On-farm slaughter and emergency slaughter in Sweden: Prerequisites for reducing food loss of pigs and cattle

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On-farm slaughter and emergency slaughter in Sweden: Prerequisites for reducing food loss of pigs and cattle

Nödslakt och slakt på jordbruksanläggning: Förutsättningar för att minska matförluster av nöt- och griskött

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Abstract

Although consumers are responsible for much food waste, recent studies have shown significant losses on farm-level. A recent report published by the Swedish Board of Agriculture presented that 3% and 8% of pigs and cattle are lost respectively, requesting further research regarding the potential in salvaging meat through on-farm slaughter (**OFS**) and on-farm emergency slaughter (**OFES**). Thus, the aim of this study was set to investigate the attitudes and interests of abattoirs and key industry actors to initiate or increase the use of OFS and OFES. A qualitative study was conducted by interviewing six abattoirs, one veterinary consultant, one meat industry trade group, the Swedish National Food Agency, and 11 game-handling establishments (**GHE**). The results showed overall concerns regarding economic and technical limitations of performing OFES and OFS, as well as limitations due to official veterinary controls. GHE was observed as having potential in a system of OFES or OFS, due to their current ability to receive carcasses of wild game. Future recommendations include investigating the potential of expanding the regulatory framework for official veterinary controls, to use OFS as a tool for non-acute injuries and to include GHE in a functioning system of OFS and OFES.

Keywords: Animal welfare, Cattle, Mortality, On-farm slaughter, On-farm emergency slaughter, Pigs

Sammanfattning

Trots att konsumenter är ansvariga för en stor del av det totala matsvinnet, har nya studier visat betydande livsmedelsförluster sker redan på gårdsnivå. En ny rapport från Jordbruksverket presenterar att 3 % respektive 8 % av allt nötdjur och grisar förloras på gårdsnivå, och rekommenderar att utreda potentialen att minska köttförluster genom slakt på jordbruksanläggning och nödslakt. På grund av detta syftade denna studie att utreda attityder och intressen hos slakterier och andra nyckelaktörer att påbörja, eller utöka, användandet av slakt på jordbruksanläggning och nödslakt. En kvalitativ studie genomfördes, där intervjuer gjordes med sex slakterier, en veterinärkonsult, Livsmedelsverket samt 11 vilthanteringsanläggningar. Resultatet vidare en övergripande oro gällande ekonomiska och tekniska möjligheter för slakt på jordbruksanläggning och nödslakt, samt begränsningar kopplat till de officiella veterinärkontrollerna. Vilthanteringsanläggningar ansågs som potentiella mottagare av djurkroppar genom slakt på jordbruksanläggning och nödslakt, tack vare sin nuvarande förmåga att ta emot djurkroppar av vilt. Förslag till framtida studier inkluderar att utreda potentialen av att utöka regelverket för officiella veterinärkontroller, att använda slakt på jordbruksanläggning som ett verktyg för icke-akuta skador samt att använda vilthanteringsanläggningar i ett fungerande system för slakt på jordbruksanläggning och nödslakt.

Nyckelord: Dödlighet, Djurvälfärd, Grisar, Nödslakt, Nötkreatur, Slakt på jordbruksanläggning

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Abbreviations and definitions

EU	European Union
OFES	On-farm emergency slaughter
OFS	On-farm slaughter
GHE	Game-handling establishment
SBA	Swedish Board of Agriculture
SFA	Swedish National Food Agency

1. Introduction

In this chapter, the problem background to food losses of meat on farm-level is presented. Then, the research gap on meat loss-reduction through on-farm emergency slaughter and on-farm slaughter is presented. Lastly, the aim and research questions are presented.

With one-third of all foods lost across the food supply chain (Gustavsson 2011), limiting food loss is an important factor across all three sustainability dimensions – economic, social and environmental. Food loss and food waste results in increased costs from producers to consumers, a reduced opportunity to feed people and is a waste of resources leading to unnecessary environmental impact. By decreasing the amount of food lost or wasted, there is potential to increase food security, decrease food prices or increase producer margins, and to either decrease the greenhouse gas emissions from the food sector or to increase production with retained levels of emissions. The need for food waste reduction throughout the food supply chain is also in line with the Swedish National Food Strategy (Regeringen 2017.) , the Sustainable Development Goals (UN n.d.), as well as two government commissioned action plans for food loss and food waste reduction (Environmental Protection Agency n.d.; Livsmedelsverket n.d.a)

According to the Swedish Environmental Protection Agency, consumers are responsible for largest share of food waste in Sweden. (Naturvårdsverket n.d.). However, recent studies by the Swedish Board of Agriculture (2021, 2022) have shown that significant losses were also found on farm level. Here, food losses of meat are of particular importance since it has the greatest impact on the environment and climate (Livsmedelsverket n.d.d). According to the Swedish Board of Agriculture (**SBA**), pre-slaughter losses of pigs and cattle in 2020 were approximately 3 % and 8 % respectively (Jordbruksverket 2022), which has a negative economic impact for producers and is a waste of natural resources. However, food losses cannot be reduced to zero. Animal-based foodstuffs are highly regulated from national and international levels, both in regard to food safety and animal well-fare. All animals intended for food use must be healthy for humans to consume, and animals should not be transported for slaughter if recently pigged,

calved or if injuries cause unnecessarily suffering. Of all animals lost before slaughter, some are stillborn, some are euthanised in the field by farmers, and some are found dead in the fields. The death of animals regardless of their stage of life is a significant economic loss for farmers due to lost sales, veterinary costs and cost for disposal of the animal (Azzam et al. 1993; Thomsen & Houe 2006; Mõtus et al. 2018). Although some of the dead cattle and pigs in Sweden are fit for human consumption, most are sent to waste treatment for incineration (Jordbruksverket 2022; Skúladóttir et al. 2022).

One possible way to salvage such meat could be through on-farm slaughter and on-farm emergency slaughter of pigs and cattle. Recent studies (Jordbruksverket 2021, 2022; Skúladóttir et al. 2022) have shown that although current legislations *(EU 2021/1374*) allow for on-farm slaughter an on-farm emergency slaughter, it is rarely used in Sweden. This has led to a suggestion from the Swedish Board of Agriculture to investigate the prerequisites to reduce on-farm meat losses through on-farm slaughter and on-farm emergency slaughter (Jordbruksverket 2022).

1.1 Aim and research questions

The aim of this study is to investigate and present the attitudes and needs of abattoirs and key industry actors to initiate or increase on-farm slaughter and on-farm emergency slaughter. The aim will be answered through the following research questions as stated below:

- What are the attitudes and interests for abattoirs towards on-farm slaughter and on-farm emergency slaughter?
- If any, what are their needs and how can they be met?
- Are there better opportunities to establish on-farm slaughter and on-farm emergency slaughter in certain areas of Sweden, based on the geographical structure of producers and abattoirs of cattle and pig?
- How could the current system of on-farm slaughter and on-farm emergency slaughter be improved?

2. Background

This chapter presents a background on the current state of the Swedish slaughter industry of cattle and pigs. First, the regulatory framework relevant to the industry is present. Thereafter, brief introduction to previous research on on-farm emergency slaughter. Lastly, a section regarding animal mortality and one section on pig and cattle pricing is presented.

2.1 Regulatory framework

With Sweden being a member of the European Economic Area and the European Union (**EU**), its standards and requirements for animal welfare, slaughter and food safety is regulated by legislations set by the EU. These legislations are held as minimum requirements, allowing member states to be interpret, adapt, and exceed these when creating their national legislation. They also include definitions of several important regulatory terms for on-farm emergency slaughter (**OFES)** and on-farm slaughter (**OFS**), of which some are presented in Table 1. For OFES and OFS, two legislations regarding transport (European Council Regulation 1/2005) and animal welfare (European Council Regulation 853/2004) had a big impact on the ability of conducting on-farm emergency slaughter (Alvåsen et al. 2014). Since these were implemented in 2006, the European Council regulation 1/2005 prohibited the transportation of animal which are ill or injured, which in Chapter 1 of Annex 1 states that "*No animal shall be transported unless it is fit for the intended journey, and all animals shall be transported in conditions guaranteed not to cause them injury or unnecessary suffering*". Similarly, Article 3 of EC 1/2005 states that "*No person shall transport animals or cause animals to be transported in a way likely to cause injury or undue suffering to them.*", also adding demand regarding the design of the transport in the likes of physical spaces, personnel handling, loading, water, and feed. However, when certain criteria are met, sick or injured animals may still be transported when they are merely "slightly injured or ill", according to Annex 1, Chapter 1 of EC 1/2005. On the other hand, as stated in the same regulation, animals who are injured or ill are rarely seen as fit for transportation. Also, the European regulations regarding animal transport, control, and slaughter (EC 1/2005, EU 2017/625, EC 853/2004) all lack a clear definition

of “slightly injured”, “slightly ill” or “additional suffering”, leaving the decision of its definition to “veterinary advice”.

Table 1. Definitions of regulatory terms according to the Council directive (EU) 2017/625

Term	Definition
Official veterinarian	A veterinarian appointed by a *competent authority*, either as staff or otherwise, and appropriately qualified to perform official controls and other official activities in accordance with relevant rules and regulations.
Ante-mortem inspection	The verification by an official veterinarian, prior to slaughter activities, of animal health and animal welfare requirement.
Post-mortem inspection	The verification, by an official veterinarian, of carcasses and offal, for the purpose of deciding if the meat is fit for human consumption.
Competent authority	The central authority of a Member State responsible for the organisation of official controls, official activities, or any other authority to which that responsibility has been conferred.
Official auxiliary	A veterinary assistant, and a representative of the competent authorities trained in accordance with the requirements established of Article 18 and employed to perform certain official control tasks or certain tasks related to other official activities.
Official controls	Activities performed by the competent authorities, or by delegated authorities, bodies, or persons to which certain official control tasks have been delegated by a central authority of the member state.

2.1.1 General guidelines for engaging in on-farm emergency slaughter

As per Chapter 6 in the Council Regulation 853/2004, the meat from pigs and cattle which have undergone emergency slaughter, outside of an abattoir, is allowed for human consumption if the following set of criteria is met:

1. *An otherwise healthy animal must have suffered an accident that prevented its transport to the slaughterhouse for welfare reasons.*
2. *An official veterinarian must carry out an ante-mortem inspection of the animal.*
3. *The animal must be slaughtered, bled, and have its stomach and intestines removed, before being transported to an abattoir as quickly as possible in a hygienic way. No other dressing but removal of stomach and intestines may take place under supervision of the official veterinarian, and must be accompanied to the abattoir, identified to the carcass.*
4. *If the transport takes more than two hours, the animal must be refrigerated unless climatic conditions, such as a cold winter transport, permits it.*

5. *A declaration of the identity of the animal, it's eventual medication and withdrawal time must be signed by the farmer and accompanied to the abattoir.*

6. *A declaration issued by the official veterinarian (see appendix 1, appendix 2) must accompany the animal to the slaughterhouse, declaring the identity of the animal, reason for slaughter, eventual treatments and observation, the place of emergency slaughter, the destination (eg. abattoir) and means of transportation of the animal and eventual notes of other relevant information for the abattoir.*

7. *The slaughtered animal is deemed fit for human consumption after the post-mortem inspection.*

8. *The abattoir followed any instructions given by the official veterinarian following the post-mortem inspection.*

2.1.2 General guidelines for engaging in on-farm slaughter

Although sharing some similarities with OFES, the guideline and purpose of OFS differs according to Chapter 6a in the Council Regulation 853/2004. The main difference is that OFES is a tool for animals who have *suffered an accident*, making it injured, ill and, hence preventing its' transportation. Instead, OFS is an ordinary and planned slaughter, conducted by competent personnel from an abattoir, that takes place on the farm where the animals come from (Livsmedelsverket 2022). For cattle and pigs, the guidelines are described as follows:

Up to three domestic bovine or up to six domestic porcine animals may be slaughtered at the same occasion on their farm when the following criteria are met:

1. *With regard to risk of injury of either animal or its handler, the animals cannot be transported to the abattoir.*

2. *An agreement between the abattoir and the owner of the animals intended for slaughter, which have been informed to the competent authority in writing.*

3. *The abattoir or the owner of the abattoirs must inform an official veterinarian, at least three days in advance, of the date and time of intended slaughter.*

4. *The official veterinarian who will perform the mandatory ante-mortem inspection must be present during the time of slaughter.*

5. *The mobile unit which must be used for bleeding and transporting the slaughtered animal to the abattoir, must allow hygienic handling and*

bleeding, proper disposal of the blood and must be approved by the competent authority.

6. *The slaughtered and bled animal must be transported immediately to the abattoir. No other dressing but removal of stomach and intestines may take place under supervision of the official veterinarian, and must be accompanied to the abattoir, identified to the carcass.*
7. *If the transport takes more than two hours, the animal must be refrigerated unless climatic conditions, such as a cold winter transport, permits it.*
8. *The owner of the animal must inform the abattoir in advance of about the preliminary time of arrival, which must be handling immediately at the abattoir.*
9. *A declaration issued by the official veterinarian (see appendix 3) must accompany the animal to the slaughterhouse, declaring the identity of the animal, reason for slaughter, eventual treatments and observation, the place of emergency slaughter, the destination (eg. abattoir) and means of transportation of the animal and eventual notes of other relevant information for the abattoir.*

Based on the EU regulation for food and animal controls (EU 2017/625), regardless of if an animal is to undergo regular slaughter, OFES or OFS, an official veterinarian must assess the state of the animal by conducting an ante-mortem inspection.

