LUND UNIVERSITY
School of Economics and Management

Master's Programme in Innovation & Global Sustainable Development

What is the greenest way to eat your greens?

A comparative sustainability assessment based on the triple bottom line model for consumption of locally grown versus imported vegetables in Skåne, Sweden

Emy Vijverberg

Em2001vi-s@student.lu.se

The global food industry is the second main contributor to climate change whilst climate change also poses threats to future food security (Ritchie & Roser, 2020). One of the suggestions to decrease the environmental footprint of consumption and increase the resilience of food systems, is the shift to local production and consumption (Stein & Santini, 2021; Van Gameren et al., 2015). However, life-cycle assessment studies show that local vegetable production may have a higher environmental footprint compared to imported vegetables (Högberg, 2010). Yet, LCAs only consider environmental impacts while for complete sustainability assessments an equal consideration of the social and economic dimension is crucial, as suggested in the triple bottom line model (Brundtland, 1987). Therefore, by performing an multi-criteria assessment based on the TBL, this thesis has investigated the differences in sustainability potential between locally grown and imported vegetables for consumption in Skåne, Sweden. The results show that Swedish vegetables are more sustainable than imported vegetables and stakeholders have indicated that increasing local production could be achievable under certain conditions. Supermarkets can play a key role in the transition towards more sustainable production and consumption of vegetables by offering more local and seasonal produce for a fair price.

Master's Thesis (15 credits ECTS)
EKHS34
May 2023
Supervisor: Astrid Kander
Examiner: Jeanne Cilliers
Word Count: 15743

Acknowledgments

I would like to express my gratitude to everyone who has helped to create this thesis. Firstly, I would like to thank my supervisor, Astrid Kander, who has been very supportive and enthusiastic throughout the entire process and challenged me to explore the different ways of approaching this topic to gather the most interesting results. Furthermore, I would like to thank all survey participants as well as interviewees for providing useful and interesting insights and information. I would especially like to thank the vegetable department managers of one ICA location in Lund as they helped me design the most appropriate survey design and were available for additional questions at any time. Lastly, I would like to thank the examiner in advance for taking the time to read this thesis and for providing feedback.

Table of Contents

List of Figures

List of Tables

1 Introduction

Recent climate change induced events, such as droughts, extreme precipitation, wildfires and zoonotic diseases have highlighted the vulnerability of the global agri-food system (Tzachor et al., 2021). While climate change poses threats to future food security, the global food industry in turn is the second main contributor to climate change (Ritchie & Roser, 2020). Land use change, excessive fertilizer, pesticide and energy use, and emissions from transportation are, amongst other factors, negative externalities of the established agri-food system. In addition to the concerns regarding the environmental impact of agricultural practices and the food industry in general, inequality on a global scale exists when it comes to access to healthy and affordable diets (FAO et al., 2021). Recent global shocks such as the Covid-19 pandemic and the Russian-Ukrainian war have perturbed the agri-food system further, with alarmingly high cases of malnourishment and food insecurity in some areas and large amounts of food waste in other areas as a result (FAO et al., 2021). To achieve global food security, sustainable production and consumption strategies and approaches need to be investigated on a global as well as on small scales to acknowledge regional differences (FAO et al., 2021).

1.1 Research Problem

In the Sustainable Development Goals by the UN, a wide variety of goals target the agri-food system, among which are Goal 2: Zero Hunger and Goal 12: responsible production and consumption (The United Nations, 2022). In literature, the strategies towards responsible production and consumption with regards to food are well represented, with often recurring themes being plant-based diets (Detzel et al., 2021), increased vegetable consumption (Donati et al., 2016), local production and consumption (Van Gameren et al., 2015) and food waste reduction (Cordova-Buiza et al., 2022). However, as indicated above, it is impossible to find one suitable strategy for sustainable development in production and consumption and improvement in food security on a global scale due to large regional divergence of circumstances (Kanter et al., 2016).

Generally, food insecurity is most prevalent in developing countries, however, conflicts, climate change and economic shocks pose threats to food security in well-developed countries simultaneously, and the risks are projected to increase (FAO et al., 2022). In a highly globalized economy, countries with large trade deficits are especially vulnerable to food insecurity resulting from shocks as they often hinder global trade (Kopteva et al., 2018). Sweden is an example of a country with a large trade deficit in food products. The country is mostly dependent on other countries for meat, fruit and vegetables (Cederberg et al., 2019). The dependency on imports for fruits and vegetables is a result of the country's cold climate and therefore limited ability to grow a diverse range of species year-round (Röös & Karlsson, 2013). To ensure food

security, accessibility to a healthy and affordable diet for all its inhabitants, Sweden is thus dependent on imports when it comes to fruits and vegetables.

Food imports often result in a greater number of transported miles compared to locally produced food, leading to a larger environmental impact (Röös & Karlsson, 2013). Additionally, Swedes have a preference for domestically produced vegetables as they are perceived to be healthier (Carlsson-Kanyama & Lindén, 2001). One solution to reduce transportation distances and supply more local products is to extend the growing season of products by producing in greenhouses and using artificial lighting and heating. However, it may be that the environmental impact of artificial light and heating outweighs the environmental impact of transportation. Högberg (2010) studied the differences in the environmental impact of the production process for Spanish, Dutch and Swedish tomatoes that were consumed in Stockholm. The results indicate that Spanish tomatoes have the smallest environmental impact unless the Swedish tomatoes are grown in greenhouses that are heated with biogas (Högberg, 2010).

The methodology that is often used for these types of comparative studies is called life cycle assessment, or in short LCA. Life cycle assessment is used to determine and sometimes compare the environmental impact of different products and production processes, based on a specific scope and clear system boundaries (Blanke, 2008; Chapa et al., 2019). The study by Högberg (2010) used the LCA methodology to specifically compare the environmental impacts of imported and local tomatoes. Another LCA study on the Swedish vegetable market investigated food waste in Swedish supermarkets by determining the most often wasted products, fruits and vegetables account for 85% of food waste mass, and the impact of the different waste treatment options (Scholz et al., 2015). However, a shortcoming of the methodology that may have important consequences is the need to set system boundaries, implying that a part of the life cycle is left out or that a small range of environmental impacts is assessed (BSI - British Standards, 2006). While LCA studies for single products consider the life cycle from cradle (e.g. mining) to grave (waste management) (Fraval et al., 2019), the LCAs that compare different production methods or origins of the same product consider cradle-to-shelf (Högberg, 2010; Blanke, 2008; Chapa et al., 2019). The result is that food waste is not considered, neither in retail nor in households, while there is a reason to believe that food waste rates between local and imported products differ, which is that the shelf-life of locally produced products is longer (Yang et al., 2021).

While the life cycle assessment methodology is the most established method to determine the environmental impact of products, it cannot be used to assess whether or not a product or process is sustainable as it only considers environmental impact categories. To assess sustainability, the social and economic impact of a product are equally important as the environmental impact (Brundtland, 1987). The most commonly used and accepted model to visualize what sustainability entails is the triple bottom line model (Correia, 2019), where the importance of equal consideration of the People, Planet and Profit dimension is presented (Elkington, 2004). Generally, the environmental impact is not considered voluntarily in commercial industries but results from regulatory or consumer pressures (Elkington, 2004). However, especially in the food industry, the impact of businesses on the social dimension is highlighted and acknowledged by focusing on the health impact of nutrition. Lastly, although a rising number of scholars now suggest that economic growth should not be strived for, see for example the degrowth

ideology (Power & Peeters, 2019), economic prosperity and profit are factors that are most important in commercial industries (Elkington, 2004).

Multi-criteria analysis or assessment can be used to structure complex multi-dimensional sustainability challenges (Dean, 2020). Therefore, an MCA, which is an indicator-based tool, will be performed in this thesis as Gasparatos and Scolobig (2012) suggest it is the most appropriate tool for thorough sustainability assessments. Bartzas and Komnitsas (2020) used MCA to determine the impacts of local agricultural production on sustainability to overcome the restrictions bound to other methods. A literature review by Lindfors (2021) found that most scholars that perform an MCA suggest selecting and categorizing criteria for the assessment based on the triple bottom line theory, to ensure complete sustainability assessment.

1.2 Aim and Scope

Accordingly, by performing an MCA based on the triple bottom line, this thesis will investigate the differences in sustainability potential between locally grown and imported vegetables for consumption in Southern Sweden. The reason to investigate local production and consumption stems from the consumer preference for local products and the limitations to the results of the life cycle assessments that compared local versus imported vegetables. Furthermore, the focus on this production strategy allows to investigate the potential of increased vegetable consumption and more plant-based diets simultaneously. In addition, the impact on food waste of local production and consumption compared to the import of vegetables will also be included in this analysis by considering food waste as one of the criteria for the environmental and economic impact. The goal of this study is not to establish quantitative differences in environmental, social or economic impacts but to map differences between local and imported produce, weaknesses in the current system and potential points of improvement. The research question that will be addressed in this study is:

In what ways can assessment based on the triple bottom line model, when comparing the consumption of locally produced versus imported vegetables, contribute to a sustainable vegetable market in Skåne, Sweden?

The focus on vegetables exclusively is selected for multiple reasons, of which the main reason is that increased vegetable consumption is a suggested strategy for sustainable development as it suits a healthier lifestyle as well as a more environmentally friendly diet (Reisch et al., 2013). Furthermore, while vegetables are among the most often wasted products in retail (Scholz et al., 2015) the National Board of Trade for Sweden describes that due to the overall high rate of environmental awareness among Swedish citizens, vegetable consumption is expected to increase rapidly (Antonissen, 2020) which amplifies the need to investigate sustainable production and consumption strategies for vegetables specifically.

The scope of the study is the county of Skåne, in Sweden. This region is the most Southern county of Sweden and hosts the most vegetable producers due to the relatively mild climate (Persson, 2018). Therefore, the supermarkets in Skåne have the widest offer of domestically

produced vegetables (ICA, 2023), which makes the comparison between the sustainability potential of domestic and imported vegetables more straightforward.

1.3 Outline of the Thesis

After the introduction of the topic in this section above, the following chapter focuses on the context of the study. After, chapter three first discusses the most relevant previous literature and is followed by a theoretical section that discusses the main theory used in this thesis: the triple bottom line. Furthermore, the theory section lists and touches upon several concepts, which are used as the criteria for the MCA. The chapter concludes with the theoretical framework of the thesis, which is used to make assessments for sustainability. Chapter four contains the methodological decisions and a description of the approach. The methodology is followed by chapter five in which the empirical results are listed. Chapter 6 consists of a discussion of the results. In the final chapter, the main findings and implications of the thesis are elaborated upon.

2 Context

In a global context, Sweden and Finland are the leading countries when it comes to population health (Raphael & Bryant, 2006). Direct public policy involvement in the health sector as well as indirect policies aimed at prevention steer this outcome (Raphael & Bryant, 2006). For a large share, public policies are indirect or preventative policies that aim "to create societal conditions that will ensure good health, on equal terms, for the entire population" (Linell et al., 2013, p. 3). One strategy adopted in the Swedish National Public Health Policy Report is education to ensure the adoption of healthy diets among the population (Linell et al., 2013). The Swedish Food Agency is the organization responsible for the provision of general dietary guidelines and bases its advice on the Nordic Nutrition Recommendations (FAO, 2015). The main takeaway message in the guidelines is: "Find your way to eat greener, not too much and be active!" (Livsmedelsverket, 2023) where greener means less meat and more legumes and vegetables. Besides a general confirmation to the guidelines (Roswall et al., 2015) the Swedish population on average has a high environmental awareness (Breiting & Wickenberg, 2010) and prefers healthy, and especially locally produced food (Carlsson-Kanyama & Lindén, 2001).

As described by Röös and Karlsson (2013), Sweden imports a large variety of food products throughout the year to maintain a varied diet outside the Swedish growing season. However, historically Sweden was almost exclusively dependent on domestically produced food until it joined the European Union in 1995 (Cederberg et al., 2019). Today, Sweden is significantly more dependent on imports, mostly for fruits and vegetables and protein sources such as meat and fish (Cederberg et al., 2019). Alternatively, when it comes to domestic production of fruits and vegetables, the opportunities within Sweden diverge due to the different climate zones. According to the national statistics bureau of Sweden, the counties of Skåne, Blekinge, Stockholm and Halland are the largest producers of greenhouse vegetables. Skåne has a total production of 876 thousand square meters and Halland fifty thousand in 2017. For outdoor-grown vegetables, Skåne is again the largest and single important region of production, with six thousand hectares of cropland. (Persson, 2018). This data demonstrates that the temperate maritime climate of most Southern regions is suitable for vegetable cultivation while further up North outdoor cultivation is impossible and greenhouse cultivation is not economically viable (Persson, 2018).

