Organic beef production = sustainable beef production?

An analysis of key sustainability criteria in the sector

Maria Svantemark

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LUCSUS
Lund University Centre for Sustainability Studies

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Submitted May 13, 2015

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Abstract

Organic production of beef is viewed as one strategy to mitigate negative externalities deriving from beef production. This study seeks to characterize key attributes of production among organic and conventional beef producers in Skåne, Sweden. The goal is to understand the extent to which their differentiation as organic or conventional is based on the practices which make them semantically different. Few previous studies have questioned the basis for the characterization and differentiation of the systems. This study is carried out through the lens of the *quadruple bottom line*, meaning that not only the triple bottom line values of environmental, economic and social sustainability but also animal welfare is considered. Previous studies have insufficiently treated these four pillars of sustainability separately and failed to address the combined effects of beef production on the environment, human health, animal welfare, and economic revenues for the producer.

A cross-sectional approach with multiple cases chosen by purposeful sampling was used to enable the comparative approach this research. By comparing different meat production systems in Skåne, it became clear that there is not a dichotomy between organic and conventional meat production systems. Instead, this research shows that there is a continuum, and that there is no strong basis for the development and application of policies based solely on the semantic distinction of meat production. This finding implicates that other bases for policies need to be considered to enable sustainable meat production in Sweden. By not only incorporating all three pillars of sustainability but going beyond by including animal welfare in a quadruple bottom line, policies with a true holistic approach are suggested.

Keywords: Sustainable meat production, organic vs. conventional, quadruple bottom line, human and animal welfare, externalities, policy recommendations

Word count: 13 999

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C	Conventional
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EU	European Union
GHG	Greenhouse gas
kg	Kilogram
MJ	Megajoule
O	Organic
O-KRAV	Organic, KRAV-certified
OLA	Outdoor Loafing Area

1. Introduction

The production and consumption of meat has increased significantly over the last decades. As the world's population and affluence is expected to increase in the future, the growing trend of meat consumption is expected to continue (Jordbruksverket, 2013b). The increase could only be realized due to an increasingly intensive and industrialized production process, starting after WWII (van Otterloo, 2012). However, a modern set of regulations to address environmental issues and animal welfare have not followed the modernized production (Thorne, 2007). Major and diverse environmental impacts are associated with this production, especially beef production, and ethical concerns towards social and animal welfare have been raised. The development of an efficient and responsible meat production system has to be contextualized, as, for example, climate and culture influence. However, environmental and social issues as well as animal welfare can be expected to be considered when discussing responsible livestock production (Place & Mitloehner, 2014).

1.1 Global meat consumption and production trends

The increased consumption of meat is not only attributed to a larger global population, but also with, for example, dietary trends, cultural factors, and increased wealth and access to meat (The Government Office for Science, 2011). However, the consumption of meat varies strongly by region. While the global per capita intake of all types of meat aggregated is 42.2 kg (in 2011), the per capita intake within the European Union (EU) is almost twice as high: 76.00 kg (FAOSTAT, 2015). By 2050, total global meat consumption is expected to increase by 58% (Food and Agriculture Organization of the United Nations [FAO], 2012). As a response to a higher demand for animal products, the production increases. In 2013, 308.5 million tonnes of animal products were produced, of which bovine meat accounted for 68 million tonnes (FAO, 2014).

1.2 Impacts of global meat production

It is broadly accepted that meat-based diets require more energy and other resources, and therefore have larger environmental side effects than plant-based diets (Kanaly *et al*., 2010). Meat production is the largest user of agricultural land, (FAO, 2013) and is associated with one fifth of total global greenhouse gases (GHG) emissions, nitrogen and phosphorous emissions, and biodiversity loss (Jordbruksverket, 2013b). Other externalities include high water use and water contamination, the release of antibiotics and pathogenic contaminants into the food-chain and the environment, and land use changes (Kanaly *et al*., 2010). In terms of environmental impacts, it is not only the amount of meat produced that matters: different types of meat, production systems, sizes of farms, and many other aspects have to be taken into account. Generally, beef has the largest environmental impact, mainly due to the methane gas that is produced by ruminants (Jordbruksverket, 2013b). Social implications of meat production include displacement and loss of livelihood due to environmental degradation and climate change (Intergovernmental Panel on Climate Change [IPCC], 2014), public health concerns, and an increased risk of pandemics and diseases, partly due to the dissemination of antibiotic-resistant bacteria (Landers *et al*., 2012). The welfare of the farm animals in terms of both physical and mental health is considered to be an important attribute of high quality food (Welfare Quality, 2009). The extensive externalities associated with agriculture are one reason for the ample political control of the sector (Jordbruksverket, 2009a).

1.3 Meat consumption and production in the Swedish context

The total private consumption in Sweden accounts for eight tonnes of CO_2-equivalents (CO_2e) of greenhouse gases per capita each year, of which 25% is derived from food consumption with meat being the largest contributor (Naturvårdsverket, 2011). To reach a sustainable lifestyle, no more than 2 tonnes of CO_2e per person and year should be emitted by 2050. The Swedish consumption is therefore not sustainable (Naturvårdsverket, 2011). About 16% of the arable land in Sweden is farmed organically, of which 13% is according to KRAV’s standards. The rate of increase of area under KRAV certified crop cultivation is slowing down. The same pattern applies for KRAV certified cattle (KRAV, 2014b). In 2013, the organic beef production in Sweden accounted for almost 15% of the total beef production (Jordbruksverket 2013a). The debate about different types of meat and production systems as well as the increased availability of organic meat are explained as drivers behind the increase. As the level of the agri-environmental payments is unclear in the coming Rural Development Programme, the future trend is hard to predict (KRAV, 2014b).

While it is broadly acknowledged that current meat production and consumption is unsustainable (Jordbruksverket, 2013b; Naturvårdsverket, 2011; Kanaly *et al*., 2010), there is no consensus on alternative paths to mitigate negative externalities for meat production. Changing consumption patterns by exchanging animal products for vegetables is suggested to be the most efficient method (Saxe *et al*., 2013). Others include decreasing food waste (Jordbruksverket, 2009b) or substituting industrialized meat with game meat or from free roaming cattle which have less negative externalities (Jordbruksverket, 2013b). Further, an increased share of organically produced victuals can also decrease the negative impacts of food (Saxe *et al*., 2013). Organic production of meat is seen as one way of reducing the negative impact of meat production and consumption in the EU.

1.4 Organic production and KRAV certification in Sweden

Organic production within the EU is regulated by the Council Regulation (EC) No 834/2007 (June 28, 2007). This regulation states that meat sold as organic should come from animals bred on organic farms. The fodder should be organically produced, only specially approved products are to be used when cleaning, diseases should be prevented, and medications should only be used sparingly (EG nr 834/2007). However, EU: s regulations are only minimum requirements. In Sweden, the most widespread eco-label for food is KRAV, a private organization. KRAV certified food products are stricter regulated than products certified as EU organic, as, for example, more concern is taken to the animals' welfare (Krav, 2014a)[1]. KRAV's regulations include that the animals should be able to perform their natural behavior and fulfil their need of movement. The fodder should be KRAV certified and mainly be produced on the farm to gain maximum environmental benefits. All cattle above the age of six moths should have the possibility to be outside during more than 50% of the day during the grazing period, which in Skåne is four months. However, there are waiver clauses which exclude breeding bulls and young bulls reported for slaughter from the rule of grazing (KRAV, 2015).

1.5 Study goals and Research questions

This study will focus on beef production and will contribute to the knowledge on how to develop a sustainable meat cattle production system in the Swedish context. Many of the present studies on meat production focus solely on GHG emissions which can give a skewed picture, as other factors such as biodiversity loss and animal welfare can be disregarded (Röös *et al*., 2014). From here on in this study,

[1] For the complete set of regulations, please see KRAVs regler, utgåva 2015.

meat and beef will be used interchangeably, both referring to meat from *Bos Taurus.* When meat in general from all or other types of animals is discussed, this will be clearly stated.

The study seeks to characterize key attributes of production among meat producers in Skåne. The goal is to understand the extent to which their differentiation as organic or conventional is based on the practices which make them semantically different. Even though the effects of both organic and conventional meat production on the environment have been thoroughly studied, the combined effects on the environment, human health, animal welfare, and economic gains of the producer have not received as much attention. Ultimately, this study will result in policy recommendations which, considering the extensive political control in the sector, are crucial to obtain a sustainable meat production system. The goal is explored by two main research questions:

Research Question 1 (RQ1). Does the semantic difference translate to clearly distinguishable practical differences between conventional and organic meat production producers based on key sustainability criteria in the sector?

1.1 How does the environmental burden differ between organic and conventional meat production?
1.2 Does organic meat cattle production offer better opportunities for human and animal welfare than conventional meat cattle production?
1.3 How does organic meat cattle production compare with conventional meat production in terms of economic costs of production during the animals' lifetime at the farm?

Research Question 2 (RQ2). What lessons can be learned from organic and conventional practices that can foster sustainable outcomes for meat production in Sweden?

2.1 Does organic meat production mean sustainable meat production, and conventional unsustainable?

1.6 Scope of study

Studies on meat production systems and the differences between organic and conventional meat production have chiefly focused on aspects such as GHG emissions, nutrient load, economic externalities, and animal welfare. Few studies have questioned the basis for the characterization and differentiation between organic and conventional meat production systems. It seems to be taken for granted that by referring to a system as organic or conventional, the attributes that differentiate them will become abundantly clear to consumers of meat products and policies which guide their production. But is this truly the case? While the field of meat production is very extensive, for a number of practical reasons, this study limits its analysis within a defined scope:

- The impact of the meat production is limited to the time from when the calf is bought or born until it leaves the farm. This means that the spatial boundary of this study is at the farm's gate. All information from farmers in this report relate to 2014, unless otherwise stated.
- While acknowledging that other costs do exist, only the costs referring to the veterinary and antibiotics expenses, as well as the cost for fertilizers, disinfection and pesticides will be considered. Due to the large variability, these costs are ideal for estimating differences in production costs between organic and conventional producers. All costs and expenses are stated in SEK.
- Income will be measured as income per kg carcass weight. All incomes and revenues are stated in SEK.
- The pesticide and fertilizer use will, together with the type of manure used and the energy origin, be the environmental impacts considered. Studies have reported that the use of these chemicals have the potential to adversely affect the environment (FAO, 2013).
- Animal welfare will be measured by the cleanliness of animals, their nasal and ocular discharge, number of days on pasture and their access to outdoor loafing area, by management procedures such as disbudding and dehorning, and by the mortality rate on herd level. These are some of among a broader list of indicators developed and described in the Welfare Quality assessment protocol for cattle (Welfare Quality, 2009).
- Human welfare is assessed by considering the contribution of meat production systems to the betterment of society. Contribution to the development of education through the provision of educational tours and the provision of tourism services to local communities are indicators used. Indirect indicators such as the effects of environmental degradation and climate change and the effects of antibiotics usage on human welfare are further discussed.