2.1.3 Veterinary system and inspections

The European regulations for OFES, OFS as well as overall food safety and animal welfare are upheld and enforced by a system of official veterinarians and official auxiliaries (EC 853/2004, EU 2017/625). Their duties include live animal inspection before slaughter, so called *ante-mortem inspection*, and inspection of the carcass and offal of animals, so called *post-mortem inspection* do ensure that all meat from animals are fit for human consumption (Swedish National Food Agency n.d.) These veterinarians must be appointed and trained by a competent authority, meaning a central national agency or organisation designated to handle issues regarding agriculture or food. In Sweden, the competent authority for regarding all animal slaughter is the Swedish National Food Agency (**SFA)**. According to their interpretation of the EU regulations, all Swedish official veterinarians and official auxiliaries must be employed by the SFA. To work as an official veterinarian of the SFA, a veterinary degree from a minimum 5-year education as well as a veterinary license approved by the Swedish Board of Agriculture (S. The degree and license

could be from Sweden, Switzerland or from another EU/EEA country (Swedish Board of Agriculture n.d.) Since official controls in Sweden is restricted to official veterinarians of the SFA, rather than just a licensed veterinarians, this means that the licensed veterinarians of other organisations, such as district veterinarians of the SBA, are not allowed to perform official controls. Overall, Sweden has a lack of veterinarians, which has recently been acknowledged in a government investigation (Regeringskansliet 2021).

2.2 On-farm emergency slaughter practices in Nordic countries

Scientific research conducted on OFES and OFS is very restricted. One of the most recent studies performed on the topic "Overview of the practices of on-farm emergency slaughter of cattle in the Nordic countries" by Skúladóttir et al. (2022) provides sufficient information regarding the current situation. A short review of the article will be presented, highlighting the main topics within the field of research.

While similarities exist in legislative interpretation among Nordic countries, the extent to which the practice is performed diverges between them. The Nordic countries are represented by Iceland, Norway, Finland, Denmark, and Sweden which are all members of the European Economic Area (EEA), the latter three nations are members of the European Union (EU) as well. EEA members follow EU legislation on health and welfare for animals but also food safety. However, only EU members are obligated to follow the legislation thoroughly while Iceland and Norway enjoy more space for interpretation and adaption based upon their separate national policies (European Free Trade Association n.d.). Yet, the legislative interpretation and provided guidelines are very similar among the Nordic countries with a few exceptions. One exception is how Norway allow for a broader meaning of "accident", defining it as an "unforeseen event".

Skúladottir et al. (2022) continues presenting data from the five Nordic countries, where in Iceland, there has not been any reported case of OFES. Although its allowed, the Icelandic Food and Veterinary Body does not provide a form neither any guidelines on how to conduct OFES. Denmark, Finland, and Norway do provide forms for OFES as well as a guideline on clinical diseases preventing the exercise of OFES. The SFA does not supply any previous mentioned guideline on OFES, however, an OFES form is provided. Sweden also requires an official veterinarian to perform the *ante-mortem inspection* (Livsmedelsverket n.d.c). Norway does not state any specific requirement on the veterinarian currently except for a degree, but soon there will be a requirement for veterinarian conducting

ante-mortem inspections to be certified (Norges miljø- og biovitenskapelige universitet 2022).

Skúladottir et al. (2022) concludes that Norway is the only country performing OFES on a larger scale today at 4.2% of total slaughtered cattle being OFES. There are no comparable numbers from any other Nordic country. Authors conclude since there is almost the same adaption of policy regarding OFES, there is other aspects causing this discrepancy. Further, Sweden has a history of OFES but due to costs involved in the process caused animals to be sent for destruction instead (Jordbruksverket 2022). Norway on the other hand have a strong farmer owned cooperatives and generally higher prices which could result in better financial support. All abattoirs in Norway can receive carcasses and perform OFES. According to Livsmedelsverket[1] Sweden has 29 abattoirs available for OFES of cattle and pigs. Sweden recorded 94 OFES of cattle in 2020, no pigs were emergency slaughtered during this period.

2.3 Attitudes and perceptions of OFES among stakeholders in the animal industry

The area of research conducted on the attitudes and perceptions of OFES is restricted (Koralesky & Fraser 2018; McDermott et al. 2022). Some of the available studies report on veterinarians' attitudes regarding OFES practices (McDermott & Mckevitt 2015; Magalhães Sant'Ana et al. 2017), farmers' views on OFES implementation (McDermott et al. 2022), and dairy industry professionals' attitudes toward OFES (Koralesky & Fraser 2018).

In a recent study by McDermott et al. (2022), the authors investigate Irish farmers′ attitudes towards OFES in the management of acutely injured cattle. Results showed that farmers had an overall positive outlook towards OFES and realised its value in good animal welfare practices. However, negative attitudes displayed tended to be against the overall low availability of OFES performers, but also the low economic value. On the topic of low economic value, OFES were perceived as having a similar financial impact to euthanising an animal on-farm, as the high costs charged by abattoirs performing the OFES and low compensation for the animal would leave little financial viability (McDermott 2022). Lastly, McDermott et al. (2022) mentioned that subsidising OFES operations of small abattoirs could potentially create a more economically viable process and thus a larger number and distribution of OFES-certified abattoirs. Subsidies were also concluded by Magalhaes-Sant'Ana (2017) to be a relevant measure regarding the disposal of an on-farm euthanised animal, where OFES was not seen as feasible.

[1] Livsmedelsverket, Control Division, e-mail 2023-03-20

Another Irish study conducted by McDermott & McKevitt (2015) displayed that 89% of surveyed Food Business Operators, which is the head of production responsibility, preferred not accepting OFES carcasses at their facilities due to decreased hygienic conditions and poorer meat quality. Consumer reactions to OFES were also conceived as a potential fear by stakeholders as low knowledge among the public regarding agricultural practices could possibly be transformed into a misinterpretation of OFES (Koralesky & Fraser 2018).

2.4 On-farm mortality and losses of cattle and pig

As mentioned in the introduction, three and eight per cent of the total production in slaughter weight of pig and cow respectively were lost in 2020. While deaths occur spontaneously and are accounted for in animal production, understanding the causes of animal deaths and to which extent they occur can provide a wider insight into how deaths can be reduced and prevented. This section will elaborate on said subject but with intention to provide awareness regarding the resource salvaging opportunities for OFES and OFS. SBAs report *Förluster av griskött, nötkött och mjölk på gården* (2022) will be used to present statistics and data regarding Swedish pig- and cattle mortality through the forthcoming sub-sections.

2.4.1 Pig mortality

Three per cent of the total pig production in slaughter weight were lost during 2020 (Jordbruksverket 2022). The slaughter weight is calculated through using an assigned value for each pig which would represent the average potential slaughter weight among pigs in different age/weight categories. In the report, pigs are separated into five age/weight categories: stillbirths, nursing piglets, weaners/growers, finisher pigs, and sows (Table 2).

Table 2. Losses and mortality of Swedish pigs. Adapted from Jordbruksverket (2020a).

	Stillbirth	**Nursing pigs**	**Growing/weaners**	**Finisher pigs**	**Sows**	**Sum**
Living weight (kg)	-	0-10	10-30	30-120	200-250	-
Assigned theoretical weight	1	1,5	15	56	179	-
Mortality (%)	-	17,2	2	1,7	16,6	-
Animal losses in thousands	316	448	52	43	18	**877**
Meat losses slaughtered weight (tonne)	316	672	779	2442	3226	**7436**
Share of total weight in total slaughter weight + losses (%)	0,1	0,3	0,3	1	1,3	**3**

Table 2 shows the total number of deaths within each age/weight category and the reported mortality rate. As shown, nursing piglets exhibit a high mortality rate (n=17.2%) along with sows (n=16.6%). Weaners/growers and finisher pigs display lower values (n=2; n=1.7). The mortality rate for stillbirths is not reported but they account for 316 000 of the total deaths. Adding together each reported death with the assigned slaughter weight value depending on age/weight category results in 7436 tonnes of slaughter weight lost. This weight is derived from around 877 000 total deaths of pigs.

Total pig production in slaughter weight during 2020 resulted in 246 540 tonnes from an estimate of 2.6 million slaughtered pigs. Out of the total number of slaughtered pigs, 2.55 million were finisher pigs. Further, the report states that it is almost exclusively finisher pigs that are sent off to an abattoir, and it is unlikely that nursing-piglets and weaners/growers are slaughtered. Sows however have a potential slaughter value as on average 50% of sows are replaced annually and a "[…] majority are sent to slaughter" (Jordbruksverket 2022:18).

Causes for pig deaths are due to various reasons. During the first weeks after birth, pigs are at their most fragile stage. While stillbirths are common, many piglets are suffocated by the sow or born in weak condition. This can be counteracted by management work and the structure of the stables. Sows' high mortality rate is generally a result of high age, problems with reproduction but also lameness/locomotive disorders. A Danish study by Kirkden et al. (2013) showed that almost 65% of the 265 inspected sows were euthanised mainly due to locomotive systems disorders (n=72%), which translates to different types of lameness. SBA also notes that locomotive systems disorders is one of the main causes in the culling of Sows, along with reproductive issues and diseases (Jordbruksverket 2022).

2.4.2 Cattle mortality

A total of 528 274 cattle were reported for slaughter or died on-farm/transport during 2020, of which 78 351 animals were not refined to food. 19 898 of these animals were stillbirths or unmarked calves which does not add towards lost produce, but rather considered a potential future resource. These numbers calculate a total production loss of 8% when counting slaughter weight including losses (Table 3).

The mortality rate among Swedish cattle was exhibited at 15%. Among the reported cattle population, calves displayed the highest mortality rate (n=4.9%) followed by stillbirths (n=3.8%) and dairy cows (n=3.5%). Dairy cows also account for 3.5% of the total losses in slaughter weight continuing with calves (n=1.3%). Male animals account the highest share of animals sent to slaughter or reported dead on-farm (n=217 511) but have the lowest mortality rate and share of total loss in slaughter weight (n=0.9%).

Table 3. Losses and mortality of Swedish cattle. Adapted from Jordbruksverket (2020a).

Type	Usage	Number of animals	Quantity, in thousands of tonnes	Share of loss, number of animals	Share of loss, slaughter weight
Suckler cow	Food	47 946	16,8	-	-
	Loss	5 001	1,7	0,9%	1,2%
Male animals	Food	217 511	71,6	-	-
	Loss	4 699	1,5	0,9%	0,9%
Heifers	Food	82 746	27,4	-	-
	Loss	5 162	1,7	1,0%	1,1%
Dairy-cows	Food	83 407	26,6	-	-
	Loss	17 764	5,7	3,5%	3,5%
Calves	Food	18 313	3,4	-	-
	Loss	25 827	2	4,9%	1,3%
Stillbirths/Unmarked calves	Food	0	0	0,0%	0,0%
	Loss	19 898	0,8	3,8%	0,3%
Total sum	**-**	**528 274**	**159**	**-**	**-**
Losses sum (%)	**-**	**78 351**	**13,2**	**14,8**	**8,3**

Like pigs, cattle are also weak during the early and later stages of life. Swedish calves have a relatively low mortality rate compared internationally, however some respiratory- and intestinal disorders still prevails. Dairy cows are exposed to problems such as reproduction issues, low yields due to mastitis, or locomotive disorders.

In a soon to be published study, Sofie Burvall (unpublished material) presents the leading causes of euthanasia on Swedish meat- and dairy farms. As seen in figure 1, the three most common causes of euthanasia on dairy farms were: Accidents/physical trauma (n=18%), lameness (n=18%) and udder-related issues (n=16%.)

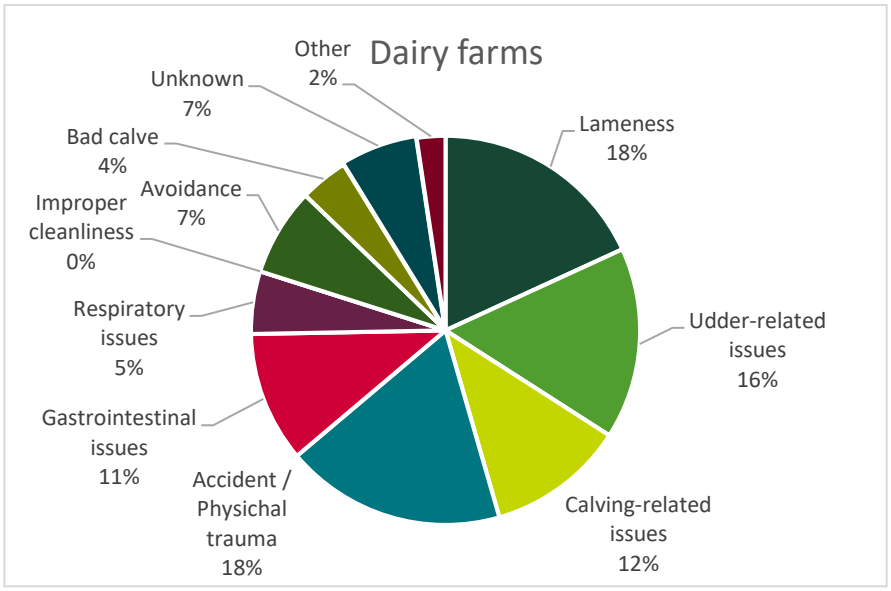

Figure 1. Leading causes of euthanasia on Swedish dairy farms (Burvall, unpublished material)

As seen in figure 2, the most common causes of euthanasia on meat farms were Lameness (n=28%), accidents/ physical trauma (n=24%) and calving-related issues (n=13%).