Even though several regions have a suitable climate for fruit and vegetable cultivation, the vast majority of fruits and vegetables are imported from other countries (Antonissen, 2020). Statistics indicate that the import dependency has grown for Sweden as the total import value of fresh vegetables has more than doubled between 2000 and 2018 (Antonissen, 2020). The recent Covid-19 pandemic has visualized the danger of extreme imbalances in food production and availability with rapid increases in malnutrition in vulnerable societies and massive food waste

in export countries due to disruptions in the supply chain (Secondi et al., 2022). Disruptions ranged from sudden demand spikes, the sudden closure of businesses such as restaurants, labor shortages, changing transportation networks and limitations to trade in general (Hobbs, 2020). Furthermore, the FAO 2022 report states that "Another crisis now looms that is likely to impact the trajectory of food security globally. The war in Ukraine will have multiple implications for global agricultural markets through the channels of trade, production and prices, casting a shadow over the state of food security and nutrition for many countries in the near future." (FAO et al., 2022, p. 17).

On a global scale, the war has led to food security because Russia and Ukraine together supply about one-third of globally traded wheat, which is an important source of calories for Middle Eastern and African countries (Behnassi & Haiba, 2022). Addtionally, Russia is one of the largest producers of fertilizers, which has indirect implications for agriculture worldwide (Behnassi & Haiba, 2022; Abay et al., 2023). Another indirect consequence of the war for other, mostly European Union countries was the increasing scarcity of energy sources due to an EU boycott of Russian oil and a reduced supply of natural gas (Abay et al., 2023). The largest risk to global food security arises from the rapid increases in global food prices that result from scarcity in input factors and market uncertainty in general. The FAO food price index illustrates the extraordinary circumstances on the global food supply chain with a peak value in March 2022, followed by a slow but steady decline in the following months but with a value today that is still higher than all values before 2022 (*FAO Food Price Index, 2023*). Due to a decline in real wages, many citizens are having trouble making ends meet (Government offices of Sweden, 2023) and although nutrition is a primary need, more and more people are struggling to afford adequate food (Henley, 2022). As a more positive consequence, creative initiatives appear that provide affordable healthy food by tackling food waste. Examples are legal dumpster diving, apps where retailers offer food that officially cannot be sold anymore (TooGoodToGo, n.d.), and entire grocery stores that only offer products that are at risk of being wasted (Henley, 2022).

The price of vegetables has risen in Sweden as well, as either the costs for production in Swedish greenhouses or transportation costs for imported products grew. The largest Swedish indoor tomato cultivator decided in September 2022 to skip the planned winter cycle simply because the lighting costs were too high as a result of the skyrocketing electricity prices (HortiDaily, 2022b). In general, most smaller Swedish tomato cultivators do not harvest in winter as the artificial lighting required for tomatoes to grow in winter is not always cost-effective on a small scale (personal communication, van Schie, 2023). This winter, the Swedish market for horticulture produce was therefore more dependent than usual on import products. For tomatoes, the two main trade partners for Sweden are the Netherlands and Spain. In the Netherlands, prices for indoor cultivation skyrocketed to an even larger extent due to the dependency on natural gas for heating, which is extremely expensive as a result of the Russian war (Sterling, 2022). Therefore, most cultivation shifted to Spain, but as most cultivation is outdoors in Spain, the high prices for fertilizers, as well as the risk of failed harvest led to rising prices for Spanish produce as well (Napolitano & De La Hamaide, 2022). On top of that, the rise in transportation costs for relatively long distances such as from Spain to Sweden has altogether increased the prices of vegetables for Swedish consumers, no matter their origin.

The Swedish governmental budget bill for 2023 includes several strategies to support the most vulnerable Swedish citizens in the recession of 2023 (Ministry of Finance, 2022). The press release points out that the state will not compensate for all price increases but will focus on energy-intensive businesses and introduce high-cost protection on electricity in the winter of 2022-2023 for households and firms. Additionally, the taxes on fuel will be lowered while simultaneously measures to improve Swedish electricity production are suggested (Ministry of Finance, 2022). The strategy towards fossil-free energy and energy dependency is to re-introduce, as well as expand, nuclear energy production especially in the Southern regions of Sweden (Kristersson, 2022). This could imply that the price of producing year-round in Swedish greenhouses becomes competitive with prices of imported vegetables. In the same speech, the prime minister said: "the competitiveness of Swedish food production will be strengthened." (Kristersson, 2022). However, the context or the pathway towards the set goal is not mentioned or elaborated upon. The Swedish government has become more right-wing-oriented since the last elections in September 2022 which seems to lead to a more nationalistic and less environmental focus in national politics (Valmyndigheten, 2022). The newly found nationalistic focus may imply that more produce will be grown in Sweden. It is difficult to predict what will happen to the Swedish vegetable market and how it will impact the sustainability of production and consumption and import (in)dependency.

3 Theory and previous research

In the following section the theoretical framework of the thesis will be explored based on previous literature, one sustainability assessment theory and different concepts. The assessment tool used is multi-criteria assessment/analysis, or in short MCA. The criteria and indicators for assessment are in turn based on the triple bottom line model to ensure complete sustainability assessment. After the triple bottom line approach has been explained, multiple concepts are touched upon that are used as criteria in the assessment. The relevance and applicability of the theory and criteria will be summarized in a visualization of the theoretical framework of this thesis at the end of the chapter.

3.1 Previous Literature

Responsible production and consumption is an important goal in the global agri-food system, according to the sustainable development goals created by The United Nations (2015). The main problem with the global food system is the resulting depletion of natural resources, including freshwater reservoirs, soils and the atmosphere which are all vital for life on earth. To illustrate, out of the nine planetary boundaries, five have passed the safe threshold and for four of them agriculture is the main driver (Campbell et al., 2017). Most established practices in the dominant intensive agriculture paradigm were adopted successively in the last century to keep up with population growth (Brown, 1981). However, as Brown (1981) already described forty years ago, those practices led to an unsustainable rate of soil erosion, indicating that this agricultural paradigm could not continue to support a growing population indefinitely. Therefore, the urgency to shift to responsible production and consumption when it comes to nutrition is large, especially when taking the rising population growth into account and the predicted loss of productive agricultural land (Grafton et al., 2015).

The FAO is highly concerned with improving food security and the most recently published report states that food insecurity has risen to extreme levels in the last two years due to the amplification of the main drivers of malnutrition: extreme weather events, violent conflicts, and shocks to the global economy (FAO et al., 2022). The main message in the reports from 2021 and 2022 is that the only way forward is global food system transformation, applied per nation to domestic specific needs and supported by governments with suitable financial incentives (FAO et al., 2021; FAO et al., 2022). To achieve food security is to increase system resilience against shocks and in general achieve globally accessible healthy, nutritious and sustainable diets (FAO et al., 2021). Although the reports do not include suggestions for specific production methods, the report of 2021 includes six pathways towards global food security, of which the applicability differs slightly per context (FAO et al., 2021). Three of the pathways are applicable to Sweden as a developed country and are helpful guidelines towards sustainable production

and consumption (figure 1). To achieve food security, the strategy towards sustainable food production and consumption must be set first. The strategy examined in this study, consumption of locally produced vegetables, could touch upon all three pathways.

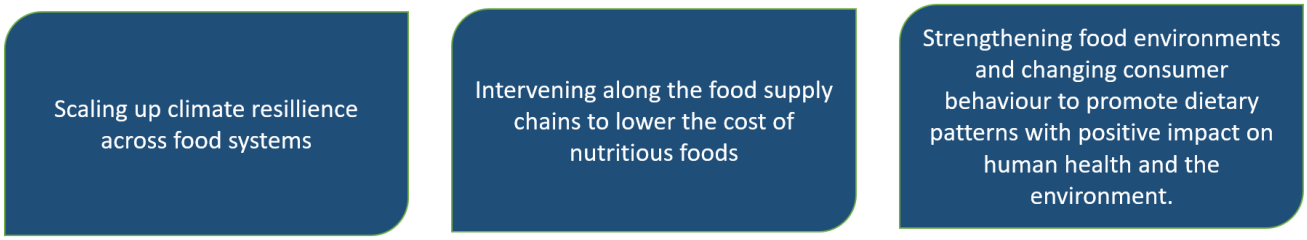

Figure 1: pathways for food security, adapted from FAO et al. (2021).

For Sweden, one of the proposed strategies in the literature for more sustainable production and consumption is to import less food produced in other countries (Carlsson-Kanyama & Lindén, 2001). It is often assumed that consuming locally is more sustainable in terms of environmental impact as well as the impact on the local economy (Chambers et al., 2007). In addition to that, the consumer perception of local food is often more positive as people regard local products as high quality goods (Juric & Worsley, 1998). In Sweden, consumers also have a preference for products grown domestically (Ekelund et al., 2007). However, local production does not necessarily imply a reduction of the environmental impact as the energy-intensity of the production process, which may vary largely between countries, determines the environmental impact to a large extent (Avetisyan et al., 2014). In the case of Swedish vegetables, the local production of exotic crops in greenhouses can have a higher environmental impact than if the crop was to be imported (Högberg, 2010). As Kanter et al. (2016) describes, such conclusions cannot be generalized for every crop and the entire country as there is a wide variety of indicators that determine whether a certain production process is sustainable or not and the appropriateness of indicators in turn relies on the scope of analysis. In fact, there is "hardly a single method that can assess the sustainability of the socio-economic metabolism. Rather a combination of different tools, methods and indicators is required to analyze various aspects of the socio-industrial metabolism." (Bringezu and Bleischwitz, 2017).

Consequently, this study aims to address how the Southern Swedish vegetable market can become more sustainable by considering more than environmental impact categories. The impact categories, or criteria in the jargon of MCAs, that are considered in this study are food waste, shelf-life and packaging, pesticide and fertilizer use and greenhouse gas emissions and energy use. Lindfors (2021) found that the selection of appropriate criteria is often based on previously performed studies. In this thesis, the criteria are inspired by the Axfood annual and sustainability report, which presents the targets for large Swedish retail brands with regards to sustainable production and consumption (Axfood, 2023).

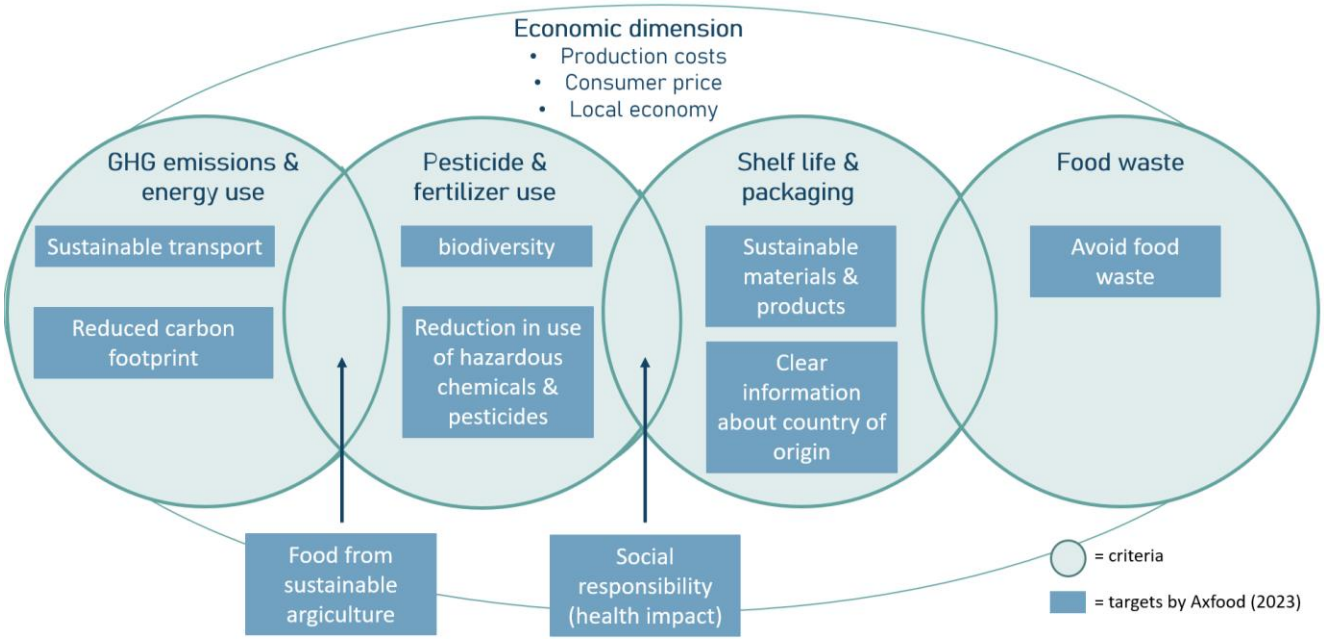

Figure 2: visualization of the criteria and how they include the Axfood (2023) targets.

