and flooring systems are significant factors influencing the issue (Schrader et al., 2001). The study investigated three systems: slatted floor, slatted floor with tail docking, and straw bedding. Results revealed that the slatted floor system had the highest occurrence of tail tip alterations, followed by the slatted floor system with tail docking and straw bedding. Moreover, reduced space allowance correlated with increased tail tip alterations. This highlights the importance of incorporating space allowance and flooring considerations into national legislation to improve the health and welfare of cattle.

The legislation regarding transportation duration is similar for the EU countries, 8 hours maximum for transporting cattle to the slaughterhouse. For Brazil, the recommendations are that cattle should not be transported for longer than 12 hours. The transportation of production animals can be a stressful moment which in those cases impairs the animal welfare. This means that legislation which regulates transportation time could be an important factor to decrease stress and improve animal welfare. According to the interviews with Axfood's beef suppliers in Ireland, transportation time is no problem in Ireland due to the short distances between farms and slaughterhouses. These prerequisites are based on the relatively small area of the country.

The national legislation concerning age of calves for transportation varied somewhat among the countries investigated. Brazil, however, appears to lack such regulations, at least based on the available online documents, except for newborn calves with unhealed umbilical cords. In Sweden and Ireland, calves can be transported 14 days after birth, the exception was Germany's certification QS, which has extended the transportation age for calves transported within the country to 28 days. In this early stage of life, the calves are sensitive to extensive changes

in environment (Roadknight et al. 2021). The transportation and new environment cause stress which also makes them more susceptible to diseases (Roadknight et al. 2021). Diseases in the early stage of life can have major consequences for the rest of the calves life, for example reduced growth and impaired immune system (Roadknight et al. 2021), impacting animal welfare and production profitability.

Based on these findings, it seems that farmers who buy calves from dairy production with the aim of raising them for slaughter must take the differences of the breed into consideration. It is very important that the producer knows about the prerequisites for raising purebred dairy cattle for beef production since they do not have the same growth capacity as beef breeds. Further, it is often the calves originating from dairy farms which are transported and moved to another farm early in life. For the calves, it is beneficial to minimize the change in environmental aspects. This can be challenging since it is almost impossible to mimic the farm where the calves were born, especially since beef producers can buy calves from different farms. For calves born in an indoor environment, protected from harsh weather and low temperatures, it could be an advantage to give those a transition period if the intention is to raise them in an outdoor based system. Otherwise, the quick transition can be very challenging for the calves and cause diseases. The transition period could be managed through arranging a space with bedding and temperate climate for the new calves, where they have time to adjust.

5.2 Pasture access

The legislation for the countries investigated differs a lot regarding pasture access. In Sweden, all cattle except bulls and calves are required pasture access, but it may not be as extensive as the pasture access of Irish beef cattle due to the weather and climate prerequisites. No legislation in Ireland demands pasture access for cattle. However, according to the interviewees from Ireland, the beef producers are eager to let the animals out whenever the weather allows it, which can be eight to nine months of the year. Pasture access and grazing are prevalent practices in Irish beef production.

It was not possible to find any regulation or legislation concerning pasture access in Germany and Brazil among the documents accessed. However, the certification Certified Humane – Raised and Handled, used to some extent in Brazil, does have an additional and optional label to their certification: the Grass-Fed certificate, which includes grass-based diets and pasture access.

According to Manning et al. (2017), the availability of pasture significantly influences cattle behaviour and their daily time-budget, particularly grazing, which

is crucial for their welfare in beef production. Pasture-based beef production systems also contribute to landscape preservation and biodiversity (Bragaglio et al. 2018). Although pasture-based systems require more land than feedlots and indoor housing systems, it is mostly non-arable land which is used in the former mentioned (Wiedemann et al. 2015). An American study showed that grazing management of ruminants have the ability of reducing greenhouse gas emissions and increasing the sequestration of carbon and soil quality (Teague et al. 2016). This shows that access to pasture is not only beneficial for the welfare of beef cattle, but also have a positive effect on the environment.

5.3 Anaesthesia during surgical interventions

The use of anaesthesia during surgical interventions varies drastically between the investigated countries. In Sweden, it is mandatory to administrate pain management for both dehorning and castration, as observed in Table 2. Further, in Irish legislation, some specifications prohibit dehorning without anaesthesia. However, the requirements are based on age, where calves under two weeks do not need any anaesthesia for dehorning. This age limit could be based on traditional management standards, where it is thought that the younger the calves are at the intervention, the less suffering is caused (Marquette et al. 2023). The economic aspect could also be another factor in dehorning without anaesthesia before two weeks of age. For castration, there is no demand for anaesthesia in Ireland. Germany also implies an age limit for both pain management at dehorning and castration. However, the range is higher in the ages than in Ireland, where the requirements for anaesthesia for dehorning are higher. In Brazil, there is no demand for using anaesthesia for dehorning or castrating calves except for surgical methods. Surgical procedures are mainly regulated by the federal council of veterinary medicine in Brazil since surgeries are legally performed only by veterinarians. Therefore, the information in this regard seems limited at the ministry of agriculture and livestock website and online documents.