After this introductory chapter, a review of the existing literature will be presented, including the theoretical framework guiding this thesis. In chapter three, the methodology is presented together with the research design and is followed by the results from the conducted fieldwork, presented in chapter four. These are discussed in the following chapter, after which polices for a sustainable meat production system is presented. Lastly, conclusions are drawn.

2. Review of literature and theoretical framework of the thesis

In the following sections, literature with importance for the understanding of the rest of this study is presented, opening with literature discussing resources needed and environmental impacts of meat production. Thereafter, socio-economic implications are discussed. Lastly, animal welfare literature is reviewed.

2.1 Resource use and environmental sustainability

The production of meat in general is associated to various environmental impacts of which some will be presented in this section. The complexity of beef production complicates the process of quantifying its environmental impacts. Studies on environmental impacts differ in terms of system boundaries, method, and allocation of impact to product and by-product and are therefore not always comparable (Sonesson *et al*., 2009). However, they give indications of environmental impacts from different systems.

Energy use between organic and conventional meat production systems can differ substantially. Tuomisto *et al*. (2012) found that the median energy use in organic beef production was almost 25% lower than its conventional counterpart. The higher energy use in conventional farming was explained by the energy needed to produce and transport synthetic fertilizers (Tuomisto *et al*., 2012). Sonesson *et al* (2009) reviewed the secondary energy[2] used in meat production in Sweden from studies examining different production systems and found that it ranges from 8-44 MJ per kg/meat. The lowest value was associated with organic grass fed free roaming cattle, whereas a hypothetic organic steer production had a value of 29 MJ/kg meat and meat deriving from conventional dairy cattle production had a value of 39-44 MJ/kg meat (Sonesson *et al*., 2009).

[2] By secondary energy use, the amount of oil, diesel and electricity used at the farm is measured. This does not include the energy needed to produce and transport fuel, or the energy needed to produce electricity (Sonesson et al., 2009).

Total global livestock production accounts for about 18% of GHG emissions as measured in CO_2e (FAO, 2006). GHG emissions from different beef production systems have been studied extensively. Mondelaers *et al*. (2009) found that organic farming has equal or lower emissions per unit area, when conducting a meta-study on both crop and meat production, which they attributed to a number of factors. The lower stocking-rate per unit area with higher ratio of forage associated with organic animal production has both positive and negative effects on GHG emissions. A high proportion of forage increases methane emissions, but on the other hand, producing and transporting feed concentrate and non-organic fertilizers and pesticides are CO_2 demanding activities. However, the positive effect on GHG emissions diminished partly or fully when calculated as per unit product, due to the lower land use efficiency of organic farming, which they found to be 83% of conventional farming's (Mondelaers *et al*., 2009). By altering the fodder towards more concentrated feed, methane emissions can be reduced due to faster growth of the animals and thereby shorter lives and due to changes in metabolism. However, positive externalities of meat production, such as grazing of animals which benefits biodiversity and the carbon sink function of grasslands, decreases with increased intensive farming (Sonesson *et al*., 2009). Another meta-study found that organic beef production accounted for about 15% less GHG emissions than conventional (Tuomisto *et al*., 2012).

Irrigation for agriculture accounts for 70% of global fresh water use (FAO, 2013). Meat production's water intensity is attributed to the animals' need for drinking water, service water, and irrigation of feed crops (Hoekstra and Chapagain, 2007). Eutrophication and pollution due to nitrates and antibiotics in the manure, and from fertilization and pesticides used in feed crop production can seep into the groundwater with detrimental effects on ecosystems and human health (FAO, 2006).

Nitrate leaching from agriculture is affected by a multitude of factors. Toumisto *et al*. (2012) found that nitrate leaching in organic farming systems was 31% lower per unit area, but 49% higher when per unit product was measured (Toumisto *et al*., 2012). Ammonia volatilization, the largest nitrogen loss from manure, is a complex process influenced by a magnitude of factors (Sonesson *et al*., 2009). In deep litter systems, 20% of the nitrogen from litter is lost due to volatilization in the stable and 30% of the stored nitrogen is lost. In solid manure systems, 4% is lost in the stable and 20% is lost during storage, and semi-liquid manure systems lose 4% in the stable and 10% during storage. Liquid manure systems have the highest efficiency when it comes to storing nitrogen, with a loss of 4% in the stable and 3% during storage (U. Listh, personal communication, March 30, 2015). Moreover, the losses to the atmosphere can be large when cattle are free roaming (Krumm, 2000).

Several studies and meta-studies have found a positive correlation between organic farming and biodiversity (Rahmann, 2011; Mondelaers *et al*., 2009). Tuck *et al*. (2014) reported 30% higher species richness in organic farming systems compared to conventional farming, a result which has been robust for the last 30 years without any sign of diminishing. The study also found that the more intensely used the surrounding landscape is, the larger is the effect size of organic farming on biodiversity (Tuck *et al*., 2014). A study on the effect of cattle grazing on biodiversity in southwestern Finland concluded that most plant species benefit from grazing (Pykälä, 2005).

2.2 Socio-economic sustainability

There are several social implications connected to meat production. Indirect consequences include the social consequences from environmental degradation and climate change (IPCC, 2014). These are, for example, an increase in injuries and deaths as a consequence of displacement of populations and more adverse weather events (McMichael *et al*., 2006), and imminent public health risks and food shortages as a result of land use change, increased water scarcity and climate change (Myers *et al*., 2013). Antibiotics use is another indirect negative effect of meat production on human welfare as it is increasingly recognized as a threat to human health due to contributions to antibiotic-resistant bacteria infections (Landers *et al*., 2012). The use of antibiotics in meat production is widespread, especially in conventional livestock systems. There is a potential for pathogenic-resistant organisms to transfer to humans via commensal bacteria, which have frequently been found in meat, when meat is consumed (Mena *et al*., 2008). Further, antibiotic-resistant bacteria have been found in close proximity to livestock production farms, and evidence that some antibiotic-resistant diseases in humans have been a result of antibiotic-use in farm animals do exist (Landers *et al*., 2012). Farming systems with high livestock density increases the risk for a rapid spread of pathogenic organisms and often requires the use of antibiotics (Landers *et al*., 2012).

Meat production farms also have possibilities to directly influence social welfare. Agritourism can create publicity for the local community and improve the welfare of rural communities. An additional benefit, in particular for small scale farmers, is the possible increase in revenues and thus in economic sustainability (Joo *et al*., 2013). Further, studies show that environmental behavioral change is better attained through real world experiences in informal institutions, such as farm visits, than by formal education (Knapp, 2000). Farmer *et al.,* (2007) found that increased proenvironmental attitudes and environmental knowledge retained in the long term after a field visit. Personal encounters with animals also contribute to children's knowledge of animals and biodiversity and can facilitate attitudes towards the importance of conservation of species (Patrick *et al.,* 2013).

One dominant factor of agriculture is the large fixed cost the land demands and the subsequent low flexibility in production (Roberts, 2008). The costliness of land means that the only response to price falls of products is an increase in production to spread the fixed cost on more products. Usually, investments in, for example, technology, more potent fertilizers, and faster growing breeds enable this increase. These additional costs have to be financed by intensified production. A vicious circle is created in which more is produced at a lower economic cost each year, but with increasing negative externalities which are not reflected in the price end consumers pay for the commodity (Roberts, 2008). On the other hand, it can be argued that the price for organic meat instead incorporates positive externalities, such as increased animal welfare, environmental protection, rural development (FAO, 2015), contributions to open landscapes, and increased biodiversity (Krumm, 2000).

Even though per animal productivity does not differ significantly between organic and conventional farms in Europe in general, per hectare efficiency is generally lower for organic farms (Nieberg and Offermann, 2003). The stocking rate on organic farms are 20-40% lower due to the higher spatial needs, the altered feed ratio towards more forage and less purchased fodder, and the lower yields in organic fodder production. To sustain economic profitability in the organic meat production sector, a higher farm-gate price is important. The premium depends partly on distribution channel (Nieberg and Offermann, 2003). Additional reasons for the higher price of organic meat are more expensive production due to increased labor costs and diseconomies of scale (FAO, 2015). The price premium and subsidies for organic products has shown to be important factors when farmers are converting from conventional to organic farming systems (Latruffe and Nauges, 2013).

2.3 Animal welfare

Animal welfare as an academic discipline is relatively young, but the interest is strongly increasing (Walker *et al*., 2014). Today, there is strong agreement among scientists that animal welfare is measurable and thus a scientific concept (Broom, 2011). However, what to include in the welfare concept is contested (Broom, 2011), and two main schools of thought have emerged (Duncan, 2005). Broom (1986) defines the welfare of an individual as: ”its state as regards its attempts to cope with its environment” (Broom, 1986: 524). The advocates of the biological functioning school argue that absence of (excessive) psychological stress (Broom, 1988), the ability to cope with the environment (Broom, 1986) and to satisfy biological needs are the central issues of animal welfare (Hurnik and Lehman, 1988). This view has been criticized for focusing solely on the biological functioning of the animal and ignoring the feelings of the animals[3] by, among others, Duncan (1993), who is an advocate of the feelings school. This contrasting view regards the physical wellbeing of an animal to be secondary to its feelings, which should be indicators of welfare. Duncan and Petherick (1991) argue that the welfare of an animal only is diminished when the physical health affects the mental state. However, this view has been questioned for not acknowledging other coping mechanisms than feelings, and further, the decreased welfare sickness induces in sleeping animals is ignored (Broom, 1998).

Further, there is no consensus on how to measure animal welfare, as the subjective feelings of animals are hard, if not impossible, to quantify (Röös *et al*., 2014). Broom (1986) argues that it is the welfare of the individual, and not of the herd, that matters. As individuals respond to the same situation in different ways, one single indicator can prove that welfare is poor and one indicator showing good welfare is not enough to proof good welfare (Broom, 1986). Some scientists argue that the most important factor when it comes to the animals’ health is the death rate among the calves (Sonesson *et al*., 2009). Additionally, a low death rate has a positive effect on the environmental impact from per kg meat, as the cow’s environmental impact is divided between her and her off-springs (Sonessson *et al*., 2009). Moreover, the externalities derived from the higher consumption of fodder needed when the cow is pregnant is excessive if the calf does not survive (Krumm, 2000).

[3] However, Broom refuted this criticism by arguing that feelings are an important aspect of the biological functioning of animals when they are trying to cope with their environment (Broom, 2011).