Figure 2 visualizes how the criteria were selected in this study to include the targets set by Axfood (2023) in a more explicit way. The sustainability report mainly focuses on environmental sustainability which results in a wider set of environmental criteria than social and economic criteria. However, even though the report did not emphasis economic sustainability, financial performance is the main goal for most commercial organizations. Therefore, the criteria retrieved from the Axfood report are embedded in the economic dimension which is represented by production costs, consumer price and the impact on the local economy as indicators in this thesis. Besides, the impact of the food industry on the social and economic dimension is quite straightforward: it must provide healthy and affordable diets. Therefore, health impact is not considered as a separate criterium as it is considered in pesticide & fertilizer use as well as shelf life & packaging. The indicators used for the social dimension in this report are taste, nutrient density and pesticide use or residue.

3.2 Theoretical Approach

3.2.1 Triple bottom line model

The triple bottom line model (TBL) is a popular framework in sustainability science to illustrate the importance of the environmental and social impact of products, business practices or investments apart from the financial incentive. The term was launched in 1994 by John Elkington, co-founder of a prominent sustainable business consultant (Elkington, 2004). The term was increasingly being used due to a growing concern and focus on arising environmental issues, which were made public by the Brundtland report, and the urgency to integrate the social and

economic dimension into decision making for environmental issues (Elkington, 2004). For a similar reason, the triple bottom line model is used in this study, as solutions to environmental problems are often not viable as long as social and economic aspects are not considered or ignored (Ahi & Searcy, 2015). Besides, for sustainable agriculture and food, production and consumption and food security, all three pillars of sustainability are required (FAO, 2023).

It is important to mention that there is quite some criticism on the triple bottom line model. For example, Shnayder et al. (2015) found that main strategy of many companies is to focus on the social dimension, that requires the smallest adjustments in general, making that the TBL model undermines a transition towards more environmental friendly practices. Another criticism to the TBL approach is the complexity of measuring the impact of businesses on the social dimension (Sridhar & Jones, 2013). Lastly, from a more holistic point of view, the inclusion of the economic dimension in sustainable development is criticized as it is argued by degrowth advocates that the capitalist economic system cannot prevail in a truly sustainable society (Powers & Peeters, 2019).

The reason why this study uses the model despite the criticism is that the vegetable market is dominated by a variety of corporate stakeholders, which means that a wide range of interests are represented (Ahi & Searcy, 2015). From a corporate point of view, a more eco-efficient way of producing is only viable if it will not harm their economic prosperity, which depends on consumer demand. Demand in turn depends on the consumer perception of the health impact and environmental impact of the products. Furthermore, the model serves as the most suitable guideline for criteria selection in multi-criteria assessments for sustainability (Lindfors, 2021).

3.2.2 Food waste

According to a recently published report by the United Nations on food waste, the average Swedish citizen wastes 112 kilograms of food a year, either directly within their household or indirectly via retail or food service waste (Forbes et al., 2021). One of the main problematic implications of food waste is its contribution to climate change, as it is estimated to account for 8-10% of total greenhouse gas emissions (United Nations Environment Programme, 2021). Food waste not only has negative environmental impacts, but also exacerbates inequality and can threaten food security. With the goal of zero hunger under the United Nations Sustainable Development Goal 2 yet to be achieved, the fact that food is wasted in other parts of the world is a major issue (United Nations Environment Programme, 2021). In addition, factors such as land use change and climate change are expected to lead to increased food insecurity and potentially limit equal access to food (Bohle et al., 1994). Scholars agree that a reduction in food waste is a solution with large potential to achieve a more sustainable and secure global food supply and would allow to make less drastic changes in diets compared to eating plant based, which is another often proposed solution (Navarre et al., 2023).

A variety of scholars have investigated the main drivers of food waste and potential policy implications (Thyberg & Tonjes, 2016; Stancu et al., 2016; Canali et al., 2016; Hebrok & Boks, 2017). However, as noted by Hebrok & Boks (2017), much of this literature simply describes the problem without offering concrete solutions. This may be in part due to the fact that food

waste is closely tied to psycho-social factors (Stancu et al., 2016) and perspectives on the issue vary widely (Thyberg & Tonjes, 2016). However, a prerequisite for suitable solutions is to have a deep understanding of the concept of food waste and how and when it occurs (Soma et al., 2020).

Figure 3 visualizes the different concepts related to food waste that require a clear distinction. When food is wasted or becomes inedible during production, this is labeled food loss (United Nations, 2021). Food waste on the other hand refers to the waste of edible products on the consumer side, where retail and food services such as restaurants are included. Food waste is a larger and more prevalent problem than food loss (Thyberg & Tonjes, 2016) and will therefore be the main focus of this thesis. However, during some of the interviews carried out for this thesis, information on food loss rates during production or transportation was revealed. In that case, the concept of food loss is used. Some stakeholders refer to post-harvest loss which includes food loss after production and food waste. Furthermore, while food waste from supermarkets is actually the smallest stream of food waste (United Nations Environment Programme, 2021), this study will focus on supermarkets as they have the most data available on the streams entering and leaving the store as well as the origin of products.

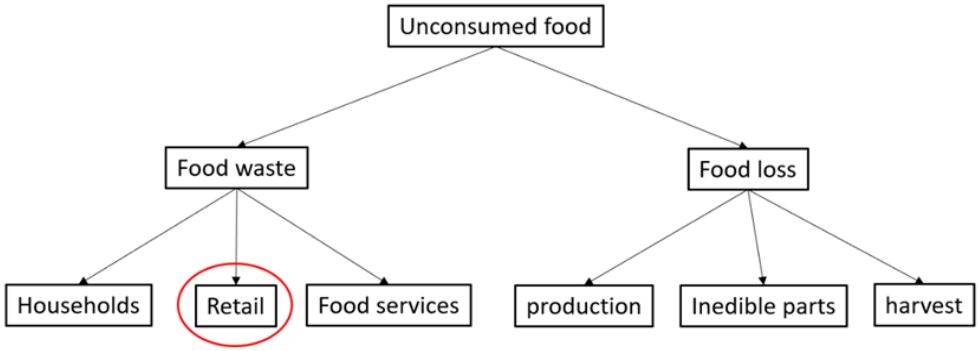

Figure 3: focus area in terms of food waste

3.2.3 Shelf-life and packaging

A potential solution to avoid food waste is the extension of shelf-life (Spada et al., 2018). Shelf-life is the amount of time a product, in this case a vegetable, can be stored before it becomes inedible (Cambridge dictionary, 2023). Shelf-life has an important impact on the sustainability potential of a product through several mechanisms. Firstly, the longer the shelf-life, the lower the risk of food loss and waste during any stage of the supply chain (Beshai et al., 2020). However, potentially as important as long shelf-life is the predictability of shelf-life for a certain product (Corbo et al., 2006). The lower the variability, the better retailers are able to estimate the correct quantities to balance supply and demand and thus avoid food waste. Moreover, shelf-life is a determining factor for nutrient density, taste and health benefits of vegetables. Generally, vegetables with a long remaining shelf-life are more fresh and thus healthier (Amani &

Gadde, 2015). However, vegetables that are harvested before they are fully ripened, an often-used strategy to extend shelf-life, have inferior flavor (Kader, 1996).

Another, well-researched, solution for shelf-life extension is food packaging (Conte et al., 2015). In essence, most vegetables do not require any packaging as their shells protect against bacteria and germs (Hunt, 2017). However, packaging often prolongs shelf-life by reducing post-harvest moisture loss (Schlimme & Rooney, 1994) and respiration (Kumar & Morya, 2019). Generally, most vegetables are packaged nowadays and "the principles of food packaging are to protect the food products from outside influences and damage, to contain the food and to provide consumers with ingredients and nutritional information." (Mangaraj et al., 2009, p. 133). The protective properties of packaging are especially valuable as it conserves the vegetables better which reduces the potential of food waste and with that a loss of energy that is ten times larger than the amount of energy used for the packaging (Verghese et al., 2015). According to the organization Fran Sverige, which represents Swedish food producers and label the products accordingly, a wrapped cucumber has a lower environmental footprint than an unpacked cucumber due to a reduction of the food waste risk (Berkeley, 2023).

While there is a synergy between packaging, shelf-life, food waste and overall environmental impact, a tradeoff is present as well. As Beitzen-Heneike et al. (2017) as well as Michaliszyn-Gabryś et al. (2022) describe, avoiding waste should be prioritized to achieve a more resource efficient and sustainable economy. It is yet unclear whether sustainable packaging or zero packaging is the optimal strategy towards sustainability when evaluating current studies. Research into sustainable packaging is centered around biodegradable packaging (Narancic et al., 2016), edible packaging made from byproducts (Hamed et al., 2022) or single material packaging to improve recyclability (Ibrahim et al., 2022).

3.2.4 Pesticide and fertilizer use

Another important criterium that is considered in the study is pesticide and fertilizer use. Synthetic fertilizers rose in popularity in the 1960s as a means to increase crop yields by increasing the overall stock of nitrogen in (eroded) soils (Mosier et al., 2013). However, when used excessively, fertilizers are known to cause eutrophication in freshwater stocks which alters the natural habitat of a variety of different watershed organisms (Viets & Lunin, 1975). Apart from the pollution of (ground)water, fertilizer use causes emissions of nitrous oxides to the atmosphere and soil pollution as fertilizers often contain heavy metals (Chien et al., 2009). When compared to articles from the last century, which report problematic high energy consumption for fertilizer production (Viets & Lunin, 1975), many improvements have been made in terms of fertilizer efficiency to reduce the environmental impact already (Chien et al., 2009). However, as Mosier et al. (2013) explain, with a rising world population, rising consumption of animal products and increasing amount of land degradation, continuous improvement in fertilizer use efficiency is essential for future food security.

Pesticide use is another method often used in commercial agriculture to control risks. Pesticides are most often a single element or mix of toxic substances that, sometimes mixed with a biological medium, reduce the chances of a failed yield (Mahmood et al., 2016). The chemicals

are released into the environment in a variety of ways to control for and eventually destroy threatening insects, diseases or fungi that would harm the crop (Mahmood et al., 2016). Pesticides came to the market in the 1940s as a means to increase crop yields (van der Werf, 1996). Although pesticides are effective, on average only 0.3% of the applied pesticides reach the target which implies that the other part accumulates in the environment (van der Werf, 1996). Problematic consequences of pesticide use are acute poisoning incidents leading to deaths as well as indirect consequences on human health by the consumption of produce with pesticide residue (Bourguet & Guillemaud, 2016). Due to the accumulation in the environment and the related negative effects on both human and environmental health (Rani et al., 2021), there is an ever-expanding list of pesticides that are prohibited and biorational pesticides are favored nowadays (Mahmood et al., 2016). Biorational pesticides make use of strategies that include other living organisms that are the natural enemy of the target insect or methods that work with specifically targeted natural hormones.

3.2.5 GHG emissions & Energy use

Lastly, greenhouse gas emissions and energy use are considered as an impact category in this study. Generally speaking, fossil energy use and the amount of GHG emissions are closely related, although the energy source determines the intensity of emissions (Amponsah et al., 2014). Energy use and GHG emissions occur in many stages of the production process. Firstly, the production of pesticides and fertilizers require energy, and fertilizers emit GHGs. The production process itself may use a lot of energy if the products are cultivated indoor and transportation contributes to overall energy use and GHG emissions as well. The results from previous studies show that the type of energy, renewable or fossil, used for artificial lighting and heating in greenhouse cultivation is crucial for the overall environmental impact of vegetables (Högberg, 2010). However, horticulture is a sector with rapid innovation and development and many producers in this sector strive to sustainable production (Harvest House, n.d.). Besides, the energy sector in general has undergone a large transformation since 2010, with rapidly increasing adoption rates for renewable energy and large shocks in supply and thus prices due to the Ukrainian war (Hortidaily, 2022a). Furthermore, Hospido et al. (2009) found that the highest energy consumption for outdoor grown vegetables occurs during refrigerated transportation in the case of imported vegetables. All in all, it might be the case that this study will give different results than the previous research into the differences in energy use and GHG emissions for imported and domestically produced vegetables.