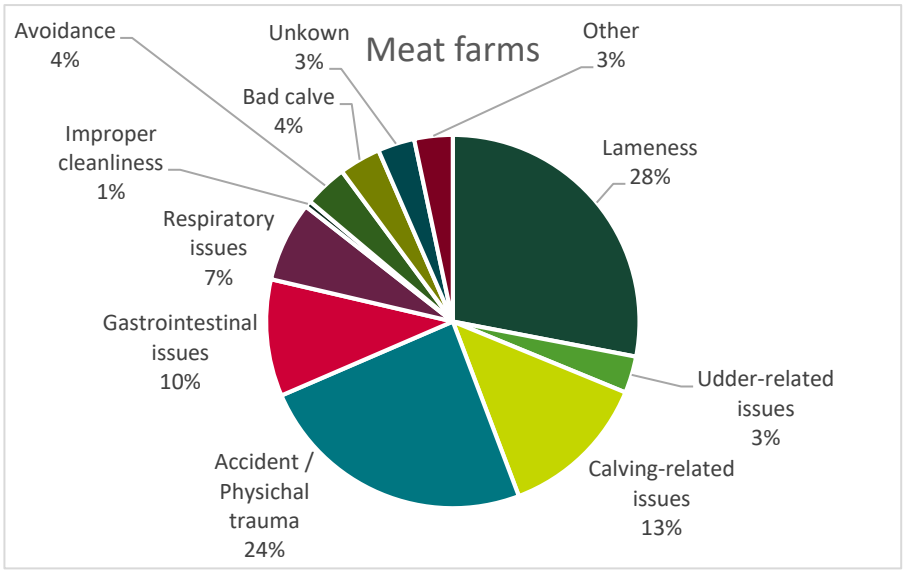

Figure 2. Leading causes of euthanasia on Swedish meat farms (Burvall, unpublished material)

3. Material and methodology

This chapter will present and describe the methodology for the study. The research design is presented at first, before the methods for data collection, sampling and selection is described. At last, the analysis method and delimitations of the study is presented.

3.1 Research design

Due to the aim and research questions of the study, a qualitative approach with inductive reasoning was used, with interviews as means of collecting data. In contrast to quantitative and structured methods of collecting data, qualitative and unstructured approaches collect in-depth information while also emphasizing on the interviewees' own perspective (Bryman 2012). To draw conclusions from those perspectives, inductive reasoning was used for a bottoms-up approach, allowing for conclusions more closely linked to the gathered data (ibid.)

3.2 Data collection

Data was collected through qualitative, semi-structured interviews from three set of groups – abattoirs, key interest groups and game handling establishments. The groups were divided by their functions and operations within the Swedish meat industry. The first group, abattoirs, was defined as a firm or establishment, used for slaughtering and dressing pigs and cattle intended for human consumption. The second group, key interest groups, were defined as a group of individuals or organisations, private or governmental, with one or more shared concern or responsibility of abattoirs, which represent the interest of its sector. This includes for example industry trade groups, unions, veterinarians, government agencies or other stakeholder representatives. The third group, game-handlings establishments, was defined as a firm or establishment in which game and game meat obtained by hunting, intended for human consumption is dressed and prepared.

To retrieve relevant data but also enabling the respondents to delve further into various topics, semi-structured interviews were conducted. Semi-structured interviews are typically characterised with having an interview guide, an agenda for

the interview which contains questions or topics of relevance (Bryman 2012). However, the format allows the interviewer to part from the interview guide if deemed necessary, such as follow-up questions on answers of interest. The interviewer has the ability to control the flow and structures after the interviewee, allowing for a more adaptable interview and greater chance of more expressive, in-depth answers (Kvale et al. 2014; Alm 2019). Further, the interviewer can reply more freely and adapt depending on the direction of the interview (ibid.).

For the study, two interview guides were created in consideration with the study's research questions. The first guide (see appendix 4) was created for interviewing the first two groups, abattoirs, and key interest groups, whereas the second one was created for interviewing game-handling establishments (see appendix 5)

3.2.1 Data collection expansion during the study

During the study, data emerged regarding the handling of euthanised animals that led to an expansion of the interview groups. In response to the difficulties experienced by the main group of abattoirs in handling euthanised animals, the third group, game-handling establishments, was incorporated. The main reason was that game-handling establishments already conduct their operation based on receiving carcasses, often moose and wild boar, which are similar to cattle and pigs in size. Overall, it provided a more comprehensive analysis of OFS and OFES where the handling of euthanised animals is a key component throughout the whole process. By incorporating game-handling establishments, we sought after to give a more comprehensive understanding of how a system of OFES and OFS could be hypothetically portrayed. This expansion would not contrast the main study's main purpose of abattoir's attitudes and interests, but rather broaden the scope by incorporating a different actor within the meat sector. Additionally, with the decision being based on collected data, it allowed for discussion of the role of game-handling facilities as more than a mere thought and hypothesis.

3.3 Sampling and selection

To increase abattoir representation and generalizability, the study aimed at obtaining data from abattoirs from a variety of geographic locations and sizes, ranging from small-scale firms acting in local areas, to large-scale firms acting within a national and/or international market. This is due to an assumption that assets vary across firms of different sizes which might ultimately impact their attitudes and interest towards engaging in OFES and OFS. Such assets may include both tangibles and intangibles, such as financial capital, employees, facilities, machinery, brands, business relationships and goodwill. An assumption was also

made that smaller firms might have greater flexibility to adjust towards OFES/OFS. The decision making in a small firms could be less complex, whereas a larger firm might get hampered by complex ownership structure, bureaucratic, supply chains and hierarchy for decision makings.

Initially, a list was compiled with potential participants for the interviews. In order to select abattoirs of varying sizes and geographic location, annual statistics for slaughtered pigs and cattle during 2021-2022 was used- (Jordbruksverket 22AD; Livsmedelsverket n.d.b) Partly selected through convenience sampling, potential participants were gathered according to the availability of their contact information. One selection criterion was that potential participants should have good insight in the firm's attitude and potential of engaging in OFES/OFS. To give trustworthy and representative data, potential participants would have to be managerial staff. Examples include head of purchasing, quality manager, board managers or other personal deemed appropriate to speak for the firm. When identified, the contact information to potential participants were gathered through their websites or through personal communication.

3.4 Interviewing

The qualitative interviews were conducted through either video calls or phone calls, with video calls being the primary method. For abattoirs and key industry actors, seven interviews were by video call and two by phone call. For game-handling establishments, all eleven interviews were made by phone call. The reasons for choosing phone call for certain interviews was based on the size of the firms and title and role of the respondent. Small scale abattoirs are often busy with the daily operation of the slaughter, making a one-time phone call preferable over booking video appoints through several e-mails and phone calls (Opdenakker 2006; Bryman 2012).

For the video calls, the communications software Zoom was used for video interviews. To transcribe the interview for further processing, the audio and video was recorded through the software. As for the interviews by phone call, the interview could not be recorded by an appropriate software. Instead, the interviewer took notes throughout the call to ensure no important information was lost. Upon greeting the respondent, all interviews were started by acknowledging the respondents of the aim and purpose of the study, followed by asking for permission of recording the interview, their participation of the study as well whether they agreed to be represented in the study by their name and their organisation. After agreement, the interviews proceeded by asking the respondents of their overall views on OFES and OFS. Based on the content and extent of their answers, the interviewed proceeded along the lines of the interview guides (see appendix 4, appendix 5). Depending on the respondents' answers to the questions, certain

questions in the interview guide could be left out if considered to have been addressed. Through focused and active listening, follow-up questions were used if an answer was seen as interesting, having potential to lead to key information. If seemed vague or unclear, answers were repeated to and confirmed by respondents to minimise misunderstandings. To end the interview, respondents were given an opportunity to speak out on anything they though were relevant to the study. This could be a meaningful way to capture any thoughts that might have been left out during the conversation (Kvale et al. 2014). Also, they were asked if they had any recommendations for persons who could be valuable to interview for the study, allowing for a potential snow-ball recruitment of participants.

3.5 Analysis method

The gathered data were transcribed and analysed by inductive thematic analysis, as described by Braun and Clarke (2006). As a method, Braun and Clarke (ibid) praise its clarity and ease of use through a clear set of steps throughout the whole process of analysis (see Table 4). Compared to other qualitative research methods, such as grounded theory, it is a more accessible form analysis thanks to its flexibility in identifying themes and patterns. Researchers can identify themes in different ways, using mind maps, tables, or other tools to create a web of codes, ultimately resulting in a set of categories and themes. Also, researchers are given the choice of using an *inductive* or *deductive* approach. For this study, an inductive approach was used, as it was deemed more suitable due to the descriptive character of the research question. It identifies themes more linked to the material itself, rather than the deductive approach, which theoretical analysis tend to be better suited for hypothesis testing, producing a more detailed result while a richer, more broad analysis is lost (Braun & Clarke 2006).

To conduct the thematic analysis of the attitudes of abattoirs and key industry actors, the study followed the six-stage model as described below by Braun and Clark (2006) (Table 4).

Table 4. Braun and Clarkes six-stage model for thematic analysis.

Stage	Description of the process
1. Familiarizing with the collected data	Transcribing the collected data, reading the transcripts, start writing down ideas of how to interpret the material.
2. Begin coding of the collected data	Creating codes through identifying and naming content deemed valuable for the aim of the study
3. Searching for themes	Gathering codes relevant to each other, creating themes
4. Evaluating themes	Check if the themes are related and hold a reasonable connection to the codes, as well as the collected core data
5. Defining and naming themes	Analyse and specify the true meaning of the themes, naming them accordingly
6. Writing the result	Final step of the analysis. Secure that all them can be clearly related to the collected data. Write out the complete analysis as the study's result.

According to stage 1, the analysis began by transcribing the interviews shortly after they were conducted. For the interviews conducted in Zoom, the recordings were first processed through audio-to-text processers Transkriptor or Microsoft Word before being proofread and adjusted for eventual spelling errors. For the interviews conducted by phone calls, the notes were proofread and adjusted to ensure it reflected the conversation properly. Lastly, the transcriptions were read by both authors on repeat occasions to become familiar with the material.

At stage 2, the material was assigned codes based on the true meaning of words or sentences (see Table 5). This was done with the qualitative data analysis software MAXQDA Analytics Pro 2022. To increase credibility of the analysis, the first interview was coded by both authors independently, later to be discussed and compared to ensure that the coding was coherent. After assuring coherency, coding of the following interviews was split evenly among the authors.

At stage 3, comparison and categorisation of the generated codes began, based on similarities and differences between each other as well as the research questions. This was done through the MAXQDA features MAXMaps, Creative Coding and Smart Coding tool, creating a visual web-like overview through mind maps and assigning colours to codes. As themes started to emerge, their relevance towards the codes and data was checked in accordance to stage 4. Finally, at stage 5, each category and theme were analysed and given an appropriate name, defining the essence of each theme. The identified themes will be presented and explained in Chapter 4.

Table 5. Example of coding and thematising during analysis

Transcribed data	Codes	Category	Theme
As far as how the emergency slaughter could be used today, it is impossible to comply with the current legislation if an official veterinary must sign the certificate.	Difficult to comply with the regulation. Need to ease the regulations	The bottleneck of veterinary inspections	The challenge of complying with the OFS and OFES legislations
The emergency slaughter is not applicable as I see it, because you still need a live animal inspection by an official veterinarian. This will mean increased animal suffering if you cannot euthanise the animal at once.	Emergency slaughter endangers animal welfare	The bottleneck of veterinary inspections	The challenge of complying with the OFS and OFES legislations
It also places further demands on what conditions exist on each farm to be able to carry out slaughter. As an example, access to good quality water is needed. In rural areas, farms might only use water from their own well. Does it maintain good enough quality for food use?	Difficult to secure food hygiene during on-farm slaughter	Technical factors	Factors for implementation of OFS and OFES

3.6 Delimitations

Empirically, the study's scope was delimited to abattoirs and trade groups, GHE, government agencies and veterinary consultants. Inclusion of groups in earlier and later stages of the value chains, such as farmers, retailers, and consumers, would be valuable but was excluded due to time limitations. As for the abattoirs, the choice of respondents was limited to those conducting slaughter of cattle and pigs, excluding those only slaughtering poultry, lagomorphs, sheep, goats and others. This was in order to stay within the boundaries of animal category's as described in the meat loss report by the SBA (Jordbruksverket 2022). As for the maps of geographic structure of abattoirs, GHE and producers, the mapping was based on the two hour limit of non-cooled transportation of carcasses, as drawn by the EU-regulations on OFS and OFES (*Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin* 2022).

Methodically, the study is limited to interview conducted by phone and interview. At first, the aim was to include one or more visits to physical slaughterhouses to deepen the understanding of the respondent's perspective. However, this delimitation was deemed necessary due to the monetary funds and

time required for travelling across Sweden if interviews were to be conducted on-site at the abattoirs.

4. Results

This chapter will present the empirical material that has been gathered throughout the study. The chapter will begin with presenting the geographical structure of producers, abattoirs, and game-handling establishments, followed by a summary of the interviews with abattoirs, key industry actors and game-handling establishments. At last, the result of the thematic analysis will be presented.

4.1 Geographical structure of producers and abattoirs

This section will present an overview of the geographical diffusion of Swedish producers, abattoirs, and GHEs. As mentioned under chapter 2.1, transport must be conducted within two hours to prevent the need of cold transport. Further, OFES acts on the notion that there is an emergency, increasing the need for shorter transport distances to enhance animal welfare.

Three maps have been created using GIS-data collected from the SBA (figures 3, 4 and 5). These maps, one for animal producers, one for abattoirs and one for GHEs, highlight the transport time between producers and abattoir/GHE facilities ranging between 60 to 120 minutes for producers, and 30 to 90 minutes for abattoirs and GHE. Due to the data available to the SBA, abattoirs and GHE displayed transport time only up to 90 minutes. An insight into the abattoir- and GHE geographical structure will provide background understanding to the importance of transport in discussion regarding OFES and OFS.