The Five Freedoms might be the most widespread concept of animal welfare for animals kept under intensive farming conditions. It was developed by a technical council on the initiative of the government of the United Kingdom in 1965. The Five Freedoms were stated in the report, known as "The Brambell Report" after the council's chairman, as the abilities for the animals to "stand up, lie down, turn around, groom themselves and stretch their limbs" (Brambell 1965, as cited in McCulloch, 2012, p. 960). In 1993, these freedoms were codified into guidelines to ensure fulfilment of both psychological and behavior needs of the animals. The current guidelines are (Farm Animal Welfare Committee, 2013):

1. *Freedom from Hunger and Thirst* – by ready access to fresh water and a diet to maintain full health and vigour.
2. *Freedom from Discomfort* – by providing an appropriate environment including shelter and a comfortable resting area.
3. *Freedom from Pain, Injury or Disease* – by prevention or rapid diagnosis and treatment.
4. *Freedom to Express Normal Behaviour* – by providing sufficient space, proper facilities and company of the animal's own kind.
5. *Freedom from Fear and Distress* – by ensuring conditions and treatment which avoid mental suffering.

Several attempts have been done to operationalize these freedoms. The Quality Welfare Assessment Protocol is the largest integrated project on animal welfare in Europe and might be the most ambitious attempt at operationalization that exists. The main focus is on individual animal-based measures (e.g. health aspects and behavior) in contrast to the conventional measurements of resources and management. It is argued that animal-based measures reflect the "outcome" of the other measures. (Welfare Quality, 2009).

2.4 Relevance to sustainability science

A multitude of interpretations of sustainability have emerged since the Brundtland commission defined it as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, Chapter 2, para.1) in 1987. Some definitions of sustainability, such as the triple bottom line, have become increasingly widespread. This concept gives equal importance to environmental, economic and social concerns when it comes to decision-making (Pope *et al*., 2004). The concept has been further developed by Rawles (2010) to include animal welfare in a quadruple bottom line. Clark and Dickson (2003) argue that all elements within nature-society systems have to be jointly understood for a full understanding of the system. The exclusion of animal welfare would thus mean that full understanding of the behavior of the system could not be possible. By not only incorporating all three pillars of sustainability but going beyond by including animal welfare in a quadruple bottom line I will suggest policies with a true holistic approach to ensure sustainable meat production.

2.5 Theoretical framework

This research is carried out through the lens of Rawles' (2010) *quadruple bottom line*. Rawles' (2010) has developed her theory in the light of the "*triple crunch*", i.e., the current economic, environmental, and social (poverty or inequality) crises. She argues that sustainable development is absolutely crucial for the future wellbeing of humanity, but that animal welfare has to be included as a core value. She underpins this by arguing that as sustainability is ethically aspirational and is concerned with certain desirable values crucial for our society to prosper in the long term, it cannot ignore billions of sentient beings and should thus include animal welfare. Further, instrumental rationality only rewarding economic gains should not be the foundation on which the worldview is based. Instead, a "quadruple bottom line" in which animal welfare values would be incorporated with the usual triple bottom line values should become the basis for policy making. Animal welfare should focus on the welfare and humane treatment of domesticated animals as individuals, as opposed to as part of an ecosystem or a species (Rawles, 2010).

Further, Rawles (2010) argues that ethical food production systems, in which not only profit is valued, will not emerge through the workings of the free market by educating consumers and label products. Instead, she promotes systematic interventions in the market through the workings of policy changes based on the values of the quadruple bottom line. These values would work in an interconnected manner and would include environmental values in relation to e.g. biodiversity, climate change, and pollution; social values such as reducing intragenerational inequalities; economic values which would focus on meeting human needs over generational barriers; and, lastly, animal welfare values which could, for example, be measured in relation to the Five Freedoms (see section 2.3) (Rawles, 2010).

3. Research design and methodology

In the following section, I will start by describing the research design I applied to this study. Thereafter, I will discuss the benefits of using case studies for this research and describe the characteristics of the cases, followed by a discussion of the data collection methods I employed.

3.1 Research design

In this research, I used a descriptive research design. As a multitude of different indicators for sustainability is investigated, a mixed methods approach was necessary. Further, I employed a micro-level cross-sectional approach with multiple cases chosen by purposeful sampling which benefitted the comparative approach of my research questions. Within the mixed methods approach I combined extensive research (the interviews carried out) with intensive research (the use of case studies and data from various sources) (Swanborn, 2010). Extensive research permitted me to make comparisons between units of observation (in this case the different farms I worked with). The advantage of this approach is that I could expand the 'width' of the information gathered. Intensive research permitted me to gather valuable information within each unit of observation. This allowed me to develop the 'depth' of information gathered (Swanborn, 2010). The mixed method approach has the possible benefits of confirmation of results and generation of increased knowledge compared to single research approaches (Olsen, 2010). Therefore, I use a combination of review of existing literature, interviews, and observations. Further, a cross-sectional design is suitable when multiple cases which share certain characteristics but differ in terms of variables of interest are studied at a single point in time (Bryman, 2012). In this study, meat production farms within the same geographical area were studied with focus on their different production systems in terms of environmental impact, human and animal welfare and economic gains.

The fieldwork was conducted in February and March in Skåne, Sweden. The assumptions are somewhat simplified, as complete evaluations were impossible to conduct due to time and resource restrictions. Further, the spatial boundary of the study means that environmental impacts, animal welfare and costs outside of the farm's gate are ignored. With primarily a background within economics, and not animal behavior science, the lack of proper training limited my choice of indicators from the Welfare Quality Assessment protocol for cattle. This could possibly influence the outcome of the welfare assessment.

3.2 Sampling routine and case studies

Case studies give the possibility to thoroughly investigate unique features of selected cases (Bryman, 2012). To fit the comparative approach of my research questions, I chose my cases on the basis of their differences rather than on their similarities, in accordance with Walliman's (2011) recommendations for comparative studies, wherefore purposive sampling was a more suiting sampling method. Purposive sampling is a non-probability sampling method most commonly used in qualitative studies in which subjects are selected on the basis of certain distinguishing characteristics of importance for the study (Tongco, 2007). It is useful when the research is aiming to compare different types of cases or when unique cases are examined, and can lead to more in-depth information of the carefully selected cases than the broad information from a larger number of cases probability sampling results in (Teddlie and Yu, 2007). In this study, profound understanding of heterogenic production systems with as many distinguishing features as possible was important to enable comparison of aspects in different systems which are of importance for sustainability. Purposive sampling is sometimes critiqued for being inherently biased and that sites could possibly be chosen due to convenience or on recommendations (Tongco, 2007). However, non-probability methods contribute to internal validation, and careful sampling of representative cases could also potentially provide external validity in the studied domain (Tongco, 2007).

Given that the aim of this study was to compare organic and conventional meat production, the first step was to identify farms within each group of interest. As a further goal was to investigate the differences within each production system, the second step was to analyze the respective differences of the farms within each group. With the help of Stefan Karlsson, chairman at the association Skånes Nötköttsproducenter, and extensive Internet research, candidates were identified based on factors such as number of animals, type of production system, label given to farm, ways of distributing the meat et cetera (Figure 1). This resulted in three farms labelled as conventional - Troedstorp, Rolsberga Gårdsarp and Sonarps gård, and three farms labelled as organic - Kongaö Säteri, Bosarps gård and Ängavallen (Table 1). Once the farms were identified, the questionnaire was sent to the farmers and a subsequent visit was conducted to interview them and observe the animals. By the following presentation of the cases studied, the reader will get an overview of key differences between the farms.

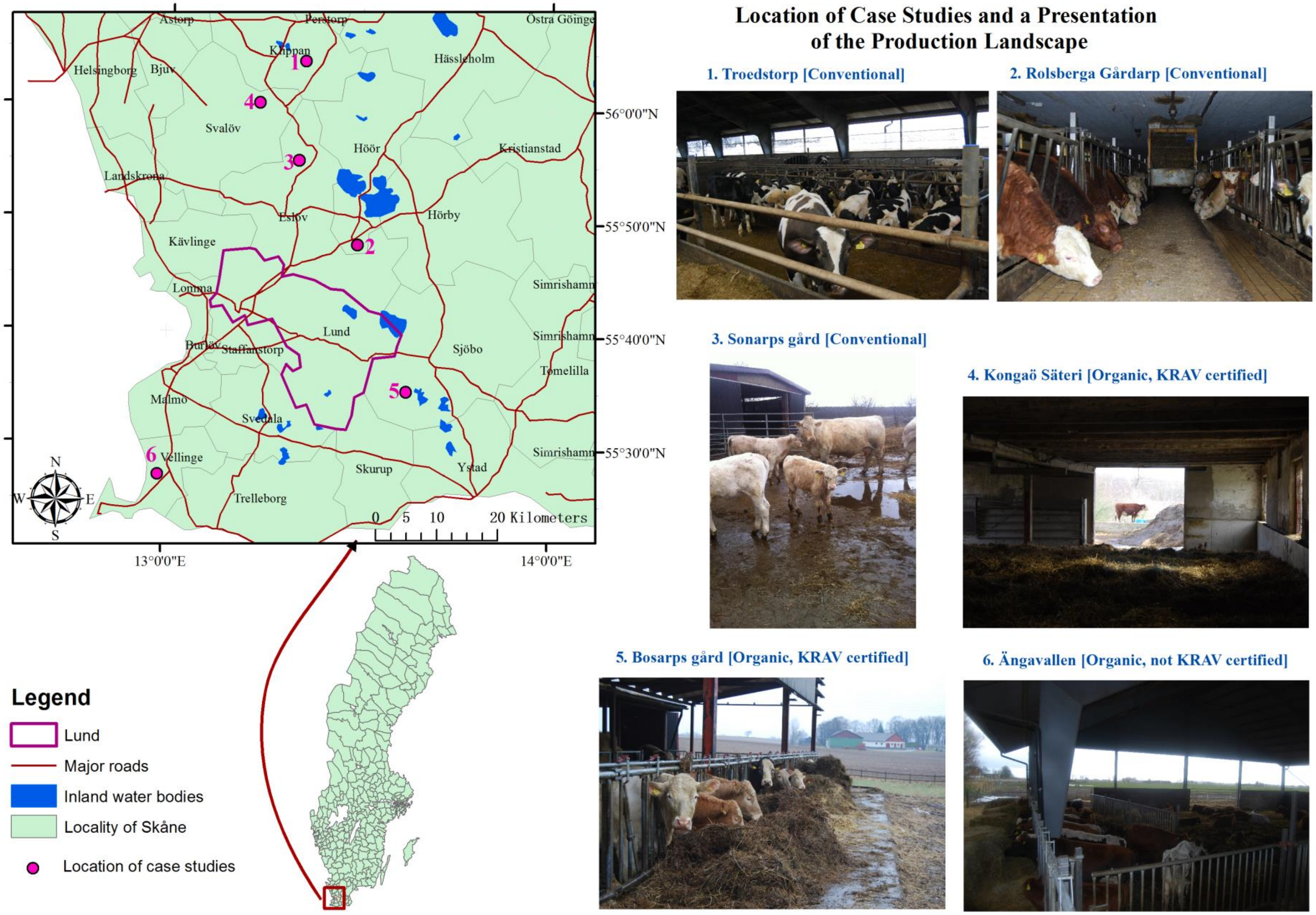


Figure 1. Location of case studies and a presentation of the production landscape.