3.3 Theoretical framework

The theories elaborated upon in the previous sections together serve in making assessments regarding sustainability, based on the theoretical framework of this thesis, visualized in figure 4. To reduce estimation biases, four vegetables are selected to analyze: cucumbers, tomatoes, cauliflower and iceberg lettuce. The vegetables have in common that they are produced in Sweden but not all year round without the use of artificial light and heating. Therefore, seasonality

is important to consider as the domestic produce is only offered 'in season' and is imported from other countries for the remaining parts of the year. For every product, with a distinction based on origin, the total impact on the social, economic and environmental dimension will be assessed by considering the criteria and their measurable indicators. The final outcome is based on a comparison between the origin of the products. For example, if the Spanish tomato has the shortest shelf life and most pesticide use during production, the product will be least healthy and thus score a – (minus) on the People dimension. This way of scoring is one of the simpler versions of interpreting the results in a MCA, but it is the most suitable to determine the optimal solution without specific quantitative information (Lindfors, 2021).

As touched upon before, the criteria have a more explicit focus on the environmental dimension. However, shelf life and pesticide use also determine the health impact and thus social dimension and production costs and consumer prices are generally important for the viability of production and consumption strategies. Furthermore, the weighting strategy will limit a bias towards the product that is most environmentally friendly as the other dimensions are considered as equally important.

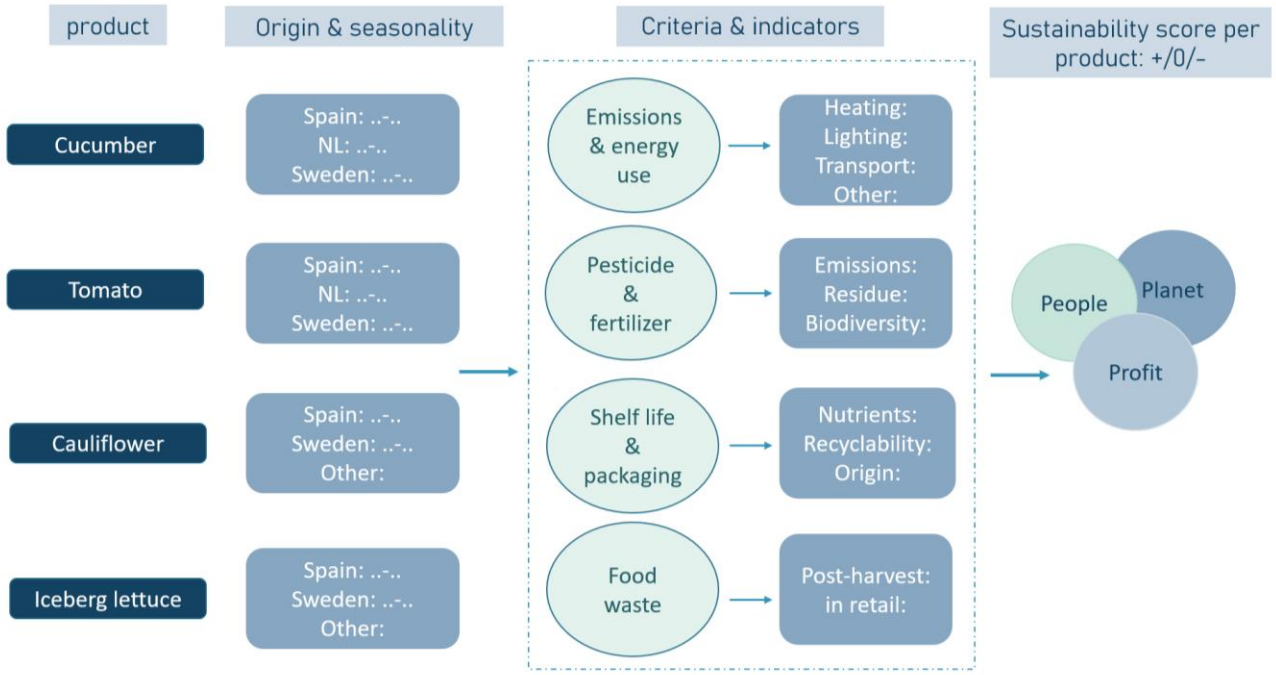

Figure 4: the theoretical framework of the thesis

4 Methods

4.1 Design

4.1.1 An exploratory case-study

As the theory section has demonstrated, a similar study for the Swedish vegetable market has not been conducted before. An inductive approach is therefore most suitable as there is a limited stock of literature available to consult. Panke (2018) describes that inductive questions are often best served with an exploratory approach. It is the most suitable design whenever the empirical situation is unideal, when there is a common lack of (scientific) understanding about a topic or whenever new hypotheses about a well-studied topic arise (Swedberg, 2020). In this study, an exploratory study is the most appropriate design due to a combination of an unideal empirical situation unanswered questions regarding a relatively well-studied topic. The research question is:

In what ways can assessment based on the triple bottom line model when comparing the consumption of locally grown versus imported vegetables contribute to a sustainable vegetable market is Skåne, Sweden?

The two sub-questions that have not been answered with existing studies are:

Is there a difference in retail food waste rates between imported and local vegetables?

What is more sustainable for Skåne, Sweden: local or imported vegetables, when considering more than exclusively the environmental dimension?

These two gaps in current literature are explored for Skåne by answering the main research question. Due to the case-study design the findings are not generalizable to wider scopes but more encompassing statistical methods of collecting data would not be possible with another approach due to time constraints. Furthermore, the aim of this study is not to quantify differences per impact category but instead to map differences between local and imported produce and investigate potential opportunities for improvement in terms of sustainability for the current vegetable market.

The scope is selected for two reasons. Firstly, it avoids the problem of exploratory studies being too broad or vague (Panke, 2018; Swedberg, 2020). Besides, as was already briefly touched upon before, the most Southern region hosts the most vegetable producers of Sweden which results in a different vegetable market than in the more Northern regions. The focus on retail

for gathering information about food waste stems from the fact that supermarkets are transparent about the origin of their products, with Swedish options clearly labeled (Svenskmärkning – Från Sverige, 2023). Additionally, vegetables have a relatively short shelf life which is hard to predict beforehand as it depends on a variety of conditions (Corbo et al., 2006) and are therefore among the most wasted products in retail (Beshai et al., 2020) which makes it interesting to study the sustainability improvement potential.

4.1.2 Mixed-methods

In order to gather the required data for the multi-criteria assessment, both quantitative and qualitative data are gathered simultaneously. The primary data is gathered with surveys and interviews as well as with written answers to interview questions. The multi-criteria assessment involves the inclusion different criteria that are measured with indicators that are often a mix between quantitative and qualitative data, operate at different scales and have different uncertainty levels (Bartzas & Komnitsas, 2020). Therefore, a mix-methods approach is most suitable as it allows to gather information for the different indicators and criteria. Additionally, Swedberg (2020) describes that mixed-method approaches improve the strength of exploratory studies.

In general, interviews are most often the main methodology in inductive exploratory studies (Mojtahed et al., 2014; Jain, 2021). Swedberg (2020) describes that most exploratory studies conduct open-ended interviews that may differ per interviewee. In this study, the interviews are a mix between open-ended and semi-structured interviews: the questions were created before but the order is flexible and there is room for follow-up questions. Besides, the interview questions differ for the diverse stakeholders but interviewees with a similar expertise did get similar questions.

Surveys are conducted simultaneously to gather quantitative data on retail food waste rates and qualitative data relating to the context of retail food waste which helps determine whether the quantitative data is generalizable or not (Panke, 2018). In the case of this study, the survey respondents are the managers of vegetable departments of ICA supermarket locations across Skåne. The managers have the best insight into the quantities of produce that enter and leave the supermarket but have only limited impact on the quantities wasted per category. The waste rates largely depend on demand, which is highly variable and dependent on a range of factors which are hard to predict. Therefore, a purely quantitative survey is likely to give less accurate results than a mixed-method approach where the quantitative data is supported with open questions (Hitchcock & Davis, 2023).

4.2 Approach

The methodology consists of a step-wise approach that begins with market research and the selection of important stakeholders, followed by data collection, data analysis and lastly inter-

pretation. The market research starts with exploring websites of Swedish producers, wholesalers and farmers organizations, annual reports of supermarkets, and other literature. In Sweden, supermarket brand ICA has the largest market share in the retail branch and has historically been the largest when it comes to the offer of local vegetables (Antonissen, 2020). Therefore, an orientation interview with an ICA location in Lund, Skåne, was scheduled to help determine the relevant stakeholders, the scope of the research and a suitable survey design.

Data collection through surveys consisted of the following steps:

1. Orientation interview with an ICA location in Lund to determine what type of questions would gather the best insights.
2. The outcome is: focus on four vegetables that are grown in Skåne and are imported as well (cauliflower, tomato, cucumber, iceberg lettuce) and avoid ICA Nära as they often only offer either imported or local vegetables.
3. Design trial survey for the same ICA location and gather feedback
4. Finalize the survey design and hand it out via email to all ICA locations in Skåne (n = 39) except for ICA Nära shops. The survey design is included in Appendix I.
5. Visit ICA shops personally to increase the response rate
6. Gather and anonymize the results
7. Data analysis in Microsoft Excel due to a small sample size (n = 4) and a mix of open and closed questions.

For the interviews, a stakeholder analysis was conducted first to understand the system of local production and import for vegetables in Southern Sweden. The stakeholder analysis included reading articles, annual reports from supermarkets, visiting websites from wholesalers, and sending emails to potential stakeholders to gather information. Furthermore the stakeholder analysis was based on the orientation interview with the ICA supermarket and later supported with additional insights gathered from already conducted interviews. The stakeholder analysis is visualized in figure 5 which shows that the main stakeholders in the system are Swedish, Dutch and Spanish tomato, cucumber, iceberg lettuce and cauliflower producers. Additionally, wholesalers, exporters, and importers play a key role in the distribution of vegetables, which may be supported by national distribution centers beforehand. Moreover, farmer or horticulture organizations are important in regards to information provision to single producers. Lastly, the market is dependent on packaging, but it is yet unclear how packaging is provided.

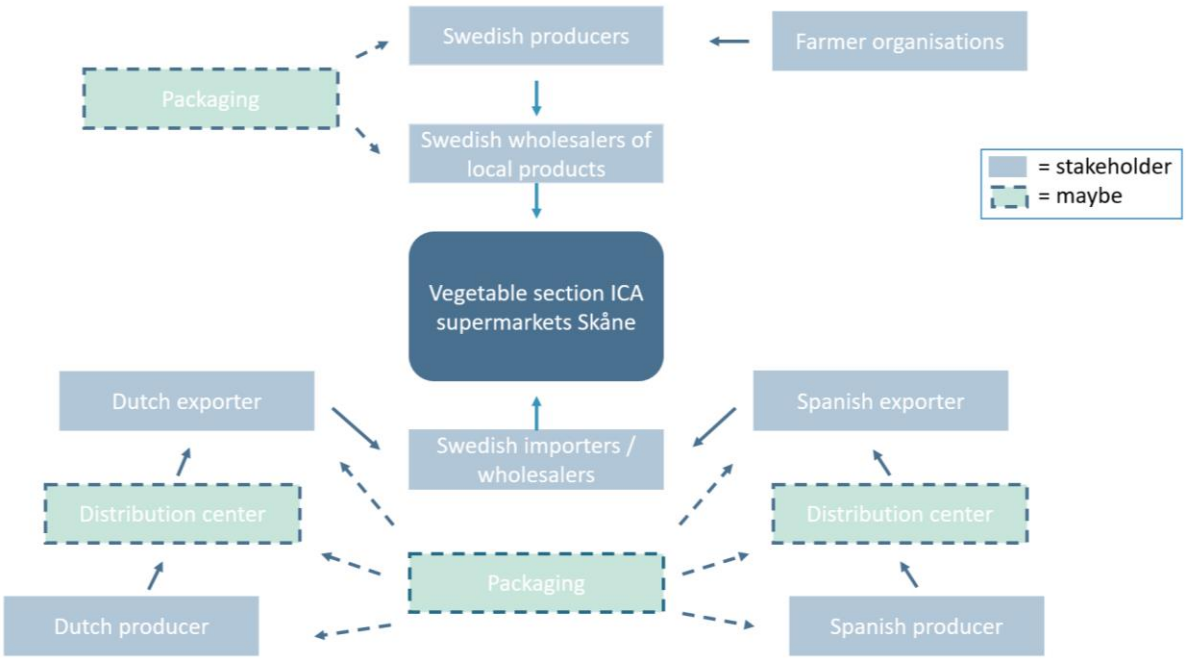

Figure 5: Stakeholder analysis for the vegetable market in Skåne

The approach for the data collection through interviews is as follows:

1. Determine the crucial stakeholders in the Swedish vegetable market by doing market research.
2. Contact at least two companies per type of stakeholder. E.g. two Swedish tomato and cucumber growers, two wholesalers etc. For the Dutch and Spanish market, grower organizations and experts were contacted to represent the average practices in the domestic market.
3. Determine the set of interview questions per type of stakeholder based on the gaps in the theoretical framework and stakeholder map. The selected interview questions per type of stakeholder are included in Appendix II.
4. Change the questions whenever it is required due to new insights from previous interviews.
5. Transcribe all interviews and code in Nvivo, based on the themes mentioned in the theory section, see figure 6.