4.1.1 Abattoirs and producers

Sweden has around 94 EU-certified abattoirs for bovine and porcine animals (Livsmedelsverket n.d.b). 62 facilities are approved for both porcine and bovine animals, 25 exclusively for bovine, and seven for porcine. As for producers of cattle and pigs (see figure 3), there is a high concentration of producers for both animals in the southern- and southwest parts of Sweden. Large parts of the western, north-western, and northern parts of Sweden have fewer animal producers.

Large parts of western Sweden are not connected to any abattoir within 90 minutes (see figure 4). Southern Sweden has a greater distribution of abattoirs, most

producers are covered within 30 to 60 minutes. Although, some areas of >90 minutes are exhibited. Most of the northern east coast display 30 to 60 minutes transport time noting only a few exceptions. However, towards the inland, facilities grow scarce. Distribution between the north and south are 30% and 70% respectively.

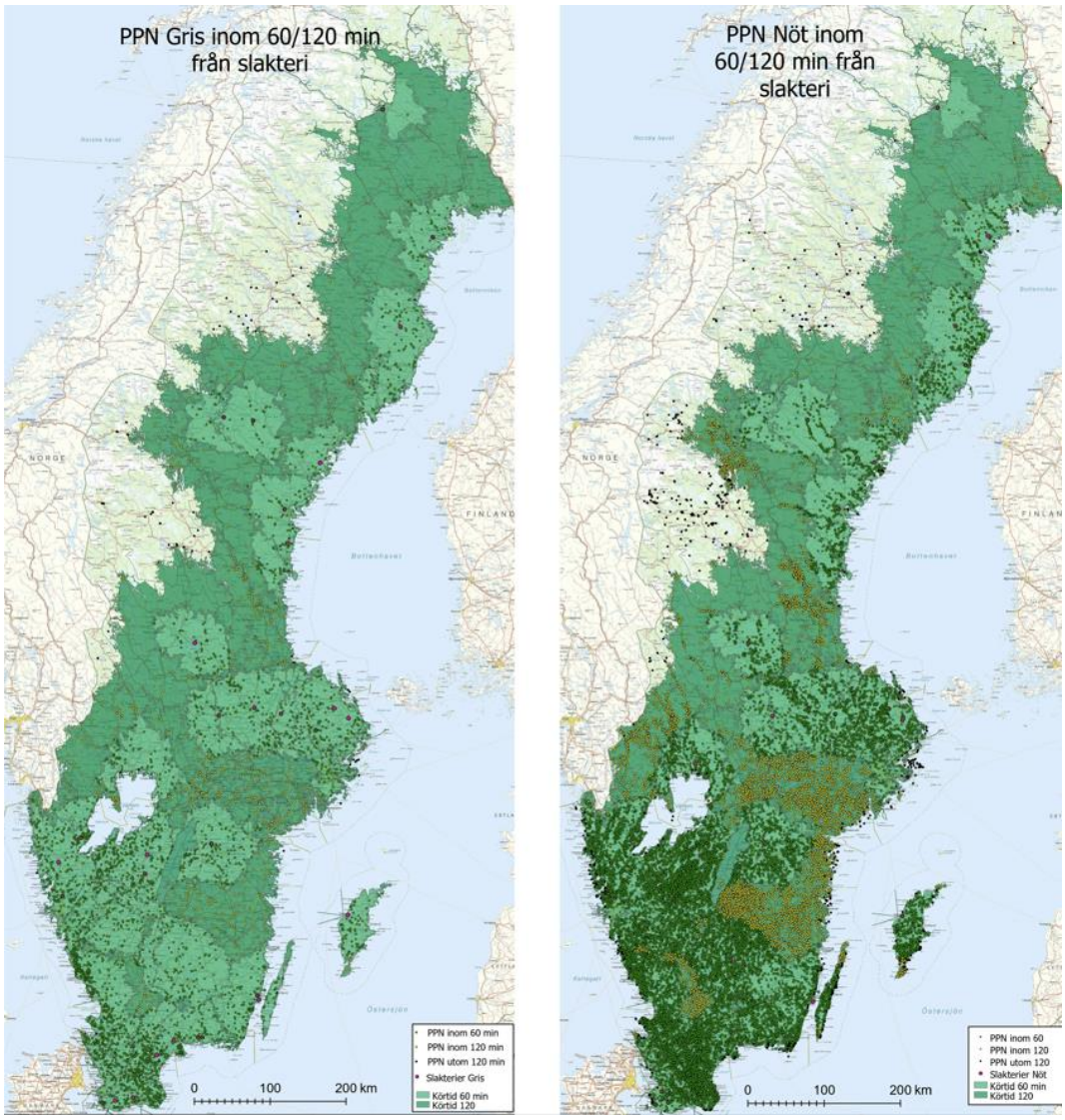

Figure 3. Geographical distributions of producers of pigs (left) and cattle (right) within the two - hour transportation requirement for on-farm slaughter and on-farm emergency slaughter[2]

[2] Jordbruksverket, Geodata Division, e-mail 2023-02-21

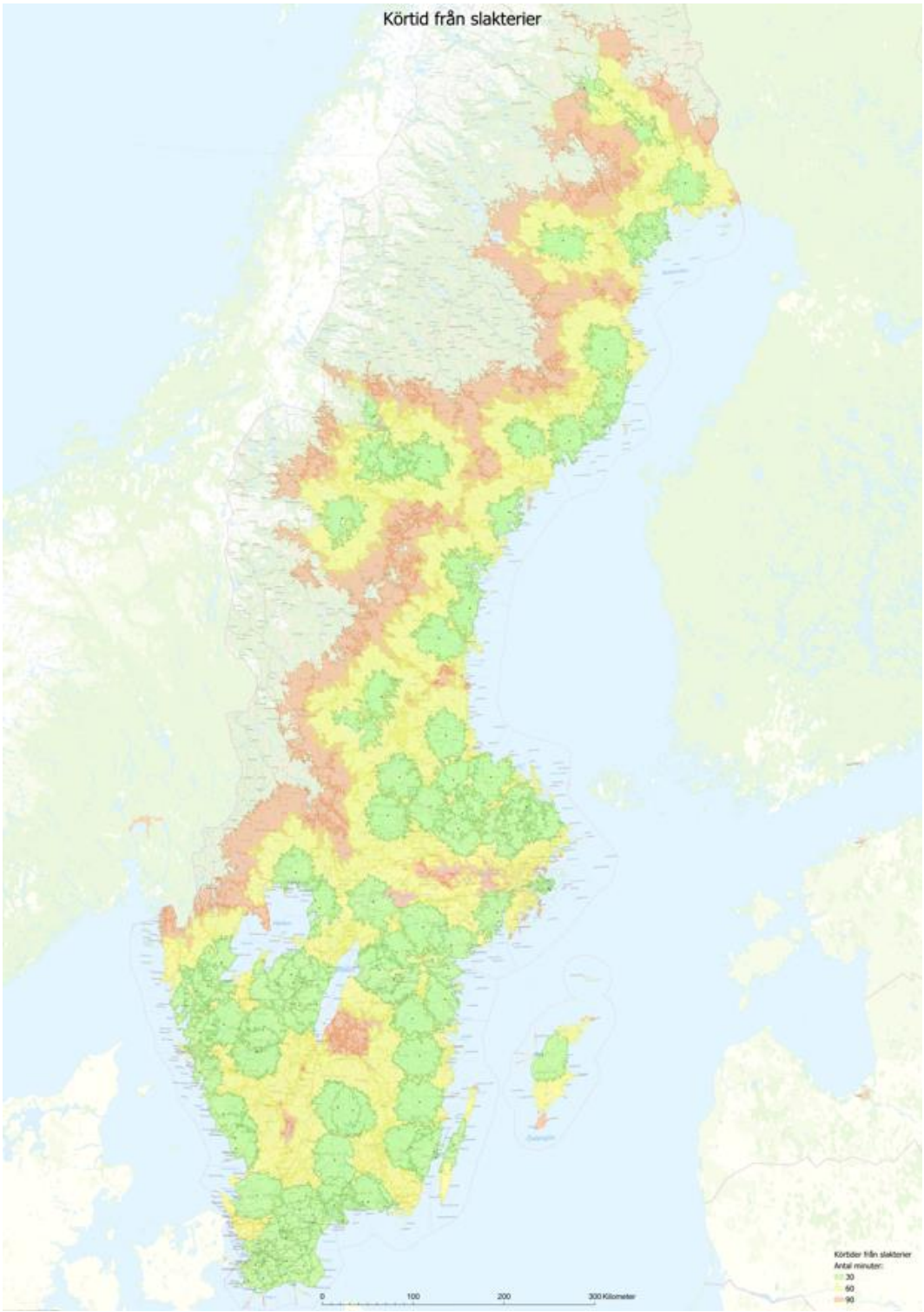

Figure 4. Regions within the two-hour transportation requirement for on-farm slaughter and on-farm emergency slaughter, based on the geographic locations of abattoirs[3]

[3] Jordbruksverket, Geodata Division, e-mail 2023-05-15

4.1.2 Game-handling establishments

There are currently 138 EU-certified GHEs in Sweden (Livsmedelsverket n.d.b) 47 facilities are solely GHEs, while remaining 91 are also EU-certified as slaughterhouses and/or cutting plants. All entities are approved for slaughter of wild ungulates, where the 47 facilities do so exclusively. A dense distribution of facilities in the south resembles the spread of abattoirs (see figure 5). Yet, the north provides a better distribution of facilities compared to abattoirs, covering more of the inland. The western border also displays a better geographical coverage. Facility distribution between north and south are 28% and 72% respectively.

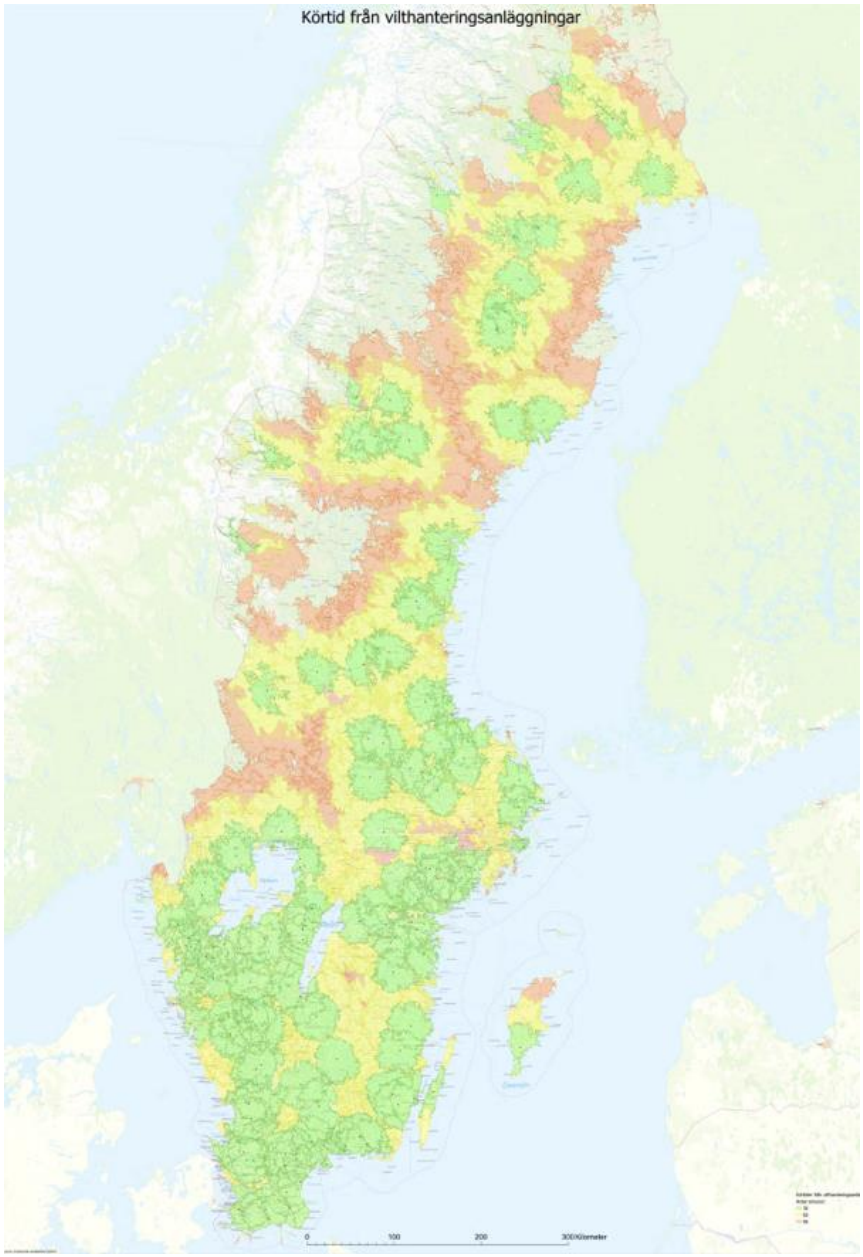

Figure 5. Regions within the two-hour transportation requirement for on-farm slaughter and on-farm emergency slaughter, based on the geographic locations of game-handling establishments[4]

4.2 Summary of the interviews

The study resulted in a total of 20 interviews with representatives from a variety of groups – six abattoirs slaughtering primarily cattle and pigs, one abattoir industry

[4]Jordbruksverket, Geodata Division, e-mail 2023-05-15

group, one government agency, one veterinary consultant and eleven game handling establishments (GHE). To respect their privacy, the respondents will be presented anonymously.

For the abattoirs and GHE, all interviewees held a managerial position, such as owner, vice president, head of purchasing, purchasing manager or quality manager. The size of the abattoirs varies greatly in both revenue, personnel, and production, ranging from leading national and international meat producers to small-scale, local operations with only a couple of employees. In annual production per 2021, the number of slaughtered animals ranged between >1000 to <500 000. Geographically, the abattoirs and GHE were located in 13 different counties, from Norrbotten to Skåne (figure 6).