3.2.1 Farm number 1: Troedstorp

The conventional production at Troedstorp is focused on young bulls which are raised in fully enclosed pens without outdoor access (Figure 1). The calves, mainly milk breeds, are bought when they are on average 18 days old, from five different milk farms, and are slaughtered at the age of 17 months. This cycle is being repeated continuously over the year. The meat is sold to HKScan, Sweden's largest company within meat and charcuterie. There are about 600-650 bulls mainly of Holstein breed (SLB: Svensk låglandsboskap).

3.2.2 Farm number 2: Rolsberga Gårdarp

Rolsberga Gårdarp buy 200-220 suckling bull calves from 4-15 different suppliers through HKScan in the fall at the age of 6-8 months and fattened over the winter. The about 30 heifers which are a net loss but necessary to graze semi-natural pastures are bought in the spring at the age of one year and slaughtered one year later. 70 bulls live in an open air shed with deep litter bedding and access to an impermeable Outdoor Loafing Area (OLA), the rest of the bulls are held in fully enclosed pens (Figure 1) with slatted floors without access to an OLA. The heifers are held in an enclosure with deep litter bedding without access to an OLA. The animals are a mixture of different heavy meat breeds and the meat is sold to HKScan.

3.2.3 Farm number 3: Sonarps gård

At Sonarps gård, Charolais (heavy meat breed) are bred to be sold either to other breeding facilities or to slaughter. A few 6-month-old purebred calves for slaughter are bought every year as well. There is a total of about 300 animals: 130 foster cows, 75 bulls, 75 heifers and 100 calves. They are held in open air sheds with deep litter bedding and access to an impermeable OLA partly covered with deep litter bedding (Figure 1). The meat is sold to the slaughterhouse.

3.2.4 Farm number 4: Kongaö Säteri

At Kongaö Säteri meat labelled Swedish Seal pasture-based and KRAV is produced. The meat production as a whole became KRAV-certified in 2008. The total number of animals is about 800. Currently, there are 240 foster cows, 10 breeding bulls, 220 calves, 170 heifers and 180 steers. The breeding bulls and the foster cows with their calves as well as some of the heifers and steers are held in sheds with deep litter bedding and access to a permeable OLA (Figure 1), whereas other heifers and steers are held in enclosures with varied bedding material and varied access to OLAs. The animals are mainly Hereford (light meat breed). The meat is sold and marketed as Hereford meat from Söderåsen. It is sold and delivered by the owners themselves to five different ICA stores, 14 restaurants, and directly to private persons.

3.2.5 Farm number 5: Bosarps gård

At Bosarps gård all calves are breed to be slaughtered, no animals are sold and very few are bought. They are held in an open air shed with deep litter bedding and have a roofed outdoor feeding area (Figure 1). The animal production got KRAV-certified in 2012. There are 15 suckler cows with their calves, 15 two-year-old heifers which are to be covered, 30 young animals for slaughter and two breeding bulls of different heavy meat cross-breeds. The meat is sold and distributed to private persons by the farmers themselves.

3.2.6 Farm number 6: Ängavallen

Ängavallen is a family owned farm, restaurant and conference facility where everything is produced 100% organically. The meat, of which some is in processed form, is sold in the farm's restaurant (70%) or in the farm shop (30%). The dominating breed is the endangered Swedish breed Rödkulla, but there are some Fjällko, another endangered Swedish breed, as well. Both are combined milk and meat breeds. The owners strive for what they call "natural" animal production and the cows are milked only once per day. There are about 100 suckler cows, 50 calves and four bulls. All animals are held in open air sheds with access to pasture all year round (Figure 1).

Table 1. Studied farms and some of their key characteristics.

Farm	Label given to farm	Number of animals	Type of production	Type of stable
Troedstorp	Conventional (C)	600-650	Fattening of bulls (1.5 year cycle)	Fully enclosed pens without outdoor access
Rolsberga Gårdarp	Conventional (C)	230-250	Fattening of bulls (6 month cycle)	Fully enclosed pens without outdoor access[a]/Open air shed with access to outdoor loafing area (OLA)[b]/ Deep litter bedding enclosure without access to OLA[c]
Sonarps gård	Conventional (C)	300	Breeding for sale and slaughter	Open air sheds with impermeable OLA
Kongaö	Organic (KRAV)	800	Breeding for slaughter	Open air sheds with permeable OLA[d]/ Enclosures with varied bedding material and varied access to OLAs[e]
Bosarps gård	Organic (KRAV)	75	Breeding for slaughter	Open air sheds with separated roofed feeding area
Ängavallen	Organic (EU organic)	150	Breeding for slaughter and for milk production	Open air sheds with permeable OLA

[a] 150 bulls
[b] 70 bulls
[c] 30 heifers
[d] 570 animals
[e] 350 animals

3.3 Data collection

3.3.1. Interviews

The flexibility of the interview is a very attractive feature of the research method, and might be the reason for its popularity in qualitative research (Bryman, 2012). In this study, the main source of data was the two types of interviews – semi-structured and open-ended - that were conducted with the farmers. Semi-structured interviews are beneficial when the focus on which specific issues to address is clear and to ensure comparability between multiple cases (Bryman, 2012). Results of semi-structured interviews were summarized as tallies in absolute numbers and percentages to obtain data on the differences in characteristics between different meat production systems (Tables 3, 6, 7). Open-ended questions served to distill and clarify the results of semi-structured interviews, making it possible to understand the complexities behind the quantitative outcomes of questionnaires (Tables 4-5). The benefit of open-ended questions to generate in-depth information, which can be hard to obtain with closed questions, also suited the aim of this research (Silverman, 2015). The answers to the interviews provided me with data to answer the environmental, economic, social, and to some extent animal welfare questions in relation to RQ1. However, methods such as interviewing are prone to reactivity, i.e. people know that they are part of a study and might therefore, consciously or unconsciously, reply untypically (Webb *et al*., 1966 as cited in Bryman, 2012). To avoid relying solely on such a method, interviews were combined with observations.

3.3.2. Observations

Observations can be useful in a wide array of research situations, for example when collecting data about animals (Walliman, 2011). Due to the complexity of objects, it is usually necessary to identify and focus on specified variables to observe, which is enabled by using a clear and efficient method. This is especially important when observing fast moving objects (Walliman, 2011), such as cattle. The animal welfare assessment used in this study was inspired by the Welfare Quality Assessment protocol for cattle. However, due to time and resource constraints and the fact that the protocol is developed for fattening cattle in intensive housing systems, I could not fully adopt the protocol. Nevertheless, I found it suitable to use measures from the Welfare Quality Assessment protocol for cattle as the criteria are based on contemporary scientific knowledge of animal welfare and are developed with respect to validity, feasibility, and reliability. The chosen criteria and indicators, informed by both interviews and observations, are presented in Table 2. I used multiple indicators to assess the animal's welfare, as advocated by Broom (1986). The indicators were chosen due to their feasibility when prior training was not possible, if they applied to the Swedish system and whether they would be useful measures in different types of production systems. Whenever possible, individual and animal-based measures were chosen.

Table 2. Welfare principles**,** criteria**,** and indicators.

Welfare principle	Welfare criteria	Indicator
Good housing	Comfort around resting	Cleanliness of animals
	Ease of movement	Access to pasture, access to OLA
Good health	Absence of disease	Nasal discharge, ocular discharge, mortality rate
	Absence of pain induced by management procedures	Disbudding/dehorning, castration
Appropriate behavior	Expression of behaviors	Access to pasture

When observing the animals, any disturbance was avoided as far as possible. If more than one type of housing was provided at the farm (as was the case at Rolsberga Gårdarp and Kongaö Säteri), I assessed the number of animals within each housing type proportionately to their share of the total number of animals at that farm. I avoided bias in my sampling of animals by using a randomization tool[4] to decide on which enclosures to assess. When enclosures were fewer than four, I assessed animals from all of them. To decide on sample size for each farm and order in which the measures were observed, I followed the guidelines in the Welfare Quality Assessment protocol (2009). Within each enclosure, I observed 50 % of the animals on a "first come, first serve" basis, until the quota for the farm was filled. For feasibility reasons, as access to the enclosures from different angles was not always possible, animals whose heads and sides could be observed from a distance not exceeding two meters were chosen. The side turned towards me when I first approached the animal was assessed. For a detailed assessment criteria description of the animal based measures, please see appendix A. The observations provided me with data to answer questions of animal welfare related to RQ1.

The subjective element of observations can have affected the outcome of this research. However, I tried to account for this by using a set formulary with specific indicators, as advocated by Walliman (2011). Further, despite my effort to observe the animals unobtrusively, my presence disturbed them and fomented unrest, which can have affected which individuals I had the possibility to observe. Lastly, the risk of confirmation bias, that is, the tendency to only register data which confirm prevailing beliefs and

[4] I used the List randomizer at random.org.

ignore or reinterpret data which reject prevailing beliefs (Nickerson, 1998), can be imminent when conducting observations.

4. Results

When analyzing the answers from the questionnaires, it became clear that environmental burden differs between the systems. Fertilizer, pesticide and feed concentrate use is more widespread in conventional meat production and energy origin also proves to differ between systems. All farms provide social services to some extent, even though with varying frequency and for different audiences. Veterinary and antibiotic expenses prove to differ more between farms than between systems, but in terms of income for retailed meat, a clear divide could be seen as the income was significantly higher for organic farms. Observations showed that there is a tendency for conventional farms to score lower in the overall wellbeing of animals, which however is not true for all indicators and all farms. Thus, a clear divide in terms of the animals' welfare between systems cannot be defined.

4.1 Result from questionnaires

4.1.1 Large differences in the type and amount of fertilizer used between production systems[5]

All farms use all the manure produced by their animals, but the type of manure differ (Table 3). Whereas the organic farms and Sonarps gård only or mainly use deep litter manure, the other two conventional farms use liquid manure to a larger extent. Rolsberga Gårdarp, which only uses deep litter manure to a small extent and mainly liquid manure, can be assumed to show the lowest nutrient load per unit manure when it comes to manure management. Troedstorp which uses 50% deep litter manure and 50% liquid manure and can be assumed to have a larger nutrient load per animal than Rolsberga Gårdarp but lower than the other farms. As the use of non-organic fertilizers is restricted to certain organic fertilizers in organic farming, the usage of inorganic fertilizers is zero on the organic farms. However, large

[5] At Ängavallen, the animals' impacts, positive and negative, should be divided between the meat and the milk and is therefore lower than the numbers presented. However, the allocation of burden between milk and meat could not be made in this study.