Eventually, a third category of data was gathered as certain stakeholders indicated that they would not be able to schedule an interview due to time constraints but would be willing to answer the questions via email. Due to this communication strategy, some stakeholders indicated that they could answer the questions more precisely. However, the main constraint of

written answers instead of an interview is the inability to ask follow-up questions. The written answers were coded similarly as the interviews.

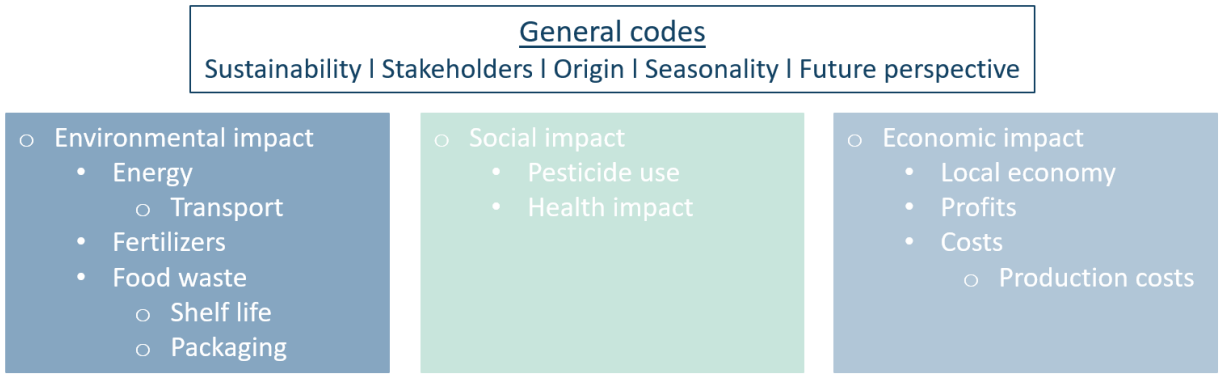

Figure 6: Nvivo codes

4.3 Limitations

As science is "the pursuit of truth and the limitation of error" (Roberts & Priest, 2006, p. 42), it is important to assure data reliability and validity, where reliability means to what extent the same test will give similar results under different circumstances and may also be referred to as 'generalizability' (Medicine et al., 2019) and validity concerns the suitability of the data in regards to the aimed type of outcome (Roberts & Priest, 2006). In some cases the representativity of the research is of additional importance where the aim is to have a set of data that is typical enough to represent the population (Brunswik, 1955).

As touched upon before, the data used in this study is primary data, which is often associated with high credibility in research (Streefkerk, 2023). On the other hand, due to the exploratory nature of the research as well as the fact that it is a case-study, the sample size is small which in turn potentially undermines the representativeness of the study (Zagheni & Weber, 2015). As the small sample size is partly a result of the selected case-study, it can be seen as a delimitation because the design was consciously selected (Ross & Zaidi, 2019).

However, an additionally, unforeseen driver of the small sample size was the difficult data collection process. In general, organizations are unwilling to share information if it does not contribute anything to their organization or work, especially if the information is sensitive (Kaiser, 2012). To avoid non-participation, participants were provided with a clear and extensive explanation of the course and purpose of the study (Kaiser, 2012). Additionally, participants filled in a consent form upon participation where they could indicate under which conditions their contributions may be used, which was signed by both parties as suggested by Kaiser (2012). However, even though measures to increase trust and transparency were taken, the sample size remained small. In total, 39 supermarkets were contacted to fill out the survey and eventually by personally handing out the surveys four people agreed to participate. Besides, a selection bias

cannot be excluded with certainty. All four participants indicated that they do not consider vegetable waste as a problem in their supermarket. Studies show that employees attitudes and behavior are crucial in supermarket food waste management (Mattsson & Williams, 2022). Therefore, a potential selection bias towards supermarkets who have already adopted measures to avoid food waste may has influenced the results.

For the interviews, the process started out by contacting two companies or organizations per type of stakeholder. The first emails were followed by reminder emails which resulted in the participation of two Swedish vegetable producers. After that, the strategy has shifted to calling offices to see if they were interested in participating. A total of eight stakeholders have participated in the interviews that represented all stakeholder groups that were selected in the analysis.

The sample size for the surveys however is too small to be representative for vegetable food waste in supermarkets in Skåne. Yet, Hackshaw (2008) states that in exploratory studies, the new hypotheses are often firstly tested for a small sample size to explore the possible relationships between phenomena before investing unnecessary large amounts of time and resources in a large study. Whether or not the reliability of the data is high is difficult to say in this case as the outcome of the study applies specifically to the vegetable market in Southern Sweden and is not necessarily supposed to be generalizable to other geographical locations. The study design already incorporates details that apply to the case study specifically and therefore the 'test' itself is not directly applicable to different circumstances. In turn, the validity of the data is high as the exploratory nature of the study is best served with a mixed method approach (Panke, 2018). Lastly, representativity of the data to a wider context is not applicable in this study, as "an exploratory study is based on research that is not representative in nature." (Swedberg, 2020, p. 20).

5 Empirical Analysis

5.1 Survey results

Firstly, the results of the surveys are analyzed. The four respondents, who are the managers of the fruit and vegetable department of ICA locations in Skåne were asked to give exact numbers of purchase and sales per month, per product and per origin. Due to the small sample size, the results are not significant and serve as a purely indicative, exploratory outcome. One of the first findings is that the food waste percentages (wasted quantity/total quantity bought) are slightly higher for imported vegetables and mostly differ per type of vegetable. The vegetable waste resulting from the survey ranges between 1.0% and 7.1% for local cucumbers and iceberg lettuce respectively and 1.3% and 9.3% for imported tomato and iceberg lettuce respectively. The ranges suggest that as expected, local products are slightly less wasted compared to imported vegetables. Besides, the results show a large divergence between the stores in terms of food waste which either indicates that the managers do not have accurate data available or that there is potential for improvement by sharing best practices between the stores.

The managers were asked if there is any difference in shelf life between local and imported products and most of them indicated that local products have a longer average shelf life than imported products, which may be a reason for the difference in food waste rates. The participants were also asked to indicate what the most common reasons are for the food to be wasted, by distinguishing between imported and local vegetables. For imported vegetables, the first reason is that the vegetables have a shorter shelf-life than expected, the second reason is that the vegetables have cosmetic deviations or do not look fresh and the third reason is estimation mistakes (a larger offer than demand). For local products, the main reason that products are wasted is that comparable products are offered at a lower price. The other two reasons that were mentioned are estimation mistakes, that the products have cosmetic deviations or do not look fresh.

Furthermore, all the participants indicated that vegetable food waste is not a problem in their supermarket as they had found ways to either reduce it or find another use for the vegetables that have reached their best before dates. As an answer to the question: ‘Have there been projects to reduce vegetable food waste in your ICA location?’ two responses were:

> “Yes, we lower the price of products that almost reach their best before date or look unusual. The kitchen uses some of the products for their meals. We donate to the church and the rest streams go to the vegetable waste bin.”

"Yes, control the amount of products we buy to make the food waste decrease."

Furthermore, all survey participants indicated that they are not aiming to improve in regards of vegetable waste management but continue as they already operate. However, the question that investigates what happens to the leftovers, that was posed directly after the sales and purchase questions, indicates that in multiple supermarkets still a large share, between 20% and 50% of the vegetable waste ends up in either the food waste bin or general trash.

5.2 Interview results

While the surveys were mainly aimed at discovering the practices in supermarkets and considerations of the managers regarding local versus imported products with a focus on food waste, the interviews targeted a broader range of in total eight stakeholders to discover how the vegetable market in Southern Sweden functions. A function description per stakeholder is provided in table 1 below. The interviewees will be referred to as their provided numbers to simplify the empirical results.

Number	Stakeholder	Function description
1	Small-scale vegetable cultivator located close to Gothenburg	Growing tomatoes, cucumbers and bell peppers in greenhouses and potatoes outdoor. Environmentally aware.
2	Large scale tomato producer	Danish horticulture company with a location in Skåne where tomatoes are produced in greenhouses. Largest in Sweden. Has year-round production.
3	SydGrönt	Swedish organization for vegetable cultivators. Supports vegetable producers in Skåne, serves as a wholesaler. Owned by producers. Aim to create awareness among citizens.
4	HarvestHouse	Dutch horticulture organization that connects horticulture growers in Europe. Serves as consultant and wholesaler.
5	Horticulture expert with a focus on Spain	Dutch horticulture expert with over 30 years of experience in different horticulture sales and consultancy companies. Has most sales experience from selling projects in Spain.
6	Packaging expert	Chief Sustainability Officer at Paptic packaging solutions. Company that replaces plastic foil and wrapping with wood-pulp based alternatives.

7	Wholesaler in Skåne	Sells both domestically produced vegetables as well as imported vegetables to all of Sweden
8	Vegetable department manager	Vegetable department manager at an ICA location in Lund, Skåne. Has been working there for 16 years and makes all purchasing decisions together with his colleague.

Table 1: Overview of the interviewees

5.2.1 Local vegetables

An important stakeholder in the Southern Swedish vegetable market is SydGrönt, which is a growers organization. One of the main goals of the organization is to create awareness among all Swedish citizens and promote the consumption of local or domestic and seasonal products. They help consumers make more conscious decisions with, among others, a calendar of the products that are in season in Sweden:

"Pre-cooked vegetables, beet roots, sprouts, potatoes, onions and carrots are products that are in season almost all year round. Most greens, such as all types of lettuce, herbs, and some cabbage are in season from May to October. Other types of greens, such as broccoli, fennel, cauliflower, beans and some type of cabbages follow with being in season from June to November mostly. Cabbages like red cabbage, celeriac but also pumpkins are in season in the autumn, from August or September to December. Tomatoes and cucumbers are in season from April to November and February to November. There are a few products that are very shortly in season, for one or two months only such as asparagus, zucchini and rhubarb." (stakeholder 3).

This implies that between December and April there is barely production of vegetables in (Southern) Sweden. However, indoor cultivation allows to produce year-round as growing conditions can be controlled. Stakeholder 8 explained that the cucumbers they sell come from cultivators that use hydroponic systems to grow year-round. Furthermore, stakeholder 2 explained that they are the only year-round tomato cultivator in Sweden at the moment. Year-round production in the case of tomatoes entails planting an additional cycle that can be harvested in winter:

"So winter crop you start planting in September, starting harvest in November, you can harvest during the winter, spring, even summer. And then end of the summer in August we used to stop the production and clean up in a short period of two to three weeks and put new plants in. Because the area is not so big we can do the clean-up quicker. So this way we are able to supply our customers with the same product all year round." (stakeholder 2).

However, stakeholder 1, explained that year-round production is not viable for them due to both the high investment costs for installing lamps as well as the higher production costs related to increased electricity consumption. The latter cost was a threat to stakeholder 2 as well last winter:

"the winter between 2022-2023 was out of the discussions. The market was not ready to pay actually money which we could spend on the electricity." (Stakeholder 2).

Both producers describe that electricity for the lamps is the main problem with year-round production both economically and environmentally. Although indoor cultivation in Sweden requires much energy, most energy comes from renewable sources. Most horticulture producers have their own powerplant which runs on woodchips and produces the required heat. Regulations have steered this shift to heating with renewable types of energy:

"because 95% should be, how to say, from biofuel. So we are not allowed to burn natural gas anymore, for example fuel, and we are not doing that. And I know that after 2028 it will be like zero." (Stakeholder 2).