The methods for castration and dehorning of calves differ internationally. In Sweden and Ireland, the allowed method for dehorning young calves is hot iron; the same method is recommended in Brazil. It was not possible to find any regulations where Germany specifies the method for dehorning calves. For castration, the surgical method is used exclusively in Sweden. In Ireland, castration could be performed using several methods such as rubber ring and burdizzo clamp. As for dehorning, Germany does not seem to specify allowed methods used for castration, and the same is true for Brazil.

Consumers' thoughts regarding animal welfare aspect on anaesthesia during surgical interventions has been studied in South America by Teixeira et al. (2018). The study concluded that most consumers are opposed to surgical interventions without anaesthesia.

Stafford & Mellor (2005a) reviewed research on castration of beef cattle. According to the review, evidence shows that surgical castration causes more pain compared to other methods, but the wound from the castration heals quicker than when using a rubber ring or burdizzo. The results suggest that surgical castration is more painful during the procedure and in the days following, while the rubber ring and burdizzo are more painful in the long term. A problem with the burdizzo clamp seems to be the potential failure of castration, which can lead to unwanted breeding and a need for a second intervention. Furthermore, the review concludes that for older cattle, the most humane method for castration is surgery under local anaesthetic and additional ketoprofen, which is analgesic and antipyretic. However, another study by Earley & Crowe (2002) concluded that for surgical castration, the use of ketoprofen resulted in a lower cortisol response than local anaesthesia, suggesting that systemic analgesia is preferable.

Rubber ring is often used for castrating younger calves and according to researchers it is most likely causing a severe amount of pain if no anaesthetic is used to prevent the pain (Stafford & Mellor 2005a). Many of the studies included in the review used cortisol as one of the main indicators of stress level in the animals (Stafford & Mellor 2005a). A study found that time of castration affects the growth of steers, implementation of early castration resulted in higher growth rate than for those later castrated (Knight et al. 2000).

Regarding dehorning it is a surgical intervention which is common in beef- and dairy production (Stafford et al. 2021). Dehorning means removing newly developed horn buds on calves or developed horns on adult cattle. The intervention on calves is usually performed with a hot iron, burning the horn buds, and preventing them from growing into a horn. Dairy bull calves are often disbudded on the farm, before moving to the beef producer. Most producers with intensive systems prefer to have dehorned cattle because of the security for both animals and the keepers (Stafford et al. 2021). Dehorning adult cattle can be done with a saw.

When comparing hot iron dehorning of calves with amputation dehorning of older cattle, there is evidence that the former is less painful in calves (Stafford & Mellor 2005b). The pain management for dehorning is dependent on use of different analgesia, where sedatives, local anaesthesia and anti-inflammatory drugs plays an important role (Stafford & Mellor 2005b).

Additionally, another study found that dehorning has an effect on the cortisol level for calves at the age of 10-12 weeks (Doherty et al. 2007). The same study tested if local anaesthetic could reduce the stress response for calves at the time of dehorning. It was concluded that the local anaesthetic could reduce the calves' pain and stress during the intervention, but since the behavioural response did not differ among the treatments, it has no effect on the recovering period after dehorning (Doherty et al. 2007).

Faulkner & Weary (2000) investigated whether an anti-inflammatory drug could reduce the pain in calves after dehorning with a hot iron at five to eight weeks of age. The calves in the control and treatment groups were given a sedative and local anaesthetic. During the behavioural study of calves after being dehorned and receiving the anti-inflammatory drug, behaviours like head shaking and ear flicking were observed (Faulkner & Weary 2000). The control group, which did not receive the anti-inflammatory drug, tended to perform more of these behaviours, and the conclusion was that this was a sign of reduced pain after the intervention in the treatment group (Faulkner & Weary 2000). Additionally, (Stilwell et al. 2012) also conducted a study to investigate the impact of different anaesthetics used for dehorning calves. Similar to the previously mentioned study, they concluded that anti-inflammatory drugs have an effect on pain during and after the intervention.

It seems for castration, the surgical method combined with pain management is the most preferable from an animal welfare perspective. Regarding dehorning, hot iron seems to be a common method for the intervention. The effective pain management for dehorning seems to be local anaesthetic, preferably combined with anti-inflammatory and sedative.

5.4 Use of antibiotics

The reports conducted by the European Medicines Agency (2022) shows that Sweden is the leading country in the EU regarding restrictive veterinary use of antibiotics in production animals with only 10.6 mg/PCU (Population Correction Unit). Out of the included countries in this thesis, Ireland comes on second place with 33.6 mg/PCU, followed by Germany with 69.9 mg/PCU.