Table 3. Fertilizers used at farms.

	Liquid manure	Solid manure	Deep litter manure	Semi-liquid manure	N27 (tonnes)	NS274 (tonnes)	Calcium nitrate (tonnes)	K50 (tonnes)	MPK 21310 (tonnes)	Chicken manure[a] (tonnes)	Biofer[a] (tonnes)
Troedstorp (C)	50%		50%		80						
Rolsberga Gårdarp (C)	75%		25%			14.820	22.7	8.460			
Sonarps gård (C)	30%		70%		18				18		
Kongaö Säteri (O-KRAV)	45%	10%	45%							455	42
Bosarps gård (O-KRAV)			100%								
Ängavallen (O)			90%	10%							

[a]Approved for use at organic farms.

differences of the amount and type of fertilizer used within the conventional farms can be observed. All of the conventional farms use inorganic fertilizers, with an increased total use of fertilizers and thus a negative influence on their nutrient load and energy use. Of the organic farms, only Kongaö Säteri chose to use additional fertilizers. Ängavallen's reason for not using even organic fertilizer is because of the (very small) risk of infection and as part of their brand is to sell meat 100% free from medicine and toxic residue. Not using external fertilizers is part of this strategy.

4.1.2 Pesticide use is a preserve of conventional production systems

The use of pesticides is also restricted for organic farming, and, thus, none of the organic farms use any. Whereas Sonarps gård does not use pesticides in any production of animal fodder either, the other two conventional farms use pesticides to a large extent (Table 4). The farms that use pesticides also use disinfection when cleaning the stables and Virkon S is also used by Ängavallen. The rest of the farms only use hot-water pressure wash for cleaning the stables. All of the organic farms use eco-labelled electricity, which is a requirement for KRAV certified production, but not for EU organic (Table 4).

4.1.3 Distinctions can partly be made between systems regarding sources of forage and feed

The animals at the organic farms are only fed with forage, minerals and salt. The conventional farms all feed their animals with feed concentrate of different kinds (Table 4). Additionally, on the organic farms, the extensive grazing periods (Table 7) enhances biodiversity, while the grazing period on the conventional farms is zero or limited to few animals with the exception of Sonarps gård which has a grazing period comparable to the organic farms. Ängavallen stands out terms of biodiversity in two ways. Firstly, their animals have large areas to graze all year round even though the amount of grass is varying. Secondly, Ängavallen only breed endangered Swedish breeds and contributes thus to the conservation of those breeds.

Table 4. Pesticides and disinfection use, energy origin, and fodder given to the animals at the farms.

	Pesticides	Disinfectant		Energy origin	Fodder
		Stalosan F	Virkon S		
Troedstorp (C)	15-20 different kinds, unknown quantity	300-400 kg		Unspecified	Forage, minerals, salt, and feed concentrate[a]
Rolsberga Gårdarp (C)	Eight different kinds, unknown quantity		Unknown quantity	Unspecified	Forage, minerals, salt, potatoes, and feed concentrate[a]
Sonarps gård (C)				Unspecified	Forage, minerals, salt, draff, and feed concentrate[a]
Kongaö Säteri (O-KRAV)				Biofuels and wind turbines (Södra el)	Forage, minerals, and salt
Bosarps gård (O-KRAV)				Hydro power (Eon)	Forage, minerals, and salt
Ängavallen (O)			50 liters diluted	Eco-labelled electricity (Bixia)	Forage, minerals, and salt

[a]The fodder given depends on the age and/or sex of the animal.

4.1.4 Ancillary activities of some conventional systems reduce their environmental burden

The conventional farms do take measures to mitigate their environmental impact to some extent. At Troedstorp, all farm houses are heated using residues from the farm's oat production. At Rolsberga Gårdarp, the use of plant-protecting agents and activities such as manure spreading are optimized by thorough analysis of the weather forecast. Fertilization is also considered carefully at Sonarps gård, and pesticides are not used for the meat production. All of the conventional farms use their own manure to reduce the need for inorganic fertilizers.

4.1.5 Both organic and conventional systems offer useful social services for communities in which they operate

Direct social services are measured by educational tours, which all farms but Rolsberga Gårdarp provide to some extent. However, the frequency and audiences varies (Table 5). The organic farms offer educational tours to a larger extent than the conventional, especially Ängavallen who offers exceptionally many as compared to the other farms. Ängavallen also offers extensive possibilities for tourism, the other direct indicator, and Kongaö Säteri offers a few tours for tourists per year. The rest of the farms do not offer any opportunities for tourism.

Table 5. Direct social impacts in terms of possibilities for tourism and educational tours at the farms.

	Possibilities for tourism	Educational tours
Troedstorp (C)	No	Yes, once or twice yearly, usually for students from Agricultural schools or other farmers via HKScan or Skånes Nötköttsproducenter.
Rolsberga Gårdarp (C)	No	No.
Sonarps gård (C)	No	Yes, for school classes but not on a regular basis.
Kongaö Säteri (O-KRAV)	Yes (tours).	Yes, 4-5 times yearly for Kindergarten children, tourists on study trips, students from agricultural schools or open visits to the public.
Bosarps gård (O-KRAV)	No	Yes, 2-3 times yearly for customers or journalists.
Ängavallen (O)	Yes (restaurant, hotel, tours, conference).	Yes, for customers and guests about 100 times/year, for school children about 20 times/year and for other farmers about 20 times/year.

4.1.6 Veterinary expenses and antibiotics use differ more between farms than between systems

As can be seen in Table 6, costs vary considerably different between the farms. No clear pattern for the cost of antibiotics between production systems can be identified, but the use differs significantly between farms. The cost for antibiotics is substantially higher on Troedstorp than on the other farms. The many cases of pneumonia as a result of mixing calves from different herds can explain the high number. This farm also shows the highest cost for veterinary visits. However, one large cost item in the veterinary's visits is the costs for anesthetics and analgesics when dehorning the animals. At Sonarps gård, the relatively high veterinary expenses compared to cost for antibiotics derive from the inspection before sending breeding animals to test stations. Kongaö Säteri routinely check their animals for gestation and have many calvings during the year which requires veterinary assistance if complications occur. At Bosarps gård, the high veterinary cost is explained by the few animals which share the burden of the fixed cost for the Swedish Animal Health Service. At Ängavallen, the veterinary is used as a sounding board to help with their extensive preventing strategy to avoid sickness.

4.1.7 Income per kg of product is higher for organic than for conventional production systems

There is a clear distinction between the calculated income per kg meat for conventional and organic farming (Table 6). Whereas the conventional farms have a relatively similar income per kg, there is a wide spread amongst the organic farms. It is worth noting that all organic farmers, including Kongaö Säteri which has the most animals of all farms in this study (800), claim that that they do not receive any, or very small, profit from the meat production. This problem does not apply for conventional meat producers. At organic farms, the cows instead contribute with fertilizers which are essential in the organic crop production at the farms. At Ängavallen, the cows are a necessity for their concept of serving only food produced at their own farm, and the profit is therefore made in the restaurant/hotel or in the farm shop. However, while the income per kg is higher for organic than conventional production, there can be limits to the possibilities of expansion for organic farms, such as limited total amount of land available.

Table 6. Economic expenses related to key variable costs at the different farms compared with income per kg of meat.

Farm	Per animal veterinary expenses	Per animal antibiotics cost	Fertilizers	Disinfection	Pesticides	Income per kg
Troedstorp (C)	124.80	136.80	200,000	10,000	105,000	38.10
Rolsberga Gårdarp (C)	15.23	14.98[a]	100,587	Unknown cost	18,575	40.29
Sonarps gård (C)	18.33	0.00	150,000	0.00	0.00	40.59
Kongaö Säteri (O-KRAV)	89.21	10.00	639,000	0.00	0.00	58.25
Bosarps gård (O-KRAV)	65.33	0.00	0.00	0.00	0.00	72.58
Ängavallen (O)	13.33	3.33	0.00	1,000	0.00	69.00[b]

[a]This number indicated the total pharmaceutical cost on the farm as the antibiotics cost could not be disentangled.

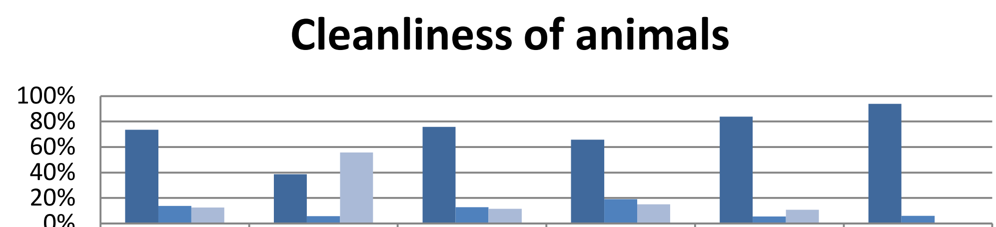
[b]The meat is sold internally to their own restaurant or farm show and is thereafter sold to private persons. The supplement charge for the restaurant and farm shop is about 100%, which means that the number in Table 6 will be about twice as high when the meat reaches the consumers.

4.2 Animal welfare indicators

The animal welfare assessment showed that some differences between production systems can be noted, but that the differences between the individual farms are greater than the systematic differences.

4.2.1 No clear divide in terms of cleanliness of animals can be observed

Figure 2 shows the cleanliness of the animals on the different farms as an indicator for comfort around resting. It is worth to remind the reader that if several housing types were provided, animals from all housing types were assessed. However, as one type of housing proved to be dominant, that type will be discussed. No clear distinction between the production systems can be seen. All of the organic farms provide deep litter bedding for their animals. Sonarps gård (a conventional farm) also provides deep litter bedding, Rolsberga Gårdarp has boxes with slatted floors (partly covered with rubber mat) and to a small extent deep litter bedding. Troedstorp mainly provide pens with separated feeding places with concrete floors combined with raised resting areas, sometimes bedded with a bit of sawdust, but for the younger calves, deep litter bedding is provided. It must be noted that the animals at Kongaö Säteri and Ängavallen have outdoor access to fields which at time of visit were muddy due to rainfall which is abundant in Skåne in February and March. The Outdoor Loafing Area (OLA) at Sonarps gård is impermeable and partly covered with deep litter bedding. Thus, the cleanliness of the animals is affected by their respectively access to OLA and can therefore not be directly connected to their comfort at resting at these farms. However, when comparing the farms without OLA (Troedstorp, Rolsberga Gårdarp and Bosarps gård) it is clear that deep litter bedding has benefits when it comes to the cleanliness of the animals and thus the comfort around resting whereas slatted floors prove to provide least comfort.