Stakeholder 2 even describes that they are planning to become fully independent from the electricity network, which will allow them to provide a more stable year-round supply as well as expand production:

"it is very possible that we will install one more woodchips boiler with possibility to produce electricity with a turbine. And then we will actually be independent from the market, we will be able to produce own electricity to turn on the lights and it will come from the powerplant source." (Stakeholder 2).

In contrast to the high energy consumption in greenhouses, Swedish greenhouse cultivation generally requires very little fertilizer. Indoor cultivation allows to grow the plants in substrates instead of soil and have circulation of water and fertilizers, which are dissolved in the water, that are not taken up by the plant. The closed environment in greenhouse cultivation also allows to reduce pesticides use:

"But in the greenhouse which is a closed environment you can work very differently because you can control the climate and you can stop things in a different way." (Stakeholder 1).

"if we are talking Scandinavia I can definitely say that, that everybody prioritizes biological control." (Stakeholder 2).

Besides, stakeholder 3 describes that very little chemicals are used during production, either indoor or outdoor, in Sweden. However, stakeholder 3 also described that growers must keep up with the set quality which sometimes implies that pesticides are used to avoid insects in the food products. Additionally, losing the crop to a virus of insect is less sustainable and more expensive than using pesticides to save the yield according to him.

Lastly, stakeholder 1, 2 and 8 all describe that the quality and taste of Swedish produce is better. For both producers an optimization of the taste is their main goal of production, even though it may lead to a lower yield. Furthermore, both producers indicate that many consumers prefer Swedish produce for the taste and because they believe it is healthier:

"I think people think that the Swedish products are more healthier. And this is, I agree with them because I know myself." (Stakeholder 2).

Stakeholder 1 also indicated that she believes her produce is healthier than imported vegetables due to a higher nutrient content. However, they are currently collaborating with Lund University to find out if this is true.

5.2.2 Imported vegetables

The survey results have shown that from the four selected vegetables in this study, only tomatoes are imported from the Netherlands in certain seasons. The growing practices in the Netherlands and Sweden are mostly similar as the climate in both countries requires to grow tomatoes in greenhouses. The main difference is that almost all growers in the Netherlands have year-round production and thus make use of artificial lighting in winter. Besides, the energy sources are less often renewable and most growers are still dependent on natural gas for heating. Greenhouse cultivation in the Netherlands also allows to re-circulate water and fertilizers similar to Swedish practices which saves both water and fertilizer compared to outdoor cultivation.

When it comes to pesticides, stakeholder 4 described that it is difficult to determine the amount of pesticides used during production:

"Only if any fungi or diseases are found pesticides are used. Some other growers use biopesticides which are natural enemies of certain diseases or threatening insects. This is not seen as pesticide use in horticulture as the product will not be affected." (Stakeholder 4).

Spain is another important supplier of vegetables for Sweden and the surveys show that all four vegetables are imported from Spain in the winter season. Generally, the main difference between Spanish versus Dutch and Swedish growing practices is the warmer climate in Spain which allows to grow produce outdoor in the winter season. The Spanish producers aim at producing in the North-European winter season, which means that most of their crops are harvested between October and April. Cauliflower and Iceberg lettuce are grown in field, while tomatoes and cucumbers are grown in greenhouses. However, Spanish greenhouses are very different from Dutch and Swedish greenhouses:

"most of the greenhouses in Spain those are low-tech open greenhouses and they don't have climate control. In most cases it is a frame covered with plastic and the walls can be put up. It's just a covered piece of land where the climate cannot be controlled as in high-tech greenhouses. So they have no heating, no automatic windows that open when it gets too hot, no recirculation of water." (Stakeholder 5).

Although the low-tech cultivation uses little to no energy, the lack of climate control in these types of greenhouses result in lower yield, in lower quality vegetables and in increased use of pesticides, water and fertilizer per product. Stakeholder 5 described that while in high-tech greenhouses an average yield of 60 kilograms per square meter for rank tomatoes is achievable, the Spanish producers harvest 20 to maximum 25 kilograms of rank tomatoes per square meter. A meta-analysis has found similar results: open-field cultivation emits almost three times less GHG emissions but uses on average four times more land (Clark & Tilman, 2017). Furthermore, stakeholder 5 explained that the growing conditions cannot be changed in Spanish greenhouses which makes that the quality of the crop is most often less good than products that have grown

under ideal conditions. The lack of heating in Spanish greenhouses leads to a specific problem that occurs when the temperatures at night are low. In that case, the cold crop often condensates in the early morning, making the crop moist and susceptible to fungal diseases. To combat the fungi, pesticides are applied to the crops. The problem with fungi is that it cannot be combatted with biopesticides, and whenever a grower uses biopesticides against insects and sprays against fungi, the biopesticide population will die. Furthermore, the crops in Spain are almost exclusively grown in the soil, which does not allow to re-circulate water and fertilizers. Therefore, the Spanish production methods use more water and fertilizers which is problematic when considering the importance of sustainable resource use and may become more problematic in the future as Spain is threatened increasingly by water scarcity (Lavrnić et al., 2017).

Another environmental impact related to production in low-tech greenhouses is the plastic waste:

"If you calculate that in the province of Al Maria alone, not to mention Murcia and other areas, in Al Maria alone there are more than 40 thousand hectares of greenhouses, plastic greenhouses. In the whole of the Netherlands there are 10 thousand hectares of greenhouses, but those are glass greenhouses and that will last for the lifetime of the greenhouses. But in Spain you have to replace that plastic every three years because that plastic ages under the influence of UV." (Stakeholder 5).

5.2.3 Supply chain of vegetables

When it comes to the supply chain, multiple stakeholders are involved both in the domestic and international supply chain of vegetables. After the stakeholder analysis had been performed (figure 5) there were some unclarities about the structure of the supply chain. The interviews provided multiple insights.

Firstly, stakeholder 1, 2, 4, 5 and 8 described that growers sell their produce to wholesalers. Most growers determine themselves to which wholesalers they sell their produce. ICA supermarkets can in turn decide themselves as well from which wholesalers they purchase vegetables. Producers often make price agreements a year ahead with the wholesalers and all produce will be sold for this price, unless there is overproduction. In this case, the producers often find other purchasers that buy the products for a discounted price. In the case that the products are of poor quality, stakeholder 2 mentioned that:

"if we are talking about food waste here in our company honestly we try to sell everything that we produce. If we have some third class tomato or a tomato which is not okay for consumers then we send to biogas." (Stakeholder 2).

Some growers are part of a wholesaler organization, that supports the growers in decision making and offers packaging solutions. Examples of those types of wholesalers are stakeholder 3 and 4. Stakeholder 4 describes that the organization employs a wide variety of experts that strive to find the optimal production processes, transportation modes and packaging solutions.

To ensure that the products are fresh and have a long shelf life once they arrive at the destination, experts discuss the desired packaging properties with the growers and try to determine the most sustainable packaging solution.

As was already indicated in the theory section, there is a complex relationship between packaging, shelf life and food waste. Multiple stakeholders indicated that it is very difficult to establish the optimal balance and it takes a lot of trial and error. Stakeholder 1 explained that they tried to find a more sustainable packaging solution than plastic for their tomatoes and cucumbers: wood-based containers, but failed as it increased the environmental burden of transportation due to the increased size and weight of the products. Stakeholder 8 also described that they purchased bell peppers from Spain that were not wrapped in plastic. The quality was so poor that they had a lot of food waste. They had to decide to either purchase Spanish bell peppers with plastic wrap or import Dutch bell peppers of better quality that would have a similar shelf life as the wrapped plastic bell pepper. However, both stakeholder 1 and 8 describe that some products such as cucumber require plastic wrap as it greatly impacts their shelf life and therefore food waste potential. Stakeholder 3 on the other hand explained that they do not wrap their cucumbers in season as the turnover rate in the supermarkets is high enough to prevent food waste.

The environmental impact of plastic packaging is the main reason why alternatives are rising:

"thin plastic films are the most common packaging material in the world… it is very very difficult to recycle so it is being a single use material, it is something we should not accept anymore at all." (Stakeholder 6).

Stakeholder 6 works for a company that invented a wood-pulp based packaging solution that is, among other things, useful for vegetable packaging. However, during the interview it became clear that the solution does not have the properties to protect against moisture-loss. Three out of four vegetables under analysis in this study however need the properties of moisture-loss in order to extent their shelf-life. The packaging solution can thus only be used for a few types of vegetables such as onions, potatoes and carrots.

However, the company notices that there is a huge market potential as thin plastic wraps are the most used type of packaging while its properties are not actually required in many cases. Stakeholders in the private sector increasingly adopt the view that alternatives are required, and in some cases national legislation pushes for a quick transition too:

"in France for example there is a legislation that all the vegetables and fruit packaging needs to be something else than plastic." (Stakeholder 6).

Currently, products that need to be protected against moisture loss to extend shelf life are still wrapped or packaged in plastic, although a minimization of the plastic content is an important goal:

"We also always consider with which design as little as possible plastic is used. And the type of plastic packaging is based on what is most easily recycled in the importing country. Lastly,

we try to determine what is the ideal weight of a package of tomatoes based on the shelf life and turnover rate of supermarkets." (Stakeholder 4).

Stakeholder 7 indicates that in order to preserve imported vegetables well the products are harvested when they are not fully ripe yet to account for the transportation distance. Stakeholder 8 indicates that Dutch tomatoes are in store mostly 8 to 9 days after harvesting and most Spanish products are in store 9 to 11 days after harvest. Both stakeholder 8 and 2 indicate that this is the main reason why there is a difference in quality and taste between imported and Swedish products. However, stakeholder 4 indicates that the difference in quality between Spanish and other products is a result of the lack of a controlled production process in Spain in the low-tech greenhouses. The Swedish products are generally of better quality as they both have been grown in a controlled environment and can be picked at the exact right time. Stakeholder 7 indicates that most Swedish products arrive at their warehouse twelve hours after being picked. However, one risk of the high-quality Swedish products is their shelf life:

"the tomatoes that we get picked today from the producer in Malmö, they get picked at the exact right time so they are much better when we get them, but then they will be overripe sooner. So sometimes the shelf time on those are shorter than from Holland, but the quality is better and the taste as well." (Stakeholder 8).

However, apart from packaging, controlling the temperature of the environment is another strategy for shelf life extension:

"The handling of the products and the cold chain are the most important factors in keeping the products fresh and improve their shelf-life." (Stakeholder 7).

Stakeholder 1 indicated that she thinks the lack of knowledge on storage temperature is one of the most important drivers of vegetable food waste:

"sometimes the trucks don't even have the heat on and then if it's minus outside then the products just break down. A big part of the problem is the transportation and the wholesalers themselves who don't know how to store it but also the store staff in the vegetable department, they have super poor knowledge and no passion for what they do." (Stakeholder 1).

Stakeholder 8 mentioned that they do not have a special program to educate personnel that works temporarily at the vegetable department. Furthermore, he indicated that only tomatoes and bananas are supposed to be stored outside the fridge while stakeholder 1 explained that cucumbers break down when they are stored below 12 degrees Celsius. It could thus be true indeed that there is a lack of common knowledge on product specifications which leads to food waste that can easily be prevented.

To summarize, the most important stakeholders in both international and Swedish supply chains are the producers, wholesalers, which may serve as packaging stations and consultants simultaneously, and the supermarkets. Furthermore, the Swedish supply chain is very short which improves the quality of products but may decreases shelf life. The Dutch and Spanish supply chains are significantly longer which may pose a threat to food waste due to the risk of incorrect transportation temperatures, but mostly impacts the quality and taste of the products. Both

stakeholder 7 and 8 indicated that the price and quality of the products are the most important determinants for purchasing decisions. Secondly, they prioritize the purchase of Swedish products, and preferably as local as possible.

5.2.4 Pricing

As just mentioned, both wholesalers and supermarket managers consider the quality and price of the vegetables to be the most important. At the same time, they have a preference for Swedish and local produce. The survey results however indicated that in Swedish winter, all four selected vegetables are imported from Spain. As was mentioned before, Spanish products are often of low quality in comparison to both Dutch and Swedish products. The Spanish horticulture expert explained why Spain has such high export quantities:

"The main reason why the Spanish products are price competitive with Dutch and Swedish produce, or even cheaper, is because the investment costs the Spanish low-tech greenhouses are one-fourth of the costs of the high-tech greenhouses that include climate control. Another reason is that the Spanish producers do not use any artificial heat or light in their greenhouses and therefore use less energy during production. For Spanish producers, the transportation is one of the largest costs, especially as trucks often go back to Spain empty."