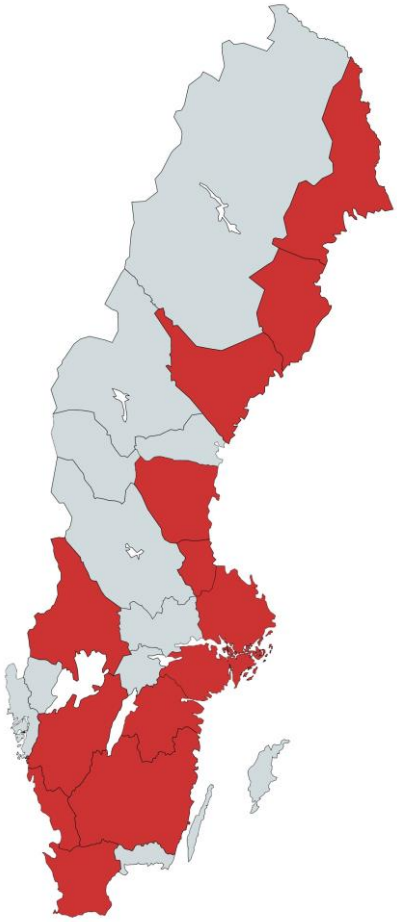

Figure 6. Geographical locations of interviewed abattoirs and game-handling establishments

All included, the interviewed abattoirs slaughter both pigs and cattle, although some divide their slaughter on different facilities based on the type of animal. For the GHE, four are slaughtering wild game exclusively, whereas seven slaughter a mix of game and farm animals, such as lamb, cattle, or pigs. Currently, no abattoir or

GHE are performing or offering OFS or OFES as a service. However, one GHE is licensed for OFES of cattle, and one abattoir has recently applied for OFES of cattle, which is yet to be approved by the SFA. Three abattoirs offer what they describe as "acute slaughter" of cattle, prioritising animals to be transported within a couple of days. This is distinguished from OFES since their ruling is that all acute animals must be alive, suitable for ordinary transportation and being capable of walking through the slaughtering facility like ordinary animals. No such acute slaughter is offered for pigs.

The key industry actors consisted of representatives for a meat industry trade group, the SFA as well as one veterinary consultant. The meat industry trade group is owned by and represents the eight largest abattoirs in Sweden, which role is to increase profitability for their customers and owners by driving the development of the Swedish meat industry. Issues of interest include the breeding, animal welfare, sustainability and trade of pigs, lamb, and cattle. The interviewee was the vice president of the organisation. The veterinary consultant represents a firm owned by four industry trade groups of pigs, lamb and cattle, including the previously mentioned meat industry trade group. Being primarily a veterinary organisation, its purpose is to counsel animal farmers regarding animal health and production issues. The interviewee was a veterinarian and operations manager regarding animal autopsy.

The thematic analysis of the interviews resulted in two themes with two subcategories each (Table 6) which now will be presented together with quotes from the interviews.

Table 6. Themes and categories derived from the thematic analysis

Theme	Categories
The challenge of complying with the OFS and OFES legislations	The bottleneck of veterinary inspection
	The split perspectives on handling of non-acute injuries
Factors for implementation of OFS and OFES	Technical limitations
	Economic limitations

4.3 The challenge of complying with OFS and OFES legislations

One of the strongest indications during the interviews with all groups were how the OFS and OFES legislations ultimately posed challenges that made it difficult for abattoirs to engage in it. Out of these, the main factors derived from the interviews resulted in two categories. The first category, *the bottleneck of veterinary inspections*, regards the perceived difficulty that the need of multiple inspections by veterinarians imposes on OFS and OFES. The second category, *the split perspectives on handling of non-acute injuries*, touches on the split views on how

abattoirs and key interest groups perceive how non-acute injuries to animals can be handled to reduce meat losses through OFS and OFES.

4.3.1 The bottleneck of veterinary inspections

One topic often mentioned by the respondents were that in the case of acute injuries, such as an animal with a broken leg, OFES is not a valid option. Although this might sound contractionary to the very word "emergency slaughter", similar opinions were found among other respondents. Six of the abattoir mention that the acute conditions of an injured animals are what may hinder taking advantage of OFES - one cannot wait for an official veterinarian when animals are suffering. Abattoir 1, a small-scale abattoir located in northern Sweden explains:

> *"If we are to have anyone to engage in OFES, the animal should get [the first] inspection at the abattoir after being euthanised. Remove the requirements of ante-mortem inspection for the sake of the animal. The saying is that necessity knows no law, and here we are dealing with [acute injuries such as] legs and spinal fractures." – Abattoir 1*

Similarly, Abattoir 2, also a small-scale abattoir located in northern Sweden, mentions that a problem with OFES is that it most of the time is an emergency - one cannot wait a couple of days before euthanising an animal. That was why they offered on-call, 24/7 slaughter during the previous OFES system during the 1990's. As of today, even if abattoirs offered on-call slaughter as a service, the problem still lies in acquiring the permissions from a veterinarian. Abattoir 1 says that even if a farmer would be able to find an on-call veterinarian at 2 am, they would most likely be busy treating sick or injured pets at a veterinary hospital, leaving injured farm animals far down their priority list. Similarly, Abattoir 3, a large abattoir located in Västergötland, fears that injured animals might be left unattended overnight while waiting for a veterinarian. Although a veterinarian is available and could attend quickly on site, the current demand for ante-mortem inspection by official veterinarians from the SFA would not even have allowed it. The veterinary consultant explains:

> *"The case was that [the SFA] changed which veterinarians who could sign the OFES certificates. But then came criticism that veterinarians working with pets could sign certificates, so they changed to an official veterinarian […] who works with farm animals. But then, the SFA chose to interpret it that it must be an official veterinarian from SFA, meaning that it is not enough to have a licensed district veterinarian [working with farm animals], which makes signing OFES certificates impossible. – The veterinary consultant*

What the veterinary consultant points out is that although district veterinarians hold a professional license, are working on behalf of the SBA and might be treating farm animals daily, they are not permitted to sign an OFS or OFES-permit since they are

not an official veterinarian of the SFA. To clarify, they depict a scenario which shows the time and resources needed to meet the inspection criteria.

> *"In case of injured cattle, the farmer first want to get a prognosis and turns to his or her district veterinarian. Once on site, the veterinarian might give a bad prognosis, leaving no other option than to euthanise for destruction, home slaughter or emergency slaughter. If a nearby abattoir [offering OFES] gives them that option, then the veterinarian who's already there is not allowed to do the [ante-mortem] inspection." – The veterinary consultant*

Aside waiting for an official veterinarian to arrive, this process becomes even more time consuming since farmers can't contact an abattoir before the ante-mortem inspection. All in all, the veterinary consultant describes the scenario as time consuming, complicated, and involving many actors, all while having an acutely injured animal waiting to be euthanised. To solve this, they argue for a change of the permission of ante-mortem inspection, either by incorporating licensed veterinarians who work on farm animals, or by introducing digital tools, such as live video inspection or online courses for faster certification. Abattoir 1 takes this a step further, arguing that the abattoirs themselves should get permission to perform ante-mortem inspections for OFES due their employees long experience in dealing with animals.

> *"This means that the abattoirs should have the right to [euthanise] if we can see that the leg is broken. To stand there and wait for two hours for a vet, no thank you. I don't think it's ethically sound. If we removed this [ante-mortem inspection] with the veterinarian, I think more people would start thinking about engaging in OFES. – Abattoir 1*

To summarise, the purpose of veterinary inspection is understood by abattoirs and key industry actors but is seen as too time consuming with the demand of official veterinarians. If this is to be solved, their opinions are to ease the legislation by either allowing non-official veterinarian to perform it, increasing the number of official veterinarians, or removing the demand of ante-mortem inspection for OFES.

4.3.2 The split perspectives on handling of non-acute injuries

Animal welfare emerged as topic whose importance cannot be understated when considering OFS and OFES, although the respondents' opinions on the matter were divided. When discussing the potential of reducing food losses of animals unfit for transportation, little interest or attention of the respondents were drawn to the topic of OFS. Based on this, this category will present several split views on the relation between OFS, food loss reduction and animal welfare.

According to representatives of the SFA, the purpose of OFES is to offer a tool for animal welfare in the case of acute injuries, without food loss of an otherwise healthy animal if the injury is not deemed as too grave. Representatives of the SFA explains animal welfare as the key factor when considering OFES:

> *"Animal welfare is the priority, because that will regulate the conditions for whether OFES can be carried out. You cannot allow animals to suffer more than necessary, and this means that you cannot wait for practical conditions to be put in place. You cannot wait for a veterinarian to come and issue an OFES certificate, it must be done immediately. And there the logistics sometimes can be difficult to get in place. – The Swedish National Food Agency*

In comparison, they describe that OFS is not a tool for slaughter of injured animals, even though it might be suitable in the case of minor injuries or animals in late gestation. The main difference is that OFS is a planned slaughter, scheduled in advance, whereas OFES is acute situation.

> *"The thing is that with OFS, it is an ordinary, planned slaughter that takes place on the farm because [the farmer] wants it to take place right there. […] It will primarily be for perfectly fit and healthy animals." – The Swedish National Food Agency*

Described as highly requested by small-scale enthusiasts seeking out a stress-free end-of-line scenario for their animals, representatives of the SFA explains that OFS could be seen as a way of producing a more ethical, premium product. Its potential is also shared by Abattoir 4, a medium-size abattoir located in southern Sweden, who could see positive results regarding animal welfare and stress-levels of animals euthanised on their farm. On the other hand, other abattoirs were sceptical of OFS from an animal welfare perspective. Abattoir 5, a large abattoir with multiple facilities in southern Sweden, refers to a study from 2018 which showed that stress-levels between mobile slaughter and stationary slaughter were insignificant. Another sceptic is Abattoir 3, who believes that farmers and abattoirs might be too humanising when discussing OFS. Abattoir 3 explains:

> *"They still have to get moved to a new place [on the farm] with a mobile slaughterhouse, and although it is possible to create good conditions, it is also quite easy to fail with these temporary set ups for stunning and killing. […] If the animal it taken from its herd, maybe it doesn't really matter if that place is 150 meters from the stable or if it has to travel 20 minutes to get here [to the abattoir]. I don't think we should put in too much of our human perceptions about death." – Abattoir 3*

The meat industry trade group and Abattoir 5 mentions the difficulty in evaluating the best solutions for non-acute injuries. They ask themselves how one should value weeks of treating lameness in a hospital pen, compared to transporting the same animal for 1,5 hours to the abattoir, potentially shortening the suffering. Abattoir 5 points out that when breaking down terms like "unnecessary suffering" and "for

animal welfare reasons", you could even make the argument that veterinary treatments might endanger animal welfare.

> *"If you'll push it's meaning to the extreme, which I occasionally do in discussions, even treatments might be out of the picture. I've owned cattle myself; I know that they feel discomfort when getting a syringe shot. So, you basically cannot treat animals if you take those terms as an absolute." – Abattoir 5*

Instead of holding OFS and OFES as the best solution for animals unfit for transportation, abattoir 5 believes that the clear guidelines and definitions for when an animal is suitable for transportation. "It is a matter of what's ethically sound", as they say when describing their preferred opinion over OFES and OFS – transportation optimising. They describe how through planning the pick-up route of the animal transport vehicle, suffering of injured animals could be minimised without the need for on-farm slaughter, with all the issues that comes with it. Further, abattoir 5 describes it as "a regular slaughter with a special procedure". If an animal transport loads at on average at four or five farms, injured animals would get loaded last, meaning they spend the shortest possible time on transport, enters the abattoir the fastest and gets slaughtered as soon as they arrived – a type of fast-track for animals. It ultimately what they believe is the correct view on animal welfare – shortening the suffering, rather than a lengthy try to eliminate it.

> *"We have different views on what [animal welfare] means. I don't think its good animal care to let a cow limping for four months during treatment. I think it's much better for that animal to [get transported] - even though it were to have a little pain during that time, I still think it must be suffering less during those hours."– Abattoir 5*

All in all, when considering how to handle animals with non-acute injuries not suitable for OFES, none of the abattoirs or other key industry actors mention OFS as a potential tool for getting animals to slaughter. Instead, abattoirs favour to transport these animals alive by transport optimisation. This non-perception of OFS as a tool for animals that, for example, suffers from lameness, also reflects the views of the SFA and their description of which animals that are suitable for OFS.

4.4 Factors for implementation of OFS and OFES

On-farm emergency slaughter is performed very rarely. Collected data exhibits a pair of factors which obstructs the use of OFES and might hinder the development of OFS. The main factors derived from the interviews focused on *technical limitations*, such as the abattoirs' need for emergency slaughter-enabled facilities and sufficient equipment capable of handling such operations. *Economical limitations* were also expressed to such an extent in which OFES were deemed not

economically viable, at least the way to exist today. The technical and economic limitations will be presented separately along with sub-factors in each category.

4.4.1 Technical limitations

Regarding on-farm emergency slaughter and on-farm slaughter, some technical factors are involved which obstruct its use and development. Facilities and equipment needed to perform OFES operations are not widely available or easily accessible. Due to impeding constructions of abattoirs and legislations on food hygiene, most facilities cannot receive carcasses. Abattoir 3 describes their abattoirs as having no possibility to receive emergency slaughtered carcasses as they lack an entrance for the body, which would translate into manually transporting the animals through the stable, which could then become a health risk.