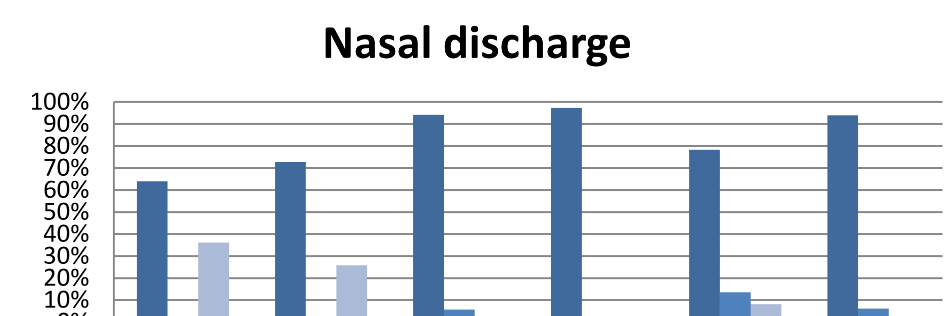


	Treodstorp (C)	Rolsberga Gårdsarp (C)	Sonarps gård (C)	Kongaö Säteri (O-KRAV)	Bosarps gård (O-KRAV)	Ängavallen (O)
0	74%	39%	76%	66%	84%	94%
1	14%	6%	13%	19%	5%	6%
2	13%	56%	11%	15%	11%	0%

Figure 2. Cleanliness of animals.
0: Clean, 1: Partly dirty, 2: Dirty.
(0: <20% of the area in question covered dirt. 1:20-50 % of the area in question covered with dirt. 2: >50% of the area in question or more covered with dirt

4.2.2 Nasal discharge is prevalent in both systems

Figure 3 displays the nasal discharge of the animals on the different farms as one of three indicators for absence of disease. Sonarps gård, Kongaö Säteri and Ängavallen show the lowest prevalence of signs of disease. At Bosarps gård, there are fewer animals without any sign of nasal discharge than at the three farms mentioned. However, the animals show only a slight discharge and scored thus 1, whereas the animals at Troedstorp and Rolsberga Gårdarp that show sign of nasal discharge scored 2, i.e. strong signs of nasal discharge.

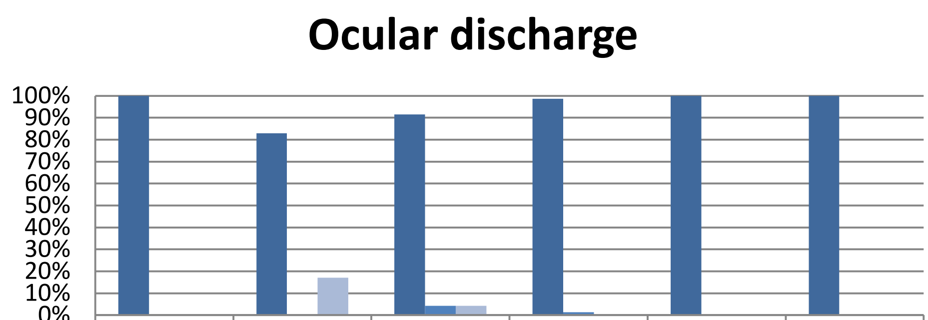


	Treodstorp (C)	Rolsberga Gårdsarp (C)	Sonarps gård (C)	Kongaö Säteri (O-KRAV)	Bosarps gård (O-KRAV)	Ängavallen (O)
0	64%	73%	94%	97%	78%	94%
1	0%	1%	6%	1%	14%	6%
2	36%	26%	0%	1%	8%	0%

Figure 3. Nasal Discharge.
(0: No sign of nasal discharge. 1: Slight signs of nasal discharge. 2: Strong signs of nasal discharge.)

4.2.3 The prevalence of ocular discharge tends to be higher in conventional systems

The second of the three indicators for absence of disease, ocular discharge, is shown in figure 4. Generally, ocular discharge appears not to be a major problem on most of the farms. Ocular discharge is only present at three farms, of which one only has a 1% frequency. Within this assessment, it is clear that the organic farms in general score better than the conventional, with the exception for Troedstorp.



	Treodstorp (C)	Rolsberga Gårdsarp (C)	Sonarps gård (C)	Kongaö Säteri (O-KRAV)	Bosarps gård (O-KRAV)	Ängavallen (O)
0	100%	83%	91%	99%	100%	100%
1	0%	0%	4%	1%	0%	0%
2	0%	17%	4%	0%	0%	0%

Figure 4. Ocular Discharge**.**
0: No sign of ocular discharge. 1: <3 cm of ocular discharge. 2: >3 cm of ocular discharge.

4.2.4 Overall wellbeing of animals tend to be lower in conventional systems, but not for all indicators

Table 7 shows the result of the other animal welfare indicators that were used in this study. Troedstorp has a significantly higher mortality rate, the last indicator for absence of disease, than the rest of the farms. This mainly is explained by the high frequency of pneumonia. Further, the occurrence of accidents is higher as bulls from milk breeds often are more aggressive than bulls from meat breeds.

When considering the percentage of animals on each farm without remarks in terms of cleanliness, nasal discharge, and ocular discharge, Ängavallen shows a strikingly high percentage. The other two organic farms have similar scores to Sonarps gård, whereas the other two conventional farms score significantly lower. Conventional farms thus tend to score lower in the overall wellbeing of animals based on these observations.

The occurrence of castration and disbudding are used as indicators for absence of pain induced by management procedures. Castration only occurs on two of the farms, both of them organic. The bulls at Bosarps gård are castrated to avoid inbreeding and genetic incompatibility as the bulls are not separated from the rest of the herd. At Kongaö Säteri, they are castrated to increase the meat quality and as steers are calmer, grow slower and do not need feed concentrate. They are also more appropriate to have grazing during the summers than bulls. Disbudding occurs to the same extent on organic and conventional farms. All of the farms that breed themselves (Sonarps gård, Kongaö Säteri, Bosarps gård and Ängavallen) strategically breed to gain hornless animals. However, if an animal would get horns, they are disbudded at Sonarps gård, Kongaö Säteri and Bosarps gård. The frequency of horns is similar at all farms. Since the animals are bought at Troedstorp and Rolsberga Gårdarp they do not have the possibility to selectively choose to breed on hornless individuals. At Rolsberga Gårdarp, the animals are too old to disbud when they are bought. The absence of pain induced by management procedures tend to be lower at organic farms due to the occurrence of castration, but whether the animals' welfare increase in the long run due to castration cannot be evaluated in this study.

The access to pasture and to OLA are both used to assess the ease of movements. Access to pasture is further used to assess the possibility for the animals to express their natural behavior, here in terms of grazing. Larger areas and lower livestock density generally also provide better possibilities for the animals to express other natural behaviors, such as moving around and playing. There are large differences between the access to pasture and OLA between the different farms. The animals at Troedstorp do not have any access at all to either. At Rolsberga Gårdarp, the heifers which are bought only to graze semi-natural pastures have a grazing period of 210 days whereas the bulls do not have any grazing time. 70 of the about 200 bulls have access to OLA all of the time. At Kongaö Säteri the access to pasture and OLAs differs among animal groups. On the farms that divide their animals according to sex, cows and heifers have access to pasture to a larger degree than male animals. As all of the organic farms and Sonarps gård provide extensive grazing periods, systematic differences cannot be clearly defined.

Table 7. Other indicators for animal welfare assessment.

	Percentage of animals without remarks	Mortality rate	Castration	Disbudding	Days on pasture	Days with access to OLA	Livestock density (1-6, with 1 being least dense)
Troedstorp (C)	44%	12%[a]	No	Yes	0	0	5
Rolsberga Gårdarp (C)	31%	2%	No	No	0/0/200 [b]	365/0/0[c]	6
Sonarps gård (C)	63%	2%	No	Yes	180	185	3
Kongaö Säteri (O-KRAV)	66%	2%	Yes	Yes	210/180/170[d]	155/185/0[e]	2
Bosarps gård (O-KRAV)	62%	0%	Yes	Yes	190	0	4
Ängavallen (O)	88%	3%	No	No	365	0	1

[a] In 2013, the mortality rate was 20%.

[b] Bulls 0 days, heifers 200 days.

[c] 70 bulls have outdoor access all year round, the other bulls and the heifers do not have access to OLA.

[d] The suckler cows are 210 days on pasture, the bulls 180 days and the young animals 170 days.

[e] The suckler cows and the bulls have access to OLA the part of the year they are not on pasture (155 and 185 days respectively). The young animals do not have access to OLA for the part of the year they are not on pasture.

5. **Discussion**

This section begins by comparing conventional and organic farms in terms of the environmental burden of these systems, their offered opportunities for contributing to the social welfare of communities, their economic differences, and their differences in terms of animal welfare (Research Question 1). Drawing from this comparison, an assessment is made to identify lessons that can be learnt to strive for sustainable outcomes in cattle meat production in Sweden (Research Question 2). Here, the validity of the semantic distinctions between conventional and organic production systems is questioned and best practices that can be drawn from the analysis of the two production systems are discussed.

5.1 Can a clear divide between organic and conventional systems be identified?

5.1.1 The environmental burden of conventional systems tend to be greater than organic systems', but can be reduced

The environmental burden has a tendency to be greater for conventional systems, mainly due to the non-renewable energy origin and the use of fertilizers, pesticides and feed concentrate. Considering the energy origin (Table 4), organic farms' environmental burden is lower as they all use energy from renewable sources. Further, it can be assumed that the results from Sonesson *et al*. (2009) and Toumisto *et al*. (2012) that organic farming requires less energy due to non-usage of synthetic fertilizers is true also for the farms studied in this research. That would mean that not only the environmental burden from the energy origin, but also from the amount of energy used, is lower for the organic systems.

GHG emissions are in the literature found to be greater for conventional systems (Tuomisto *et al.,* 2012, Sonesson *et al.,* 2012). Mondelaers *et al.,* (2009) found this to be true per unit area, but not necessarily per unit product, due to the lower land use efficiency for organic farming. Even though no conclusion can be drawn of the size of GHG emissions in this study, a clear divide between the systems is recognizable. The extensive use of grassland due to the grazing of animals at some farms (all of the organic and Sonarps gård) increases the carbon sinks function of grassland and thus decreases GHG emissions from those farms (Sonesson *et al.*, 2009), but methane emissions increase. Grazing is further beneficial for biodiversity (Pykälä, 2005), meaning that these farms' provide an environmental service. However, as all of the conventional farms use feed concentrate, their animals have a shorter lifespan of which positively influences the environmental burden per animal (Sonesson *et al*., 2009).) A divide between the systems is not clear for this indicator (Table 7).