Stakeholder 1 and 2 also describe that in winter, the costs of production in Sweden are simply higher compared to Spain due to the high energy requirements and costs:

"customers were not ready to pay more for local production because they were able to import cheap products from the Netherlands, Spain or Morocco" (Stakeholder 2).

However, stakeholder 8 explained that in season, Swedish products are actually cheaper than imported products. Stakeholder 1 indicated that even though costs might be similar or lower for Swedish products, consumers will often pay more for a similar product from Sweden than from somewhere else:

"The supermarkets are very happy to put an extra margin on local produce because it's more in demand. Because they know that people always, or mostly, choose Swedish products." (Stakeholder 1).

This statement was checked in the interview with the manager of the vegetable department of an ICA location and indeed true. The interviewee admitted that they aim to have a set average margin over vegetables, but throughout the year the margin may vary greatly:

"If you look at the percentage margin, often that would be better on Swedish products because they are cheaper when its like now, in summer. The tomato prices are lower versus in the winter for tomatoes from Holland. And then we do not always look at the percentage. Because if you pay fifty kroner for tomatoes from Holland then we can't do the same percentage margin because then it will be too expensive when we look at the actual money we make per kilo. But often when we, when the price for Swedish products are lower, the percentage margin will be higher because it will be an okay price both for us and for the customers." (Stakeholder 8).

This year was very extreme in terms of prices. The one year-round producer of tomatoes in Sweden did not plan a winter cycle this year due to the high electricity costs. However, the imported tomatoes from Spain and the Netherlands were extremely expensive as well. Prices of imported and locally grown vegetables during the past winter can therefore not be compared. However, currently, and usually in summer, the total production costs for Swedish products are actually lower than for imported products. The higher margin on the Swedish products makes that the price difference seems smaller to consumers:

"there is a difference. A better margin on the Swedish, locally grown products." (Stakeholder 8).

5.2.5 Future perspective

The Swedish stakeholders were all asked about the future perspective of the vegetable market in Skåne in order to understand whether or not the competition with imported vegetables is viable in the long-run and to see if they think Swedish production could expand.

The most straight forward strategy to more self-reliance when it comes to vegetable production would be to simply eat more seasonal produce. Stakeholder 3 describes that there is a limit to expansion, not in terms of quantity but in terms of variety due to the natural climate:

"we must bear in mind that there are natural seasons for products but also that consumers have, through the word-trade, have get used to buy almost all around the year. It has to be more of natural seasons to manage to be self-reliant. Will consumer accept that, I think many will but maybe not all."

However, expansion in terms of year-round production is possible with greenhouse cultivation. Stakeholder 1 suggests that the main barrier to expansion of production is the limit to the price consumers are willing to pay. She suggests however that fair pricing of Swedish vegetables compared to imported would stimulate them to invest in lights to start year-round production. Furthermore, the current energy market is a problem for production in Sweden:

"I think if the energy market would become a little bit more stable again, we could also continue to grow a bit more in the winter like they do in Finland. I mean technology is also improving with LED lights and so on, so if we could get the energy prices down again, we could also grow more cheaply in greenhouses in Sweden in winter. Because yes we have plenty of wood, the problem is actually the light not the heat." (Stakeholder 1).

However, stakeholder 8 was asked whether the consumers would notice a price decrease if Swedish production of vegetables would expand. The answer was:

"no, I don't think so. We have a lot of Swedish products in the summer, so it depends more on the weather. So right now with the heat that has been the cucumber production has exploded. So three weeks ago we paid 11 per cucumber, today its 3.95. So then we can match the price of course but maybe then we go, we have a little lower margin when it was expensive and now we have a little higher margin." (Stakeholder 8).

This finding would imply that the natural market mechanism will not stimulate an expansion of vegetable production in Sweden, while consumers prefer Swedish produce.

6 Discussion

6.1 Sustainability assessment

The empirical results can be summarized in the theoretical framework. Firstly, the variability of the vegetable offer in the supermarkets in Skåne, which was gathered with the surveys, is used to determine the seasonality of the products with different a origin. Figure 7 shows that certain supermarkets have access to Swedish cucumber all year round. Other than that, most products are available as a Swedish version from mid-spring to mid-autumn. In winter most products come from Spain. However, tomatoes originate from the Netherlands in spring and autumn.

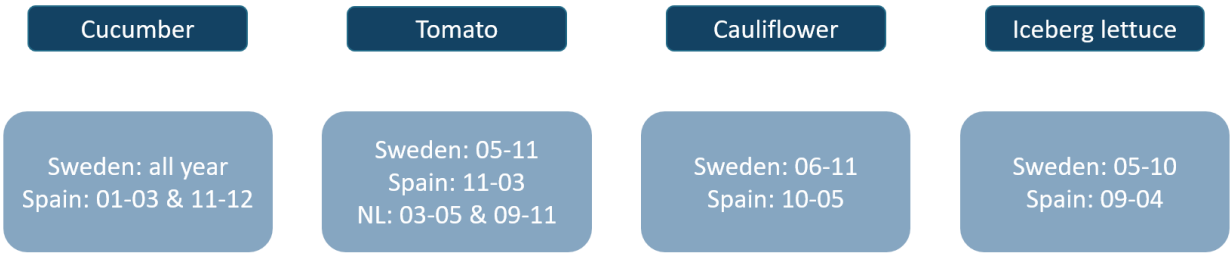

Figure 7: Seasonality of vegetables in Swedish supermarkets

Apart from the seasonality, the origin of the product to a large extent determines the total impact on the environmental, social and economic dimension. The findings per indicator and criterium, related to the production of vegetables in Sweden, Spain and the Netherlands are visualized in figure 8 based on the criteria that were presented in both figure 2 and 4.

Furthermore, the surveys and interviews gathered data to determine how the criteria and its indicators differ per origin. The data on the selected criteria eventually determines how the production methods of each of the three origins score in terms of sustainability compared to each other. The findings per origin and per criterium are visualized in figure 8.

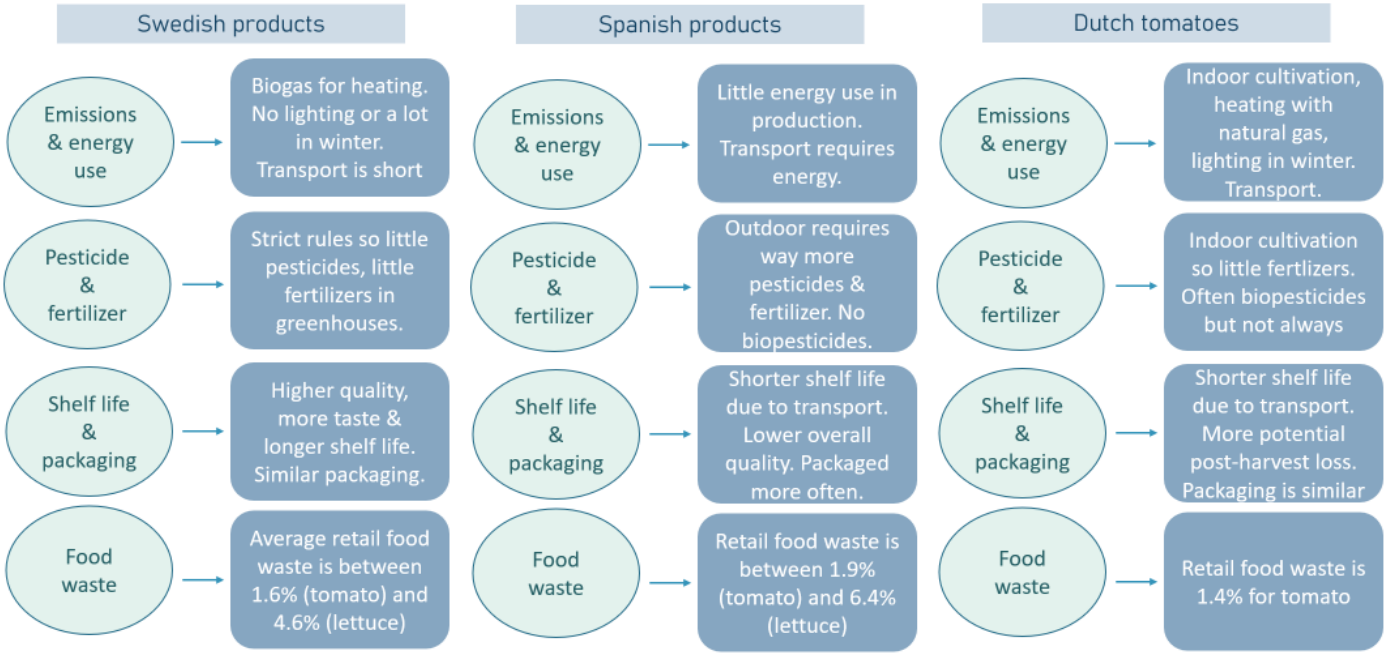

Figure 8: Criteria and indicators visualized per origin

Firstly, the energy use during production, energy use for transportation and the source of energy are compared. The transportation differences are clear, especially when considering that Spanish trucks often go back to Spain empty. The energy use during production is similar in the case of outdoor production but more difficult to establish for indoor cultivation. The energy use in Spain is very little to non-existent while in the Netherlands and Sweden there is great variability throughout the year. However, in Sweden renewable energy is used for heating the greenhouses, which makes the energy use in production more sustainable compared to the Netherlands.

When it comes to pesticides and fertilizer use, there are large differences. The semi-outdoor cultivation in Spain leads to high fertilizer and pesticide use. Tomato cultivation in The Netherlands uses little of both due to the controlled climate in the greenhouses. This is similar for tomato and cucumber production in Sweden. When it comes to outdoor production, Sweden scores better compared to Spain due to the strict Swedish regulations on chemical use in agriculture.

Not much data was collected regarding packaging. The clearest finding of the analysis is that plastic use is tried to be minimized but used when it can significantly improve shelf life. The data suggests that Spanish vegetables are most often wrapped in plastic to prolong shelf life. Furthermore, when it comes to shelf life and quality of the products in general there are clear differences. The Spanish products are generally of lower quality due to cultivation practices as well as the long transportation distance. Dutch products are clearly of higher quality than Spanish products, but Swedish products have the best quality and taste. However, sometimes the taste poses a trade-off with shelf-life as the Swedish products may be over-ripe faster. In most cases however, the shelf life of local products is highest.

The quality of the vegetables and shelf life are closely related to food waste. Firstly, food loss, which is the loss of food before it enters retail or restaurants, is the highest in Spain due to the

lack of climate control in (semi-) outdoor production. Both Dutch and Swedish horticulture producers noted that they find another purpose for products that do not meet retail quality. When it comes to food waste, the surveys indicated that Spanish products are wasted mostly, followed by Swedish products and lastly Dutch tomatoes. However, due to the small sample size this may differ in reality.

Although the economic dimension is not represented by one criterium, the other criteria are essentially all embedded in the economic dimension as was explained previously. The indicators used for the economic dimension are production costs and consumer prices and the impact on the local economy in Skåne. The production costs differ per origin and throughout the year. In Sweden the production costs are slightly higher than in other countries but in summer the products are price competitive with imported products. However, the higher margin on Swedish products hides that Swedish products are often actually cheaper than imported products. The production costs in Spain are lower than in the Netherlands and Sweden. It seems to be the case that the production costs are higher in the Netherlands than in Sweden for tomatoes. Furthermore, Swedish production is beneficial for the local economy while imports, especially low-quality and low-price imports from Spain are a threat to local economic expansion of production in Skåne.

To make an assessment regarding sustainability, all three dimension of the triple bottom line were included in the list of criteria and indicators. Even though the environmental dimension was represented with more criteria, the social and economic dimension will be given an equal weight in the final assessment which is visualized in figure 9. Table 2 gives an overview of the scores per criteria/indicators. Energy, transport, food waste and fertilizer together determine the final score for the environmental dimension while pesticide and shelf life/taste determine the score for the social dimension and costs and local economy are used to determine the scores for the economic dimension.