> *"The way our abattoirs are built, it would not even be possible to get them onto the slaughter line. Then we would have to transfer the body on a cartwheel or truck through the stable, which would not be very hygienic due to the dead and open animal. And once we would have got the animals onto the slaughter line, you would have to bring with the organs for inspection, it would be a lot to deal with." – Abattoir 3*

Abattoir 3 continues about a possibility to take care of emergency slaughtered animals but that would include having planned it rigorously, "[…] you would need a specific day". Further, it includes a halt in ordinary production. Similarly, Abattoir 4 notes that their abattoir is built for the reception of living animals, stating that "[…] the way our abattoir is constructed today, we do not" when asked whether they receive carcasses. Abattoir 4 adds "[…] our chain includes the animal leaving the truck on its own, into the system". Therefore, they cannot receive carcasses from emergency slaughtered animals. The representative for the meat-industry trade group, concludes the previous notions that the reception of dead animals is not fit in the current planning of an abattoir. Since most abattoirs are constructed to resemble an assembly line where animals become a finished product, there are some difficulties adding the carcass at a later stage in this process. To enable the reception of carcasses, new construction would have to be made.

> *"I am thinking about the process of killing and bleeding the animals, then you have to transport this body into an abattoir which cannot be located too far away. I do not know how you are supposed to deal with cooling and all that [During the transportation]. Then you have to get the animal into the facility, which I see as the biggest challenge. Unless we are talking about a smaller game-handling establishment or locations where you are used to receiving dead animals. Because the bigger abattoirs have a reception stable, there is a process where you transfer living animals to euthanasia on a line around. Therefore, to enable these animals into the system is a challenge and demands the correct reconstruction of the facility." – Meat industry trade group*

Abattoir 1 agrees with the meat industry trade group regarding reconstruction, Also, they share the view of Abattoir 3 that in bigger facilities, it would not be viable to start up the whole process for potentially only one animal.

> *"[…] you would need a special room at your facility for emergency slaughter. If you were to hook up the animal onto the existing line, you would need reconstruction, because no one has it today [the opportunity to accept emergency slaughtered animals]. Just look at the facilities in Kalmar and Linköping. They are huge facilities, and no one would turn on the light and start the whole slaughter line for just a single animal, you would need a separate space." – Abattoir 1*

While abattoirs lack the ability to receive carcasses, emphasis is also put into the shortcoming of equipment and gear to kill animals on farm which relates to both OFES and OFS. Abattoir 1 mentions several aspects needed to perform a slaughter on farm including equipment and overall issues with the setting and prevailing conditions on the farm.

> "[…] have a truck built for pulling and dragging animals out of a barn with a winch, covered surfaces and so on. You would also need the opportunity to perform bleeding where the blood is taken care of as well." – Abattoir 1

On the same notion, Abattoir 4 questions "[…] what sort of equipment is needed at the farm?", answering himself by stating "This poses even more requirements regarding the prerequisites of the farm". They have concerns regarding the access and quality of the farm water supply, a concern also shared by Abattoir 5. Overall, Abattoir 5 conveys a certain scepticism to the plausibility of reinstating operational OFES.

> "It gets messy. There is a lot of logistics involved too. You need to have [clean] water, knowing which water you use. You cannot just connect to the local water supply and hope for it to be acceptable. Blood and other disposable waste need to be taken care of. You need to have a cold chain which cannot be interrupted, you have lorries with diesel engines rolling, cooling units. So yes, I believe it is even harder today to succeed at motivating this." – Abattoir 5

Transportation is a crucial component of a working OFES-system. Issues related often include technical, economical, and animal welfare aspects. On the note of the technical dimension, vehicle design could be considered a possible solution. Abattoir 1 recollects historical evidence from trucks which could both perform OFES while also bringing in living animals to an abattoir. This was enabled due to separate compartments on the lorry. The living animals were let off at the main line while the euthanised animals were transported further to a different line specific for OFES-carcasses.

> "[…] there should be a lorry with loads of equipment. There needs to be active cooling, a dirty space which needs to be cleaned and so on. There were specific vehicles they had at the abattoirs historically. They even had compartments for living animals. It could bring in one or

> two living animals while also providing space in the back where they could roll out a tarpapering for dead animals so it could be up to five or six slaughtered cattle on an emergency slaughter lorry. […]. They had sidedoors on these vehicles which meant they could load off the living animals in the regular pocket and send the dead animals off to a separate OFES-line." – Abattoir 1

Separate compartments are brought up several times. In the case of transporting animals alive rather than having them euthanised prior, Abattoir 5 mentions an idea of having injured animals having an individual box and making logistical adjustments to minimise time spent in transit.

> "[…] injured cattle should be placed in an individual space during transport. It is loaded on the lorry last so it will have the least amount of time spent in the vehicle. The transportation then perhaps is not allowed to be eight hours long in cases like this, but rather four hours at max." – Abattoir 5

While the idea of separating injured or dead animals is cited by Abattoir 4, the interviewee sheds a light at the potential economic loss of transporting a single animal. In cases where multiple animals could be transported in a space which is instead dedicated to a single animal would drastically increase the price of that meat at the bottom line.

> "[…] instead of having it transported in its individual compartment, let us say this space would regularly fit 40 pigs and is now only carrying one pig, then the cost of transporting that meat is significantly higher. It is not economically viable." – Abattoir 4

This notion is supported by Abattoir 5 who states "[…] if you look at it from a sustainable view, I believe the costs would be higher due to a single lorry carrying only one animal". However, Abattoir 4 understands the intricate situation that is OFES. There is no possibility to wait for other animals to become injured to alleviate some of the costs involved with transportation. However, they add that the transport could consist of both injured animals along with other animals ready for slaughter resulting in the previous mentioned outcome.

> "It is about the financial part of transporting animals. You cannot wait for the animals either. "We only have one hurt animal at the moment, but we got to have at least ten" is not a viable action. But on the other hand, let us say that the producer has an injured animal while also having five other animals ready for slaughter, then you might take them all in one trip." – Abattoir 4

Food hygiene is a pivotal factor in commercially produced meat. Some of the respondents have shared concerns with regards to the possibility of performing OFES and OFS without compromising the hygienic standards. The meat industry trade group gave some overall thoughts on this, asking if it would be possible to go through with this.

> "It is just about succeeding at receiving and being able to take care of the animals and do it hygienically, because what about the possible contamination? How would that even be possible is the big challenge. How are you supposed to move an animal in a hygienic and safe way?" – The meat industry trade group

This is supported by Abattoir 4 stating "[…] it also sets requirements for the right prerequisites to exist which enable a food hygienically correct performance". Continuing on the topic in regard to uncertainties surrounding OFS, they state that there is some shortcomings about the hygiene. Small organisations have a harder time complying to the prerequisites needed and that they already offer slaughter with short transportation and a hygienically sound process at their facility.

> "[…] it has been proven, and that is where we stand on the subject, is that it makes it difficult regarding hygiene during the slaughter, to make it free of contaminants. And then there are certain requirements such as legislation which make it quite hard for a small business to carry out this operation. You would need, well, administrative and bureaucratic muscles to get it approved. This is the reasoning behind our stance, and in our situation, we already offer short distances and good hygiene." – Abattoir 4

Abattoir 5 accords with the concerns on OFS and notes that they would never be able to process and sell produce received from OFS due to their certifications and codes of conduct between them and their customers. This is because they cannot guarantee the process completely.

> "You should look at the aspects of on-farm slaughter because there are a lot of other challenges coming with it. With the certifications we have, we would never be able to use such meat [Meat from OFS]. We would never be able to receive a carcass in our facility if anyone has euthanised it on-farm, because then we cannot guarantee the handling process completely." – Abattoir 5

Abattoir 1 also display doubt on the topic, saying that one day you will eventually put yourself in a bad spot.

> "And about on-farm slaughter, more than just the possibility of having to emergency slaughter yourself, I think you will put yourself in a bad position someday. Both in regard to security reasons for yourself and also for the animal. Moreover, you cannot make it as hygienic as you would want every time at the time you request." – Abattoir 1

While the meat industry trade group is convinced that OFES would be a great solution for both producers and animals, they mention that one way to by-pass the legislative demands on hygiene could be domestic slaughter. They bring up the notion along with mentioning that it is practically common practice among producers and there is no need for an official veterinary inspection.

> "[…] I mean, many are already slaughter themselves. Hopefully, you have a big family to consume it with. And it is perfectly fine to do so, and by doing so, you will not face the hygienic requirements alike the ones in abattoirs where you have official veterinarians from the SFA." – The meat industry trade group

However, multiple respondents lifted potential problems and exhibited some scepticism about domestic slaughter. Abattoir 5 states “There is not a lot of people who prefers domestic slaughter. […] I had to euthanise an animal, and I can tell you that having 350-400 kg of meat in your home, it is not very pleasant”. Abattoir 1 notes “The situation today is so bad that the farmers cannot even slaughter themselves, they have lost the knowledge”. The veterinary consultant also sees a potential lack of knowledge on how to perform domestic slaughter and further said that during the summer months, it is impossible to let a body hang.

> “And it is not so easy with domestic slaughter, not everyone can do it. Also, you cannot slaughter at home all you want. Perhaps it is in the middle of the summer, then it is completely impossible to hang a carcass, you do not have that opportunity.” – The veterinary consultant

4.4.2 Economic limitations

Profitability and payment structure

As for the profitability and payment structure, economic incentives to re-establish and develop OFS and OFES are currently scarce. Results show scepticism among the interviewees, mainly due to a fragile payment model. Whether or not OFES is plausible depends on the size and category of animal. Costs involved with OFES operations include transportation, personnel, and equipment, whereas a single animal must cover up all those costs. Abattoir 1 states that the only conceivable scenario would be an animal worth at least above ten thousand SEK. Further, they mention that every hour the abattoir is running costs five thousand SEK.

> *“[…] it has to be an animal worth ten, twenty, or thirty thousand to make it economically viable. Every hour in the abattoir is five thousand SEK from when I turn onthe lights.” – Abattoir 1*

Regarding which animals are economically tenable, the meat industry trade group notes “[…] this is mainly about cattle”. They continue whether it could be possible to send sows for OFES, but then adds “[…] but their value is too low, so I am having trouble seeing it being possible economically”. Abattoir 5 shares similar thoughts regarding the plausibility of pigs in OFES operations. Cattle is generally bigger and more valuable per kilogram which helps taking care of the expenses. Pigs are generally worth around two thousand SEK, which does not cover the overhead costs.

> *“[…] say some cattle is worth between fifteen and seventeen thousand SEK on average, whereas a pig is worth a couple of thousands. Those couple of thousands are gone instantly when you start the lorry.” – Abattoir 5*

Abattoir 3 supports this notion as well, stating that due to the low value of pigs, there is a lack of incentive among producers to save their meat.

> *"[…] however, due to pigs often having a lower value, there might not be a similar economic incentive for the producers to save the animal. […] I do not think a business can be profitable due to the fact that pigs are less valuable compared to cattle." – Abattoir 3*

To create an incentive for both producers and businesses, a possible solution could be to change the current model of payment. When asked on their thoughts about OFES and OFS, the veterinary consultant states "[…] there is a great demand among producers [demand for OFES/OFS], however you would need to make it easier and reducing the costs involved". Although reducing the costs for the producers and abattoirs could be done in different ways. Abattoir 3 states "[…] for it to be implemented, there would have to be some sort of subsidy. The meat industry trade group is convinced that producers would have to accept a lower payment per animal emergency slaughtered. They note "I think you would have to accept a much lower payment for this animal. Because the processing costs will be much higher". Further, they add "[…] perhaps you could be okay with someone [an abattoir] just collecting the animal for slaughter and you would save the costs of carcass collection", meaning the producer would not lose or gain any money.

> *"I absolutely think [abattoirs] would have to pay [farmers] less, definitely. Otherwise, it would not even be conceivable." – The meat industry trade group*

As for market limitations and market opportunities, abattoirs rarely supply their product directly to consumers, but rather to customers such as retailers. This often infers an agreement between the parties on how the process should be and what is allowed or not. Abattoir 5 describes it as being told by the customers to have the ability to receive OFES animals if they would like, however the customers add "[…] but you have to guarantee that this meat does not end up in our products". Also, they mention that "[…] to some customers we have to guarantee that our meat does not come from producers who has any remarks. They are very far down the supply chain and setting demands". They conclude that their certifications would not allow them not having full control over the animal at all stages, thus creating a high threshold. Abattoir 3 paints a similar picture of the situation, saying that their customers have requirements which extends the legislative demands. They explain one of the requirements as "the meat can only come from healthy animals. It cannot come from injured or sick animals." This would then result in a lot of technical issues so separate the different meats. Finally, they conclude that their reception is built for living animals exclusively, and that many of their customers do not approve of OFES/OFS.

"We have chosen not to receive any carcasses, but only living animals. That is the way we want it to be, and a lot of the bigger customers require us not having any special slaughter, some of the bigger actors." – Abattoir 3

Three interviewees also had some thoughts and concerns regarding how consumers would receive the idea of eating meat from OFES animals. The meat industry trade group believes a potential risk could be consumers who disregard the advantages of OFES from a food loss perspective but rather see the possible misconduct in animal welfare and protection. They add "[…] what are the things you would need to think about when marketing this type of meat? Here is meat from form injured animals would not come out as very good, so how would you do it?". Abattoir 3 shares a similar concern when marketing OFS meat, rhetorically asking, "Would you buy premium meat from a cow with a broken bone?" and continues "I think it would prove difficult". Abattoir 4 however, thinks there could be some interest from the grocery store corporations working with food waste and sustainable development. Selling OFES meat would works towards less food waste and loss.

"Yes, it is about communication, how you package it. Look at Axfood as an example, they are quite big in working with sustainable development and talk about it in a lot of ways. […] so you could say there is an opportunity, we can salvage more meat compared to the amount discarded. So from a resource perspective, you could surely get it in there somehow." – Abattoir 4

4.5 Game-handling establishments

Eleven GHE were interviewed to investigate their current attitude and possibility to receive OFES/OFS animals. Eight of the facilities are located in south of Sweden, including regions such as Västergötland, Halland, Skåne, Blekinge, Småland and Östergötland. The three remaining GHE are located more towards the centre of Sweden in the regions of Hälsingland, Värmland, and Gästrikland. While all GHEs interviewed were allowed for slaughter of game, four facilities also conducted slaughter of domesticated animals. Animals come from own game enclosures, hunters, and local producers.