Irrigation of feed crops increases the freshwater use (Hoekstra and Chapagain, 2007) and eutrophication and pollution can be widespread (FAO, 2006). Considering the use of irrigation for food crops, the conventional farms can be assumed to have a larger water footprint. In terms of pollution and eutrophication, the amount and type of manure, pesticide, fertilizers and antibiotics used is a dominant factor. There is a divide with regard to fertilizer use, as the use of non-organic fertilizers is not allowed in organic farming (Table 3). However, within the other areas, this clear divide cannot be observed. When scrutinizing the nutrient load, the same pattern is repeated: there is a divide in terms of fertilizer use, but not for the other areas. When investigating the nutrient load as an aggregated measure the divide is not clear. The large ammonia volatilization from deep litter manure negatively influences the nutrient load per animal on the farms where deep litter manure mainly is used, which in this case is all the organic farms and Sonarps gård (Table 3). As a lot of the manure cannot be used as the cattle are free roaming during large parts of their lives at these farms, the nutrient load is higher, but, again, systematic differences are hard to detect.

Even though conventional farms in general tend to have a higher environmental burden, the conventional farms in this study mitigate their impact to some extent (see section 4.1.4). This is done by using residues from oat production to heat houses or by decreasing and/or optimizing the use of fertilizers and pesticides. Common knowledge would tend not to accommodate this in their perception of what a conventional farm is.

5.1.2 Organic systems contribute to the social welfare to a larger extent

Environmental impacts largely affect the size of the social impact of the farm in terms of decreases in human welfare due to environmental degradation and climate change. Therefore, the same pattern that applies for environmental impacts also indirectly applies to social impacts. Thus, two birds can be killed with one stone when decreasing the negative externalities from meat production. If this is decreased by decreasing and/or optimizing, for example, the use of fertilizers of irrigation, there are additional economic benefits. Further, all organic farms provide educational tours, and contributes thus to the education of members of the society and the development of proenvironmental attitudes. A distinct divide between systems can however not be identified, as two of the conventional farms also offer this opportunity. However, it is clear that organic farms offer more tours per year than the conventional ones, with Ängavallen offering exceptionally many (Table 5). Additionally, only organic farms offer opportunities for tourism, even though not all of them do (Table 5), and thus contribute more to the local community.

5.1.3 No clear divide between organic and conventional systems in terms of antibiotics usage

Further, no unequivocal pattern for antibiotics usage between production systems can be noted (Table 6). Considering the serious consequences a high usage of antibiotics in meat production has on human health (Landers *et al*., 2012), systems that require antibiotics to a large extent indirectly affects human welfare negatively. There is a significantly higher usage at Troedstorp, who buys calves from different herds, than at the other farms. The usage is lower in organic systems and at Sonarps gård, which have lower stocking densities and open air sheds. This finding corresponds to the results found by Landers *et al* (2012). Antibiotics usage does not only have consequences for human health, but carries an economic cost, is an indicator of poor health in the herd and bring about environmental consequences. Thus, there are multiple benefits in reducing the usage.

5.1.3 Externalities are not included in the price of products for neither system

It is not easy to disentangle the costs as all farmers declare their costs differently. A clear divide between the conventional and organic farms in terms of any of the costs measured cannot be seen. Even though only conventional farms use pesticides, this is not true for all conventional farms, as Sonarps gård does not use pesticides at all in relation to their animal production (Table 6). When considering the costs for fertilizers, the highest cost is associated with Kongaö Säteri, which is KRAV-certified. One important aspect is that not all costs are visible in the economic balance sheet of conventional farms, since environmental and social externalities are not accounted for.

With regard to the income per kg meat, a clear divide between organic and conventional farms is evident. Even though organic farms receive a higher income per kg meat, they do not receive any, or very small, profit. If positive externalities deriving from the production, which currently are not paid for by the end consumer, would be included in the price of meat, this could possibly change. Further, the distribution channels for organic products have a potential of influencing the revenue, which can explain the income differences between the organic farms.

5.1.4 Other reasons for differences in animal welfare than organic or conventional farming

When analyzing animal welfare indicators, again, no clear divide between organic and conventional farms is visible. However, some other patterns can be seen. In terms of absence of disease, there tend to be a divide between the farms that stall their animals in fully enclosed pens with higher livestock density and those who provide open air sheds with lower livestock density. This result is in line with Troedstorp's high frequency of pneumonia which follows from them buying young calves with low immune defense from different herds. However, this line of thought is not true for Rolsberga Gårdarp as they have a low pneumonia frequency as they buy older animals. Instead, the most probable explanation is the higher livestock density, resulting in pathogenic organisms spreading more rapidly (Landers *et al*., 2012). Pain induced by management procedures tends to be higher at the organic farms than on the conventional due to the occurrence of castration, but this is not true for all farms. It has to be considered that the reason for castration is to increase the animals' welfare in the longer perspective by gaining calmer animals which are allowed to pasture during the summer months. As the welfare indicators was not quantified and weighed against each other in this study, a more comprehensive implication of castration of animals on their welfare is beyond the scope of this discussion. No unequivocal divide can be observed between the systems for the combined welfare principle of good health.

It is also worth noting that comfort around resting, indicated by the cleanliness of the animals, could not be completely assessed due to the access to muddy OLAs or pastures for the animals at some of the farms. This result might imply that the animals even enjoy being unclean from time to time and that the high value of cleanliness is something humans ascribe to animals, which could point to the fact that the animals themselves might have higher welfare if they are unclean, but have access to OLA. The access to pasture and OLA are beneficial for the animals in several ways, as ease of movement is enabled, but no systematic differences can be observed. Therefore, again no unequivocal divide concerning the welfare principle of good housing can be noted. Lastly, access to pasture also indicates appropriate behavior. As with the other animal welfare principles, a dichotomy between the systems cannot be identified.

As an aggregated answer to RQ1, a clear divide according to the sustainability criteria used in this study is not observable. The largest difference between organic and conventional systems is evident when comparing the environmental burden between the two systems. For some indicators, such as energy origin, there is a clear divide, whereas the line is not as clear for others. This also results in a rather clear divide between the systems when it comes to indirect social implications, even though this is not true for all aspects, as, for example, no clear pattern is visible when scrutinizing the antibiotics usage. Even though social services are offered to a larger extent at the organic farms, clear systematic differences cannot be found. Further, it cannot be concluded that organic production in all cases offer better opportunities for animal welfare than conventional systems. It is worth pointing out that there tend to be more differences associated to production system in terms of fattening of cattle/breeding of cattle than there are for organic/conventional. Further, the housing of the animals appears to determine many of the indicators within the animal welfare assessment, such as access to pasture, nasal discharge, livestock density, percentage of animals without remarks, and use of antibiotics. Conventional farms tend to be associated with more negative externalities. In terms of costs measured, no clear divide between organic and conventional farms is recognizable. However, the higher farm-gate price necessary to at least break even in organic production and the more direct distribution conduce to higher revenue per kg meat.

5.2 What lessons can be learned from organic and conventional practices that can foster sustainable outcomes for meat production in Sweden?

As was discussed in relation to RQ1, a strict dichotomy between organic and conventional meat production could not be found. The sustainability of meat production can even differ within the same farm, if the animals are provided with different fodder or housing types, which is the case for all the conventional farms in the study, as well as Kongaö Säteri. The difficulty in finding a strict separation between organic and conventional meat production does not seem to apply to crops (even though this was not the focus of this study). While crop production can more easily be divided into organic and conventional, meat production is a more complex process. One reason for this is that crop production is one factor among many others which influences the environmental burden of conventional meat production. However, both conventional and organic producers can shift their production into more sustainable practices. Some of these shifts affects more than one sustainability indicator and comes with multiple benefits, whereas others tend to need compromises.

The fact that there is a greyscale in terms of sustainability between conventional and organic farms is further proven as some organic farms go beyond what is required for organic certification. At Ängavallen, who decided not to be KRAV certified as they regarded KRAV standards to be insufficient, the animal welfare is better according to almost all indicators measured and the income per kg meat is the highest of all farms when the price to end consumer is compared. Further, they do not only have the longest grazing period which benefits biodiversity, but they also only use endangered breeds and thus contributes to their continued existence. In regard to their social impacts, they contribute by far the most to education of members in the society due to the many tours they offer of their farm and provide more benefits for the local community in terms of tourism. This shows that certification is not the ultimate standard, but that there is room for improvement in certification schemes. As Rawles (2010) argues, the likelihood of ethical values for food production (especially meat production) evolving from free market approach with the help of consumer education or labelling is low. When certification schemes furthermore are insufficient, the chances of developing an ethical meat production system through customer education and labelling decrease even more, and thus are policies needed.

5.2.1 Does organic meat production mean sustainable meat production, and conventional unsustainable?

In this thesis, the sustainability concept was expanded to incorporate animal welfare and some carefully selected indicators within each category were chosen. As the definitions of sustainability differ, it is hard to define what sustainable meat production entails. However, according to the result from the indicators chosen, it can be concluded that organic meat production does not indisputably mean sustainable meat production and that conventional meat production not always means unsustainable. Some environmental impacts, such as nitrate leaching, can be larger for organic meat production. Furthermore, animal welfare does not for all indicators prove to be clearly better on organic farms than on conventional. However, whereas organic farms provide more services of value to the society, conventional farms show better economic sustainability than organic. This study finds no strong basis for the development and application of policy based solely on the semantic distinction of meat production systems as organic and conventional.

6. **Lessons learned and implications for policy**

General policy recommendations concerning the animals' diet are hard to give as results are contradictory. Long grazing periods which are beneficial for biodiversity, decrease the need for irrigation, increase the animal welfare, and decrease GHG emissions, and high proportions of forage in the diet which has animal welfare benefits and requires less energy than the production of feed concentrate result in more methane emissions, slower growth and thus more GHG emissions per animal in that regard. Using by-products from other business, such as the draff given to the cows at Sonarps gård and the potatoes given to the animals at Rolsberga Gårdarp are an efficient way to decrease the environmental burden of meat production, and is often also very cheap. However, it has to be taken into account that this might decrease the animal welfare, as the cattle's metabolism might alter which could induce health issues. The issue of the animals' diet is a clear example of the complexity of meat production and clearly shows the integration of the four pillars of the quadruple bottom line and proves that it is insufficient to treat them individually.

The fact that biodiversity benefits more from organic farming the more intensely used the surrounding landscape is (Tuck *et al*., 2014) means that environmental benefits can be maximized by situating organic farms in certain areas. Even though other concerns have to be taken into account as well, all things equal, thorough investigation of potential preferable areas and recommendations of where to situate organic farms could be a very cost and resource efficient way to decrease the environmental footprint of beef production. Ängavallen's breeding of endangered cattle breeds show that biodiversity can be benefitted in cattle production in other ways than by only grazing.