According to a study by Mulchandani et al. (2023), Brazil is on the second place of countries in the world that use the largest amounts of antibiotics for production animals. There does not seem to exist any available measurement in mg/PCU for use of antibiotics in Brazil, which would be comparable to the measurement by the European Medicines Agency (2022).

The use of antibiotics is directly related to health and husbandry management. Sweden has been working with this for a very long time (Lundmark Hedman et al. 2021), and it pays off in reduced antibiotic use. All the countries involved claim that using antibiotics as growth promoters is forbidden. Sweden, Ireland, and Germany are all connected to the EU and have included antibiotic restrictions in their legislation.

Van Boeckel et al. (2017) concluded that implementing a user fee for antimicrobial medicine used for veterinary purposes could be a short-term solution for reducing the global use of antibiotics. However, the study's authors highlight the importance of simultaneous actions for improving the management of production animals.

6. Conclusion

This study concludes that, based on the information accessed, Swedish legislation is more restricted and presents more detailed animal welfare standards for beef production compared to the major beef-producing countries investigated in this thesis. However, investigated certifications may include aspects not covered by national legislation, thus improving the overall performance of these countries in animal welfare efforts for beef cattle. While the percentage of certified beef producers seems relatively high for Ireland and Germany, no such information could be found for Brazilian certification. All countries included, except Brazil, presented regulations regarding practical compliance and farm inspections in their national legislation. The fact that no such regulations could be found and accessed for Brazil is alarming, since the legislation is not worth much if the farms are not being inspected for compliance.

Although including more aspects in the study would have broadened its application and increased reliability, the study was limited by a specific time range. Therefore, it is important to mention that the conclusion in this thesis is based on the compiled material. To make information on welfare standards for countries importing beef to Sweden more accessible to consumers and interested parts, establishing a platform that compiles relevant information about beef production welfare could be beneficial. This platform could present and compare legislation as well as implemented certificates regarding the welfare of beef cattle for the importing countries.

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Popular science summary

The animal welfare of beef cattle is one of the most important factors in beef production. Animals with adequate welfare are healthier and perform better, which increases profitability in the long-term. This study aimed to compare welfare aspects within Swedish beef production with the major beef exporting countries, Ireland, Germany, and Brazil. By examining laws, certifications, and common practices such as animal handling, housing, access to pasture, anaesthesia during surgical interventions, and transportation, we gain a deeper understanding of the differences in beef production between the countries. For the study, several interviews were conducted with Axfood in Sweden and their beef suppliers in Ireland, in order to get an insight into some aspects of the beef market.

The interviews reveal that Sweden and Ireland have different systems for beef production, with grazing being crucial for Irish beef production. Interviews with Axfood in Sweden and their suppliers in Ireland provided insights into the challenges ahead for profitability in production.

Sweden has strict animal welfare legislation, while Ireland and Germany have more general laws but a high level of certification among beef producers. Brazil has basic welfare requirements but lacks specific regulations for most aspects focused on in the study. Sweden stands out with space allowance requirements, grazing requirements, and anaesthesia requirements for surgical interventions presented in the national legislation.

The study provides insights into differences and similarities between included countries' practices and regulations, which are important for improving animal welfare and to achieve a refined understanding of how different systems work within beef production.

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Appendix 1

Questions for the interview with Axfood in Sweden.

1. How much of the consumed beef is imported?
2. From which countries does the majority of the beef come from?
3. How much beef do we consume in Sweden?
4. Do you have any certification covering welfare aspects for beef production, and if so, must all beef imported to Sweden meet the certification requirements?
5. How much does the price differ between certified beef compared to beef without certification?
6. How is it ensured that suppliers meet the requirements included in the certifications? Is there a traceability that Axfood can access to verify that the products come from certified producers?
7. Does Axfood, as one of the largest actors on the Swedish food market, have a strategy to increase the consumption of beef produced in Sweden?
8. What are the prospects for Swedish beef producers? What challenges and opportunities do you see in developing sustainability and welfare behind the imported products?

Appendix 2

Questions for the interviews with Axfood's beef suppliers in Ireland.

1. How much beef is imported and exported?
2. From which countries does the majority of the imported beef come from?
3. How much beef is consumed in Ireland?
4. Do you have any certification covering welfare aspects in beef production?
5. Is there a difference in price between welfare certified beef and beef without certification?
6. How is surveillance conducted to ensure that suppliers meet the requirements included in the certifications? Is there a traceability which can be used to verify that the products come from certified suppliers?
7. How do you see the prospects for European beef producers in the future? Which challenges and opportunities do you see in developing sustainability and welfare behind imported products?
8. If you compare exporting beef to Sweden with other countries, do you think it is more or less complicated or bureaucratic? Does it involve more rules or administrative work?

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