When asked if they would have the practical ability to receive carcasses from OFES/OFS animals, ten of the eleven asked stated they would have. Three interviewees mention they could receive such carcasses today if the current legislations would allow it. Four interviewees mentioned that due to the fact they are already receiving carcasses of game, they would have the same possibility with domesticated animals. The remaining GHE who did not state they would have the ability commented that the size of the cattle is too big for their facility (mainly receiving venison). Further they added that the economy of OFES is not profitable.

On the topic of profitability, six of the respondents raised concerns regarding, deeming it difficult to create profitability. Two interviewees mentioned pigs as not up for discussion on the OFES topic since their low value. Further, three of respondents mentioned the official veterinary inspections as either too expensive or difficult to find. Another statement is that it would be expensive to reconstruct the abattoir if necessary to enable OFES. Lastly, one interviewee states that if the meat could be sold commercially it would prove good since the farmer gets paid for the animal and avoids sending an animal for destruction.

Overall, the interviewees are positive towards the re-establishment of OFES. Multiple respondents pointed out that there is currently too much good meat wasted unnecessarily. One GHE mentioned they have a special OFES-space in their facility, not in use, further highlighting that their facility is “empty” nine month of the year.

5. Discussion

To answer the aim and research questions, this chapter aims to discuss the empirical findings in relation to the study's background and previous research.

5.1 Expanding the use of the official veterinarian

Animal welfare and food safety is tightly regulated on both European and national levels, and official controls performed by veterinarians of the SFA are critical for ensuring both. In Sweden, as well as other European countries, the veterinary inspection during OFES and OFS is especially critical to uphold due to the difficult circumstances of performing slaughter on farm-level of animals with often sub-par health and welfare. However, the attitudes and interests of abattoirs showed that their overall reluctance to participate in OFES and OFS where often linked to the veterinary inspection. Interestingly, the disadvantages associated to the current system of inspections were often linked to the very purpose behind them being so strict – issues of animal welfare and food safety. Thus, there might be of interest to investigate ways to change the current legislations regarding veterinary inspections. By having a strict interpretation of "official veterinarians" as employees of the SFA, the abattoirs' perceived bottleneck of veterinary inspections might be tightened more than necessary. This is especially true for the ante-mortem inspection, which abattoirs perceived as the biggest threshold. Here, one suggestion would be an adjustment of whom is seen as an official veterinarian within the terms of the European control regulation (Council directive (EU) 2017/625). Since the regulation calls for a "veterinarian, appointed by a competent authority, either as staff or otherwise", this could also include district veterinarians, who as employees of the SBA arguably is a competent authority. This would increase the availability veterinarians eligible for ante-mortem inspection for OFES and OFS, both in terms of numbers and geographical location. It would also be an effective measure regarding the lack of veterinarians in Sweden (Regeringskansliet 2021). Increasing the toolbox of the current work force would arguably be more resource effective than educating and employing more official veterinarians for the SFA. Since acute injuries and the demand of OFS is relatively rare, current veterinarians could have the possibility to include it in their daily work. If inspections could be performed

by the district veterinarian whom the animal producers already have assigned, the need of contacting, and paying for 2-3 veterinarians would be eliminated.

Another option, aside total veterinary inclusion of official controls, would be to provide an additional training course for ante-mortem inspection, similar to the system used in Norway which has proved to be effective for with 44 % of all dairy cattle deaths on farm having undergone OFES (Hultgren 2019). Similar to Norway, Finland and Denmark, the SFA should also provide online injury criteria and guidelines with for the practice of OFES, something that is unavailable today (Skúladóttir et al. 2022). Such guidelines could include a clear action plan depending on the type of injury or illness, its severeness and whether OFS or OFES is recommended. This could decrease the fear and anxiety that animal owners may feel about being reported for sending animals with sub-optimal welfare to slaughter.

5.2 Implementation of OFS as a tool for non-acute injuries

Meat cannot be salvaged from all injuries that animals might sustain on farm level. Animal suffering must be minimised and when serious accidents occur, farmers are left with no choice but to euthanise immediately, ruling out OFES. Simultaneously, animal with non-acute injuries might be suitable for transportation and slaughter, but they do not fulfil the requirements for OFES since they have not suffered an accident (Regulation (EC) No 853/2004, 2022), often resulting in destruction of the animals instead. Due to the Swedish interpretation of the EU legislations for OFS and OFES, there are reasons to believe that a grey area exists in-between the two for non-acute and minor injuries. To salvage the meat of animals within this grey area, one solution could be for farmers and abattoirs to utilise OFS for animals with slight and non-acute injuries.

Many minor injuries are not outright accidents and thus not applicable for OFES (Regulation (EC) No 853/2004, 2022). Such minor injuries could be certain infections and inflammations that over time can cause lameness. Nevertheless, they are injuries that might pose risk of animals being injured on the transport, thus making them applicable according to OFS criteria (*Regulation (EC) No 853/2004*; Livsmedelsverket 2022). This could incorporate cattle and pigs with earlier-stage lameness in a similar fashion to that of Norway's expanded regulation on OFES, which incorporates lame animals whose treatment has not seen sufficient improvement in seven days (Mattilsynet 2022; Skúladóttir et al. 2022). Lameness alone is responsible for 18 % and 28 % of euthanised cattle on dairy- and meat farms respectively (Burvall, unpublished material), while also being one of the most common reasons for euthanising Swedish and Danish sows (Kirkden et al. 2013; Jordbruksverket 2022). Being such a large reason for the euthanising of animals on

farm-level also means there is potential to salvage meat if destruction is avoided. Implementation on OFS for non-acute injuries would also be beneficial in regard to the current demand for an ante-mortem inspection by an OV due to the planned nature of the slaughter, as opposed to OFES.

However, the implementation of an OFS-system for non-acute injuries would require a clear understanding of how OFS in Sweden should be defined. According to the interview with their representatives, the SFA described OFS as a planned slaughter for "perfectly fit and healthy animals", whereas OFES for animals injured by accident, leaving room for doubt regarding the slightly injured animal, such as lameness. The SFA's mentioning of OFS as a method for "ethical, premium products" may hold value to small producers focused on quality meat, but their interpretation of the European legislations could arguably be made differently if seeking to limit meat loss due to on-farm mortality. As of 2023, no OFS is yet to be performed.

5.3 Challenges and opportunities to OFES limitations

Thoughts and attitudes raised during interviews converge in an overall scepticism about OFES and OFS. The abattoirs and interest organisations' beliefs note many shortcomings regarding the economically vulnerable structure of OFES which is expressed through the low value of pigs. Further, the high costs of equipment, personnel, and running of facilities along with a fear of consumer reactions towards OFES. Yet, some thoughts were voiced on potential opportunities regarding OFES through either subsidies or different payment models.

The ability to receive OFES carcasses was identified as a barrier among interviewed abattoirs. Interviewees stated that their current facilities are not constructed for the reception of OFES carcasses and claims of hygienic legislation which prohibits the reception of carcasses along with regular slaughter reception. Thus, a need was identified to construct a separate OFES reception building in relation to the abattoirs. Similarly, 89% of interviewed Irish Food Business Operators would not accept OFES, due to perceived food safety risks or bad meat quality (McDermott & Mckevitt 2015). Codes of conduct along with customer agreements were by abattoirs also stated as the main drivers of declining any processing or handling of carcasses.

The economic viability of OFES was another identified barrier highlighted by the interviewees. Causes of concern could be derived from a general perception that pigs are of a low economic value of pigs. Access to the necessary equipment to perform OFES could also become an economic complication, although it was presented as a technical limitation. Recent literature by McDermott et al. (2022) concurs with this, stating that Irish farmers perceive OFES as economically unfeasible. High operational costs along with minimal compensation for the animal

translate into similar economic prospects that of sending the animal for destruction. Yet, projected a more optimistic outlook for cattle regarding OFES potential, as the economic value of cattle is higher.

A few participants mentioned that the current OFES payment model needs to be altered. Subsidies were suggested as a potential solution, which is in line with results seen in McDermott et al. (2022). Another interviewee proposed a solution where acutely injured animals could be emergency slaughtered free of charge by an abattoir, however, letting the abattoir in question keep any potential earnings from the animals. In this manner, the producer would save the disposal cost of the animal. Magalhães-Sant'Ana et al. (2017) concluded that subsidies could be given for disposal fees of the producers, given that OFES was not feasible.

Consumer reactions were also expressed by participants in the current study as being a concern in terms of OFES. Commercialising emergency slaughtered animals were perceived as negative, as consumers might not conceive the environmental value but rather potential misconduct of animal welfare. Similar findings were seen among dairy industry professionals in British Columbia, Canada, where low knowledge on agricultural practices could potentially lead to misinterpretation (Koralesky & Fraser 2018).

Although not explicitly mentioned by the interviewees, the general distribution and opportunity to OFES are not widely available. Only 29 active abattoirs in Sweden are certified for OFES, which reduces potential slaughter facilities by approximately two-thirds[5]. Along with a general lack of means necessary to conduct OFES, this could explain the relatively low numbers of recorded emergency slaughters in Sweden during 2020 (n=94) in comparison to 4,2% of Norway's total cattle slaughter being OFES (Skúladottir et al. 2022).

5.4 The potential of game-handlings establishments

Since almost all GHE expressed the practical ability to accept whole carcasses of cattle and pigs, there is an argument to be made for their potential role in a function system of OFES. Whereas the interviewed abattoirs expressed technical difficulties of receiving and processing carcasses on their production lines, GHE's are already built and adapted for such handling. Due to comparable sizes of moose and cattle, as well as wild boar and pigs, GHE of the respective type could arguably handle farm animals as well, and their current tools and equipment would likely be appropriate. Also, such a system would benefit animal farmers in rural areas. In the current geographical structure of abattoirs of cattle and pigs, abattoirs are few and distances are vast, whereas the number of GHE are greater and more spread out

[5] Livsmedelsverket, Control Division, e-mail 2023-03-20

throughout Sweden (see figure 5). Currently, there are already 78 GHE-certified abattoirs capable of receiving pigs and cattle.

As per EC 853/2005, the regulatory framework for OFES, OFS and large wild game are highly similar except for the ante-mortem inspection. Both include similar general guidelines, where animals are bled, gutted, and accompanied by offal and the ante-mortem documentation to the slaughtering facility. However, by current regulations GHE are not allowed to perform slaughter of pigs and cattle. Here, we see two possible solutions. The first would be an adjustment of the regulations, allowed GHE to engage in OFES of farm animals. The drawback of such a solution would on the other hand be the juridical work required to change the regulation on a European level. The second, and simpler solution, would be an initiative to register current GHE for OFES and OFS of farm animals. An appropriate start would be the 78 GHE already certified for slaughter of cattle and pigs.

In such a system, farmed animals would be allowed to be euthanised at farm-level and immediately transported to a GHE for slaughter. This would either be performed by the personnel of the GHE, or the farmer under the supervision of an official veterinarian. After transport to the GHE, it would undergo post-mortem inspection by an official veterinarian in line with the current regulations or both abattoirs and GHE (EC 853/2005), ensuring proper food safety. Such a program could be run as a proof-of-concept, testing a few facilities, and evaluating their success.

6. Conclusions

To conclude and answer the aim and research questions, this chapter will present the major findings of the study, identify limitations, as well as make suggestions for further research.

The aim of this study was to investigate and present the attitudes and needs of abattoirs and key industry actors to initiate or increase on-farm slaughter (**OFS**) and on-farm emergency slaughter (**OFES**) of cattle and pigs. When interviewed, the respondents raised concerns regarding the financial and technical abilities to conduct such operations. There is a belief that cattle are the only animal viable for OFES and OFS, due to a higher economic value compared to pigs. Also, the current system of official veterinary controls was perceived as a barrier for OFES and OFS. Due to better capabilities of handling carcasses, game-handling establishments could have potential in a functioning system of OFS and OFES. The dense geographical structure of abattoirs, game-handling establishments (**GHE**), and producers in southern and south-western parts of Sweden is more suitable for potential attempts at establishing OFS or OFES. Concluding, recommendations for improving a system of OFS and OFES are to investigate the potential of expanded veterinary controls, using OFS as a tool for non-acute injuries and as well to investigate the potential of GHE for OFS and OFES.

6.1 Limitations

Upon completion of the study, there are some limitations that should be acknowledged. One is since documentation regarding OFES in Sweden is so scarce, there was little known information of its history. Although it would have been preferable to study historical legal documents, payment models and technical practices, the lack of governmental and scholarly publications prevented a thorough background of Swedish historical practices. Due to time limitations of the thesis writing, interviews and research of its history had to be excluded. Such limitations in time also prevented the interviewing of retailers and consumers. This would have been valuable to investigate since several abattoirs mentioned the potential of negative reaction from the market if they were to engage in OFS and OFES. Lastly,

as the interviews were finalized, none of the abattoirs that performed the 94 OFES of cattle in 2021 (Jordbruksverket 2022) had been interviewed. If possible, the inclusion of those opinions would have nuanced the overall perception, possibly providing the positives and possibilities of engaging in OFES.

6.2 Future research

To close knowledge gaps still to be answered regarding OFES and OFS in Sweden, some recommendations for future research topics will be presented.

First, there is a lack of available information and knowledge on the previous use of OFES in Sweden. Although most interviewees of this study were aware of OFES history in Sweden, little documentation was found. A comprehensive investigation of the historical system would provide vital knowledge on how a new system could be implemented again. A review of its advantages and disadvantages would provide valuable insights for future implementation. By collecting and compiling of pre-EU regulatory framework, as well interviewing key stakeholders, valuable insights could be provided for researchers and lawmakers.