The energy use is generally lower on organic farms which can be attributed to the fact that nonorganic fertilizers are not. From this, it can be concluded that conventional farms could lower their energy use by decreasing the use of fertilizers and pesticides. This would additionally have other positive effects on the environment in terms of nutrient load, water pollution and GHG emissions. However, this requires a trade-off as yields can decrease with decreased use of fertilizers, and more research is thus needed. Concerning energy origin the divide between the production systems proved to be clear. Conventional farms could easily shift to renewable energy and thus decrease their environmental impact. This could however come with an increased cost.

By decreasing the environmental impact, negative social impacts associated to meat production decrease indirectly. The social benefits of meat production can increase if educational tours and possibilities for tourism are to be incorporated in a farm's concept. By integrating this in an economically beneficial manner, the revenues can also increase. However, this is not a possibility at all farms.

Sustaining profitability in organic meat production proved to be challenging. Interestingly enough, not even Kongaö Säteri (an organic farm) which has the most animals of all farms in this study (800) has a profitable animal production. Thus, upscaling of production might not increase revenues in organic meat production. This implies that other sources of income, such as subsidies or higher farm-gate prices, are important, which is in accordance with Latruffe and Nauges (2013) findings. Long-term political agreements on, for example, agri-environmental payments, can help to enable investments in more sustainable procedures. Different means of distribution indicated to affect the farm-gate price. Both Kongaö Säteri and Bosarps gård deliver their meat themselves. While the main purchaser of meat from Kongaö Säteri are restaurants and private persons only accounts for a small share, Bosarps gård only delivers their meat boxes to private persons. At Ängavallen, the meat is sold internally to their own restaurant or farm shop and is thereafter partly processed and sold to private persons, which generates the highest farm-gate price. Thus, if there are possibilities for personal delivery or processing of the meat at the farm, this could increase the farm-gate price and improve the revenues to sustain profitability in organic systems. These findings confirm the result of Nieberg and Offermann (2003).

Troedstorp's high cost for antibiotics points to systematic health issues among the animals, whereas Ängavallen's low sickness rate is a result of extensive proactive work, which is motivated by their policy of never selling milk or meat from an animal which has ever been treated with medications. This gives them a very clear economic incentive of keeping their animals healthy. To invest veterinary expenditures in proactive programs instead of treatments also result in other benefits, such as increased health and lower use of medications. Some scientists argue that the most important factor when it comes to animal welfare is the death rate amongst the calves (Sonesson *et al*., 2009). Following this logic, the welfare on herd level is lower at Troedstorp than at the other farms. Despite the high death rate at Troedstorp, they managed to decrease the death rate from about 20% to 12% from 2013 to 2014. This was done by installing a modern calf rearing system which enabled them to monitor the calves' eating habits more in detail and thereby sickness was discovered earlier. The use of modern technology can thus improve animal welfare as well as increase profit and decrease environmental and social footprints. Another way to improve health within meat production systems which combine calves from different farms could be to increase the age when they are allowed to be moved from their birth farm, or to restrict the number of farms a calf buying farm is allowed to buy animals from.

The number of animals without remarks is remarkably higher at Ängavallen than on the other farms. According to Broom (1986), one single indicator can be proof of poor welfare. This means that the low percentage of animals without remarks at Troedstorp and Rolsberga Gårdarp reflects that reduced welfare is more widespread among the animal population and that the welfare on herd level on those farms is lower compared to the others. However, it does not indicate the grade of welfare for each individual animal. The organic farms and Sonarps gård, which provides outdoor access, have a higher degree of welfare than the conventional farms which do not provide any outdoor access. Determining factor for the wellbeing of the animals appears to be outdoor access, or keeping the animals in open air sheds, together with low livestock density. Thus, open air stables, decreased density and increased access to OLAs and pastures, together with proactive work to avoid sickness are key factors determining the welfare of the animals. Stricter regulations for grazing periods and larger economic incentives can partly explain why some farms employ these welfare increasing measures to a larger extent than others.

It can be concluded that unequivocal recommendations can be hard to give. Some measures which increase animal welfare can result in decreased environmental benefits or increased costs or vice versa. It is clear that treating the four pillars of sustainability separately is insufficient to reach sustainability, as the problems are intertwined. More focus on the nexuses between the areas is needed within contemporary sustainability science. Further, it should be acknowledged that there are larger differences associated to production systems in terms of fattening of cattle/breeding of cattle and housing systems in terms of open air sheds/fully enclosed pens than there are for organic/conventional systems. However, some policies can be recommended which overall increase all four spheres of sustainability. Considering the serious consequences of antibiotics usage for all four spheres of sustainability, reducing sickness rate and thus antibiotics usage can improve the sustainability of meat production systems significantly and could be done by the help of technology or advanced proactive programs. Larger economic incentives could increase the frequency to which this is done. Increasing the age at which a calf is allowed to be sold and limiting the number of farms a calf buying farm is allowed to buy animals from could also decrease sickness rate in some practices. In other areas, where results can be contrarious, more research and evaluation regarding the trade-offs between benefits are needed to enable provision of recommendations. Shifting from conventional to eco-labelled electricity, optimizing pesticide and fertilizer use, and increasing educational visits and possibilities for tourism at farms are all sustainability factors which would benefit from a thorough investigation. The benefits of open air stables, decreased animal density, and increased access to OLAs and pastures for sustainability should also be further researched. Processing of animal production at the farm and long-term agreements on level of subsidies to enable investments could be more efficient ways to increase revenues than upscaling of production, which have been proven to not affect revenues.

7. **Conclusion**

In this study, key attributes of conventional and organic meat producers in Skåne was identified to enable the analysis of whether the semantic difference between these systems translate into differences in practice. This was then used to identify if organic meat production automatically means sustainable, and if, vice versa, conventional meat production means unsustainable. The results showed that there instead of a dichotomy is a continuum between different meat producers. This implies that certification is not the ultimate standard for identifying sustainable meat products and that a sustainable meat production system cannot occur only through labelling. Instead, there is need for policies which take this grey scale into account.

To ensure a sustainable outcome, the policies requested should comprise all aspects of sustainability in accordance to the quadruple bottom line: environment, economy, society and animal welfare. Without an integrated approach is the full comprehension of this nature-society system not possible, and thus would sustainability merely be a poor understanding of a complex system. Therefore, the nexuses between these values should be in focus for policy making for sustainable meat production.

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Appendices

Appendix A: Animal welfare assessment criteria

Assessment of ocular discharge

Ocular discharge is defined as “clearly visible flow/discharge (wet or dry) from the eye” (Welfare Quality, 2009, p. 31). The animals were assessed on a scale 0-2, with 0 being the best score.

0: No sign of ocular discharge

1: <3 cm of ocular discharge

2: >3 cm of ocular discharge

Assessment of nasal discharge

Nasal discharge is defined as “clearly visible flow/discharge from the nostrils; it can be transparent to yellow/green and often is of thick consistency” (Welfare Quality, 2009, p. 30). The animals were assessed on a scale 0-2, with 0 being the best score.

0: No sign of nasal discharge

1: Slight signs of nasal discharge

2: Strong signs of nasal discharge

Assessment of cleanliness of animal

“One side of the focal animal is examined including as much of the underbelly as is visible but excluding head, neck and legs below the carpal joint and hock (tarsal joint),respectively” (Welfare Quality, 2009, p. 26). The animals were assessed on a scale 0-2, with 0 being the best score.

0: <20% of the area in question covered dirt.

1: 20-50 % of the area in question covered with dirt.

2: >50% of the area in question or more covered with dirt.

Appendix B: Questionnaire meat producers

Date:______________________**Interviewer:**_______________________**Farm:**______________________

Owner: ___________________________

PRODUCTION HISTORY/BACKGROUND

1. Since when do you own the farm?
2. Has it had previous owners within the family? If yes, since when?
3. What type of meat production process do you practice?
4. Has this type of production process changed since you bought the farm?
5. How many creatures, and of which kind, do you have?
6. Which breed(s) do you have?
7. What is the average carcass weight per animal?
8. What types of activities are carried out at the farm?.
9. How is the meat distributed/sold?

EKONOMIC QUESTIONS
If possible, please indicate the cost per year for your whole production. If this is not possible, please specify which time period and/or part of heard the cost relate to.

EXPENSES

<u>Animal related expenses</u>

10. Veterinary costs:
11. Costs for antibiotics:
12. Other pharmaceutical expenses (please specify type of pharmaceutical):
13. Costs for fodder:
    a. Hay/silage:
    b. Feed concentrate:
    c. Pasture:
    d. Other fodder (please specify type of fodder):
14. Cleaning of stables:
15. Manure management:
16. Bedding material:
17. Other animal related costs (please specify what):

Costs related to organic production

18. Certification KRAV (please specify certification company):
19. License KRAV:
20. Excessive costs at slaughter:
21. Excessive costs at packaging/handling after slaughter:
22. Other costs related to organic production (please specify what):

Secondary costs

23. Fertilizers:
24. Disinfection:
25. Pesticides:
26. Energy costs for stables:
27. Labour costs:
28. Transportation fuel costs related to meat production:
29. Other secondary costs (please specify):

INCOMES

30. Income from whole herd per year (alternatively per animal):
31. Subsidies (please specify for what and funder):
32. Side incomes deriving from meat production (e.g. showing of farm):

REVENUES

33. Average profit per herd/kg meat/animal:

ENVIRONMENTAL ASPECTS

34. Amount and type of fertilizer per year:
35. Amount and type of pesticide per year:
36. Amount and type of disinfection per year:
37. Energy origin for the stables:
38. Do you take any measures to mitigate the environmental impact of your production? If yes, which strategy do you use?

SOCIAL ASPECTS

39. Have you had any major disease outbreak in your herd (e.g. salmonella)? If yes, when was this, what type of disease, how many animals were infected, and how was it treated?
40. Do you offer possibilities for tourism?
41. Do you offer any educational tours at the farm? If yes, for whom and how many times per year?

ANIMAL WELFARE ASPECTS

41. Amount of pasture time for the animals:
    a. Number of days/year:
    b. Average amount of time per day in hours during the time period when the animals have access to pasture:
42. Amount of time when the animals have access to outdoor loafing area (OLA) during the part of the year when the animals do not have access to pasture:
    a. Number of days/year:
    b. Average amount of time per day in hours during the time period when the animals have access to OLA:
43. How many animals had to be euthanized/emergency slaughtered due to disease or accident during the last 12 months?
44. Are de animals disbudded/dehorned?
    a. If yes, at what age?
    b. Which method is used?
    c. Are anesthetics used?
    d. Are analgesics used?
45. Are the animals castrated?
    a. If yes, at what age?
    b. Are anesthetics used?
    c. Are analgesics used?