Second, there is potential for agroeconomics to develop a functioning payment model for both OFS and OFES. This would preferably be conducted with the help and approval of farmers, abattoirs, and retailers to ensure robustness of the economic model. Such models could include the variables such as the pricing of animals of different classes, as well the costs of transportation, veterinary inspections, and potential investment for abattoirs necessary for conducting OFS and OFES.

Finally, a future research recommendation is to investigate the legal possibilities of expanding the current system of veterinary controls in Sweden. Modifications should be made for reducing the time and cost of acquiring permissions for OFES and OFS, while staying within the regulatory frameworks of the European Union.

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Popular science summary

Almost a third of all food produced is lost or wasted (Gustavsson 2011), resulting in wasted opportunity to decrease environmental impact or to increase food production with retained level of emissions. Although the Swedish Environmental Protection Agency (n.d.) stated that consumers are responsible for the largest share of food waste, a recent study conducted by the Swedish Board of Agriculture (**SBA**) indicates that there is a large share of potential food loss at farm-level (2021). One suggestion from the SBA is to investigate the potential of on-farm slaughter (**OFS**) or on-farm emergency slaughter (**OFES**). OFS is a method of euthanising animals on the farm in cases where transport could potentially harm an animal or keeper. Similarly, OFES implies a slaughter on the farm but is only conducted when an animal is acutely injured and needs to be euthanised. This would benefit producers economically unlike the current system, where animals are sent to a destruction facility for non-food purposes.

Today, OFES is rarely used, and OFS has not been commercially performed yet. Therefore, the study aimed at identifying the attitudes and interests regarding of Swedish abattoirs and other industry actors to initiate or increase use of OFES or OFS. It also investigated where such a system could be implemented and how it potentially could be improved from its current state. To investigate this matter, 20 interviews were conducted. The group of people interviewed represented abattoirs of different sizes, industry organisations, veterinary consultants and game-handling establishments (GHE). To better understand the situation and landscape of OFS and OFES, the study review current European slaughter regulations, attitudes and perceptions among stakeholders of the animal industry, the use of OFES in other Nordic countries, as well the reasons for on-farm mortality of pigs and cattle.

The interview results showed general concern about the economic viability of OFES and OFS. High costs of operating OFES or OFS as well as low economic value of pigs were expressed as barrier for initiating or increasing the use OFES or OFS. Further, technical limitations such as the reception of OFES or OFS carcasses was perceived as barriers as well.

It was also found that veterinary inspection was believed to obstruct the further development of OFES and OFS. Official veterinarians are too few and it takes too much time to acquire a permit when dealing with injured animals. This could put animal welfare at risk in the current system, and animal welfare must be held at the

highest priority. However, some abattoirs argue than other solutions are better than OFES and OFS, such as transport optimisation of injured animals.

The interviewed GHE were positive towards re-establishing OFES, where a large majority of them stated they would have the practical ability to receive carcasses of pigs and cattle. Further, some of the interviewees also mentioned that there is a lot of waste of good meat and highlighted the potential to reduce food waste. However, there were also some concerns, mainly regarding the profitability of OFES and the legislative demands.

Concluding the study, some recommendations were giving for potential improvements. Investigations could be made regarding the potential of expanding the system of veterinary controls, using OFS as a tool for non-acute injuries as well as if GHE could be used in a system of OFS and OFES.

Appendix 1

▼B

CHAPTER 5

Model animal health certificate in the case of emergency slaughter outside the slaughterhouse in accordance with Article 4 of Commission Delegated Regulation (EU) 2019/624 (5)

MODEL ANIMAL HEALTH CERTIFICATE IN THE CASE OF EMERGENCY SLAUGHTER OUTSIDE THE SLAUGHTERHOUSE

ANIMAL HEALTH CERTIFICATE

In the case of emergency slaughter outside the slaughterhouse

Name of the official veterinarian: .....

No: .....

1. **Identification of the animals**

   Species: .....

   Number of animals: .....

   Identification marking: .....

   Owner of the animals: .....

2. **Place of emergency slaughter**

   Address: .....

   Identification of house (*): .....

3. **Destination of the animals**

   The animals will be transported to the following slaughterhouse: .....

   .....

   by the following means of transport: .....

4. **Other relevant information**

   .....

5. **Declaration**

   I, the undersigned, declare that: .....

   (1) the animals described in Part I were examined before slaughter at the above-mentioned location at ..... (time) on ..... (date) and were found to be fit for slaughter,

   (2) they were slaughtered at ..... (time) on ..... (date) and the slaughter and bleeding were carried out correctly,

   (3) the following was the reason for the emergency slaughter: .....,

   (4) the following observations on the health and welfare of animals were made: .....,

   (5) the following treatments were administered to the animal(s): .....,

   (6) the records and documentation concerning these animals satisfied the legal requirements and did not prohibit the slaughter of the animals.

(5) Commission Delegated Regulation (EU) 2019/624 of 8 February 2019 concerning specific rules for the performance of official controls on the production of meat and for production and relaying areas of live bivalve molluscs in accordance with Regulation (EU) 2017/625 of the European Parliament and of the Council (OJ L 131, 17.5.2019, p. 1).

▼B

Done at: .....,
(Place)

on: .....
(Date)

Stamp

.....
(Signature of official veterinarian)

(*) optional

Appendix 2

Veterinärintyg vid nödslakt

I Europaparlamentets och Rådets förordning (EG) nr 853/2004 om fastställande av särskilda hygienregler för livsmedel av animaliskt ursprung föreskrivs i bilaga III, avsnitt I, kapitel VI om nödslakt utanför slakteriet. Där stadgas bl.a. att:

- endast friska djur som råkat ut för en olyckshändelse får nödslaktas.
- tiden mellan undersökningen av djuret och avlivningen inte får överstiga 24 timmar.
- det avlivade och avblodade djuret ska transporteras utan onödigt dröjsmål till slakteriet på ett hygieniskt sätt.
- om det tar mer än två timmar mellan avlivandet av djuret och dess ankomst till slakteriet ska det kylas.
- ett nödslaktsintyg alltid ska åtfölja ett nödslaktat djur till slakteri.

1. Djurets identitet

Djurslag: _____ Kön: _____ ID-märkning: _____

2. Djurets ursprung

Jordbruksanläggningens namn, adress, telefonnummer och produktionsplatsnummer:

3. Djurets destination

Slakteri: _____

Transportmedel: _____

4. Djurets tillstånd

Motiv till nödslakt:

Ev. behandling:

5. Deklaration

Undertecknad intygar härmed att (för att nödslakt ska kunna ske måste alla tre förutsättningarna vara uppfyllda och tydligt ikryssade.):

- ❒ Ovan angivna djur är ett för övrigt friskt djur som har råkat ut för en olycka som, med beaktande av djurets välbefinnande, förhindrar dess transport till slakteriet.
- ❒ Ovan angivna djur har genomgått besiktning före nödslakt på ovanstående jordbruksanläggning kl. ……datum……..
- ❒ Journaler och dokumentation som avser detta djur uppfyller rättsliga krav och utgör inget hinder för slakt.

Ort _____ Datum _____

Veterinärens underskrift _____ Namnförtydligande/Stämpel _____

6. Bedövning och avblodning

Bedövning och avblodning har av undertecknad utförts i enlighet med gällande lagstiftning

Datum, klockslag _____ Behörig slaktare namn/namnförtydligande _____

LIVS 071 2013 01 slv Intranät

LIVSMEDELS VERKET

Adress Box 622, 751 26 Uppsala
Telefon 018-17 55 00
Telefax 018-10 58 48
E-post livsmedelsverket@slv.se
www.livsmedelsverket.se

▼B

Done at: .....
(Place)

on: .....
(Date)

Stamp

.....
(Signature of official veterinarian)

(*) optional

Appendix 3

▼B

CHAPTER 3

Model animal health certificate for farmed game, domestic bovine, porcine and equine animals slaughtered at the holding of provenance in accordance with Article 6(3) of Commission Delegated Regulation (EU) 2019/624 [3]

Name of the official veterinarian: .....

No: .....

1. **Identification of the animals**

Species: .....

Number of animals: .....

Identification marking: .....

2. **Provenance of the animals**

Address of the holding of provenance: .....

Identification of house (*): .....

3. **Destination of the animals**

The animals will be transported to the following slaughterhouse: .....

.....

by the following means of transport: .....

4. **Other relevant information**

.....

5. **Declaration**

I, the undersigned, declare that: .....

(1) the animals described in Part I were examined before slaughter at the above-mentioned holding of provenance at ..... (time) on ..... (date) and were found to be fit for slaughter,

(2) they were slaughtered at the holding of provenance at ..... (time) on ..... (date) and the slaughter and bleeding were carried out correctly,

(3) the following observations on the health and welfare of animals were made: .....

(4) the records and documentation concerning these animals satisfied the legal requirements and did not prohibit the slaughter of the animals.

[3] Commission Delegated Regulation (EU) 2019/624 of 8 February 2019 concerning specific rules for the performance of official controls on the production of meat and for production and relaying areas of live bivalve molluscs in accordance with Regulation (EU) 2017/625 of the European Parliament and of the Council (OJ L 131, 17.5.2019, p. 1).

Ifyllande av Veterinärintyg vid nödslakt

Blanketten kan ifyllas elektroniskt eller för hand. Signering ska dock alltid ske för hand av den som utfört undersökningen i samband med nödslakt. Förutbestämda blankettuppgifter (fältnamn etc.) får inte ändras.

Fältnamn	*Anvisning*
1. Djurets identitet	
Djurslag	Det berörda djurslaget anges.
Kön	Det berörda djurets kön anges.
ID-märkning	Det berörda djurets ID-märkning anges.
2. Djurets ursprung	Jordbruksanläggningens namn, adress, telefonnummer och produktionsplatsnummer anges.
3. Djurets destination	
Slakteri	Det slakteri till vilket djuret ska transporteras anges (namn, godkännandenummer och adress).
Transportmedel	Det transportmedel som ska användas för transporten till slakteriet anges om möjligt.
4. Djurets tillstånd	
Motiv till nödslakt	Motivet till nödslakten anges.
Ev. behandling	Om veterinären vid undersökningen behandlat djuret med veterinärmedicinska preparat eller motsvarande anges detta.
5. Deklaration	Tidpunkten för utförd besiktning före slakt anges av den besiktigande veterinären med klockslag (TT.MM) och datum (ÅÅÅÅ-MM-DD).
Ort	Den ort intyget utfärdats i anges.
Datum	Det datum då intyget signerats anges (ÅÅÅÅ-MM-DD).
Veterinärens underskrift	Att resultaten av besiktning samt kontroll av information från livsmedelskedjan varit tillfredsställande och att djuret därmed kan godkännas för slakt intygas av veterinären genom underskrift.
Namnförtydligande/stämpel	Den signerande veterinärens namn anges tydligt med tryckbokstäver eller med stämpel.
6. Bedövning och avblodning	Att bedövning och avblodning skett enligt gällande lagstiftning intygas genom underskrift av den som utfört bedövningen och avblodningen.

Hantering av ifyllda intyg

Ifyllda intyg i original ska medfölja de berörda djuren till slakteriet.

Appendix 4

Start

- Vill du börja med att berätta lite om dig själv, dina arbetsuppgifter och det slakteri du driver/arbetar för?
    - Bakgrund, utbildning, arbetsuppgifter, titel
    - Företagets verksamhet, marknadsandelar, anläggningar, producenter anknutna

Första åsikt

- Hur skulle du beskriva era åsikter och tankar kring nödslakt/SPJ?

- Erbjuder ni nödslakt idag? Planerar ni att nyttja möjligheterna till slakt på jordbruksanläggning?
    - Är ni medvetna om möjligheterna med nödslakt samt slakt på jordbruksanläggning?
    - Har ni möjlighet att göra det? Finns det intresse?
        - Varför inte? Saknas det resurser? Om ja, hur stora resurser? Skulle ni påbörja om ni fick stöd? Av vem?

- Finns det några tekniska problem med att påbörja/utöka nödslakt/SPJ?
    - Utformning av lokaler? Ta in kadaver i nuvarande slaktintag?
    - Kommunikationskanaler mellan slakteri/veterinär/producent, hur ser det ut?
        - Finns det möjligheter till förbättring?
    - Enligt SLV har slakterier svårt att ta in kroppar som legat längre än en timme, hur arbetar ni kring detta? (Stämmer det?)

- Ekonomiska problem? Finns det någon upplevd ekonomisk fördel/nackdel med att ta emot nödslaktade djur?
    - Skillnader ekonomiskt mellan gris och nöt?

- Legala problem? Hur påverkar regelverken arbetet för er gällande nödslakt/SPJ?
    - Är det tydligt huruvida nödslakt/SPJ fungerar enligt regelverken?

- Kompetens/personal
    - Utbildningar?

- Konsumentperspektiv
    - Potentiellt problem med att sälja nödslaktat kött?

Appendix 5

Vi vill undersöka om slakterier som hanterar vilt kan användas för att motta redan avlivade, kor och grisar, i och med att de redan idag tar emot avlivade djurkroppar. Det är därför vi ringer just er, då vi sett att ni är godkända för vilthantering.

- Vilka djurslag slaktar ni idag?
- Vilket typ av vilt köper ni in idag?
    - Köper ni in det av jägare eller har ni eget, inhägnat vilt?
- Om man bortser from huruvida ni faktiskt är intresserade eller är tillåtna att göra det, skulle ni ha praktisk möjlighet att ta emot en avlivad ko eller gris för att slakta upp det?
- Tror du att er verksamhet skulle kunna utvecklas genom att ta emot leverans av avlivade kor och grisar för slakt?

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