Impact	**Origin**		
	Sweden	Spain	The Netherlands
Energy	0	+	-
Transport	+	-	0
Food waste	+	-	0
Fertilizer	+	-	0
Planet	+	-	0
Pestidices	+	-	0
Shelf-life/taste	+	-	0
People	+	-	0

Costs	0	+	-
Local economy	+	-	0
Profit	+	0	-

Table 2: overview of the weighting decisions

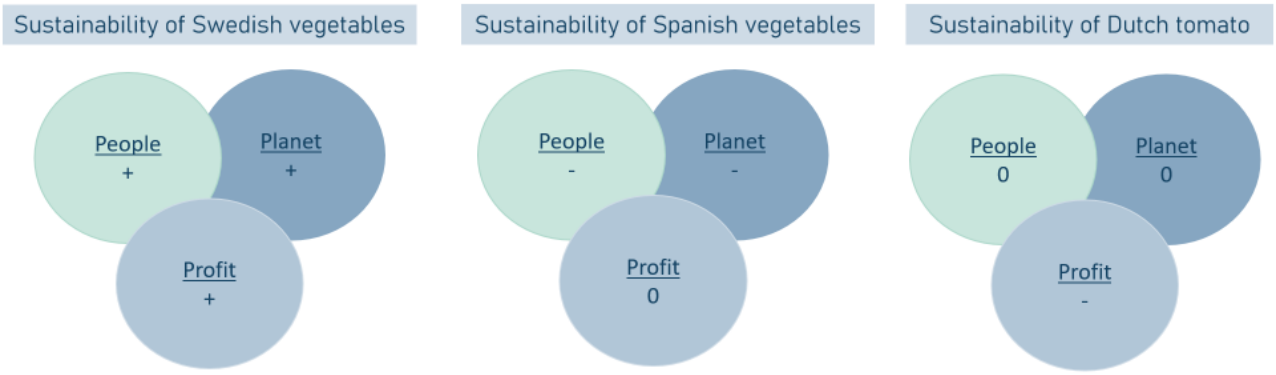

Figure 9: Sustainability assessment of vegetables from Swedish, Spanish and Dutch origin

The analysis shows that Swedish products score best on all dimension of the triple bottom line. When it comes to the social dimension, Swedish products are favored by consumers in Skåne due to their superior taste and quality. It is undiscovered if there is a difference in nutritional values between Swedish and other produce but Swedish vegetables are indirectly healthier than Spanish vegetables due to the smaller amounts of pesticides used in production (Bourguet & Guillemaud, 2016). Furthermore, by considering the average of the four criteria that determine the environmental impact of the vegetables, the Swedish products also score best on the environmental dimension. The data collection gave additional insights that were beyond the criteria adopted in this thesis, such as the problematic implications on the long term of water usage in Spain (Lavrnić et al., 2017) and the fact that the Spanish greenhouses indirectly pose environmental threats due to extensive plastic use and waste. However, even without considering these impacts in the sustainability assessment, Spanish products still score lowest on the environmental dimension. When considering the economic dimension, a serious issue for the Swedish vegetable market is the price premium that exists for Swedish produce, especially when demand is higher than supply such as in the beginning and the end of season. However, becoming increasingly less dependent on import for vegetable consumption would boost the local economy for multiple reasons, including expansion of local production and increased consumer satisfaction (Cvijanović et al., 2020).

6.2 Suggestions

One of the results of this study is that the Swedish stakeholders all indicated that more local production and consumption would be achievable under certain conditions. Firstly, more seasonal consumption and a wider adoption of conservation techniques would decrease demand for imported produce. Furthermore, fair pricing mechanisms would allow to compete with imported produce and expand local production as the extra margin on local products lowers demand and therefore supply. Lastly, a more stable electricity market would make more producers consider all year round production.

In terms of short term solutions for a more sustainable vegetable market in Skåne, it was suggested that all different types of stakeholders in the supply chain and even consumers should be educated to reduce food loss. Multiple scholars have investigated if education can help reduce household food waste and while (Al-Obadi et al., 2022) found that creating awareness reduces food waste, (Nikravech et al., 2022) noted that the perceived feasibility of food waste reduction decreased over time. However, as was discusses before, scholars agree that food loss reduction is the most impactful and achievable strategy towards more sustainable production and consumption (Navarre et al., 2023). Therefore, an emphasis in further research on education of all types of stakeholders in the supply chain may gain insights in the viability and usefulness of this suggestion.

Specifically, education should focus on the most important determinant for vegetable shelf life: storage temperature. Poor temperature management is the main reason of post-harvest losses, which can reach up to 25% to 50% depending on the crop and region (Do Nascimento Nunes & Emond, 2002). The optimal storage temperature greatly varies per type of vegetable but is important to consider as it prolongs shelf life and preserves nutrients as well as taste. However, the largest food waste potential occurs whenever vegetables are stored below their optimal temperature and/or experience temperature fluctuations (Do Nascimento Nunes & Emond, 2002). Therefore, educating all actors in the supply-chain on optimal storage temperatures would potentially reduce vegetable food waste and help achieve a more sustainable vegetable market in Southern Sweden as well as beyond this region.

7 Conclusions

Through a mixed-methods approach, a comparative sustainability assessment was performed in this thesis by making use of the multi-criteria assessment tool. The thesis has investigated how assessment based on the triple bottom line model may help to determine a strategy for a sustainable vegetable market in Skåne, Sweden. The question that has been investigated is:

In what ways can assessment based on the triple bottom line model when comparing the consumption of locally grown versus imported vegetables contribute to a sustainable vegetable market is Skåne, Sweden?

The results show that assessment based on the triple bottom line model helps to determine the true sustainability potential of production and consumption strategies. To achieve sustainable production and consumption, and eventually food security, access to healthy and affordable diets for everyone is a requirement (FAO et al., 2022). Assessment based on the triple bottom line model is essential for complete sustainability assessments as the economic, social and environmental dimensions are crucial for sustainable development.

For the vegetable market in Skåne, assessment based on the TBL model has demonstrated that the consumption of locally or domestically produced vegetables is more sustainable than the consumption of imported vegetables from the Netherlands or Spain. The data gathered insights in possible pathways or strategies for a more sustainable vegetable market in Skåne. Firstly, stakeholders suggested that a short-term solution would be to educate actors in the supply chain and especially supermarket personnel to store vegetables more carefully to extend shelf-life and decrease retail food waste. A suggested solution on the long term is a removal of the price premium on locally produced vegetables. This would in the short term most likely lead to shortages due to increased demand but will stimulate Swedish producers to expand their production to year-round in greenhouses as well as it will stimulate innovation in domestic growing techniques or conservation methods. Furthermore, another strategy that supermarkets could adopt is to create consumer awareness about the seasonality of vegetables and stimulate consumers to consume more seasonal produce by pricing mechanisms. Multiple actors already try to stimulate Swedish consumers to eat more local produce (Livsmedelsverket, 2023; SydGrönt, n.d.) but an actual reduction in the offer of exotic vegetables or increase in price could be an additional incentive to consume more sustainably.

This exploratory study paves the way for further research into the generalizability of these findings to other cases or a wider scope. A concrete suggestion for further research is to investigate the difference in supermarket food waste between imported and locally produced vegetables as the results in this thesis indicated a difference, although it is not significant and representative. Besides, it would be interesting to discover the viability of increased local production of all vegetables instead of the small selection used in this thesis. Furthermore, it would be interesting to investigate the implications of the suggestions made for food security. As was explained in

the introduction, sustainable practices are a pre-requisite for food security but not all sustainable practices necessarily improve food security (FAO et al., 2022). Two other suggestions for further research are to investigate consumer acceptance of different types of packaging solutions as well as consumer acceptance of a smaller offer of exotic vegetables when the produce is not in season.

All in all, this study has contributed by exploring the feasibility of assessing sustainability based on the TBL model and has shown that considering all dimensions of sustainability is of large importance. Furthermore, the study has exposed a market potential as Swedish producers indicated that demand is too low to invest in expansion to year-round production while consumers actually prefer Swedish produce. Supermarkets can play a key-role in a transition towards more sustainable production and consumption by increasing the offer of local vegetables for a fair price.

8 References

Abay, K. A., Breisinger, C., Glauber, J., Kurdi, S., Laborde, D., & Siddig, K. (2023). The Russia-Ukraine war: Implications for global and regional food security and potential policy responses. *Global Food Security*, *36*, 100675. https://doi.org/10.1016/j.gfs.2023.100675

Ahi, P., & Searcy, C. (2015). Assessing sustainability in the supply chain: A triple bottom line approach. *Applied Mathematical Modelling*, *39*(10–11), 2882–2896. https://doi.org/10.1016/j.apm.2014.10.055

Al-Obadi, M., Ayad, H., Pokharel, S., & Ayari, M. A. (2022). Perspectives on food waste management: Prevention and social innovations. *Sustainable Production and Consumption*, *31*, 190–208. https://doi.org/10.1016/j.spc.2022.02.012

Amani, P., & Gadde, L. (2015). Shelf life extension and food waste reduction. *AgEcon Search*, 7–14. https://doi.org/10.18461/pfsd.2015.1502

Amponsah, N. Y., Troldborg, M., Kington, B., Aalders, I., & Hough, R. (2014). Greenhouse gas emissions from renewable energy sources: A review of lifecycle considerations. *Renewable & Sustainable Energy Reviews*, *39*, 461–475. https://doi.org/10.1016/j.rser.2014.07.087

Antonissen, T. (2020). The Swedish Market for Fresh Fruit and Vegetables. In *Kommerskollegium - National Board of Trade Sweden*. https://www.kommerskollegium.se/en/publications/market-studies/the-swedish-market-for-fresh-fruit-and-vegetables/

Avetisyan, M., Hertel, T. W., & Sampson, G. (2014). Is Local Food More Environmentally Friendly? The GHG Emissions Impacts of Consuming Imported versus Domestically Produced Food. *Environmental and Resource Economics*, *58*(3), 415–462. https://doi.org/10.1007/s10640-013-9706-3

Axfood. (2023). *Annual and Sustainability Report 2022: Better quality of life for everyone with affordable, good and sustainable food*. https://mb.cision.com/Main/1306/3722821/1873214.pdf

Bartzas, G., & Komnitsas, K. (2020). An integrated multi-criteria analysis for assessing sustainability of agricultural production at regional level. *Information Processing in Agriculture*, *7*(2), 223–232. https://doi.org/10.1016/j.inpa.2019.09.005

Behnassi, M., & Haiba, M. E. (2022). Implications of the Russia–Ukraine war for global food security. *Nature Human Behaviour*, *6*(6), 754–755. https://doi.org/10.1038/s41562-022-01391-x

Beitzen-Heineke, E. F., Balta-Ozkan, N., & Reefke, H. (2017). The prospects of zero-packaging grocery stores to improve the social and environmental impacts of the food supply chain. *Journal of Cleaner Production*, *140*, 1528–1541. https://doi.org/10.1016/j.jclepro.2016.09.227

Berkeley, E. (2023, March 15). *Därför är gurkan inplastad – bättre för miljön*. Från Sverige. https://fransverige.se/aktuellt/darfor-ar-gurkan-inplastad-battre-for-miljon/

Beshai, H., Sarabha, G. K., Rathi, P., Alam, A., & Deen, M. (2020). Freshness Monitoring of Packaged Vegetables. *Applied Sciences*, *10*(21), 7937. https://doi.org/10.3390/app10217937

Bourguet, D., & Guillemaud, T. (2016). The Hidden and External Costs of Pesticide Use. In *Sustainable agriculture reviews* (pp. 35–120). Springer International Publishing. https://doi.org/10.1007/978-3-319-26777-7_2

Breiting, S., & Wickenberg, P. (2010). The progressive development of environmental education in Sweden and Denmark. *Environmental Education Research*, *16*(1), 9–37. https://doi.org/10.1080/13504620903533221

Bringezu, S., & Bleischwitz, R. (Eds.). (2017). *Sustainable resource management: global trends, visions and policies*. Routledge.

Brown, L. R. (1981). World Population Growth, Soil Erosion, and Food Security. *Science*, *214*(4524), 995–1002. https://doi.org/10.1126/science.7302578

Brundtland, G. (1987). What is sustainable development. In *Our Common Future*.

Brunswik, E. (1955). Representative design and probabilistic theory in a functional psychology. *Psychological Review*, *62*(3), 193–217. https://doi.org/10.1037/h0047470

BSI - British Standards. (2006). Environmental management — Life cycle assessment — Principles and framework. In *BS EN ISO 14040:2006*. http://www.cscses.com/uploads/2016328/20160328110518251825.pdf

Cambridge dictionary. (2023). *Shelf life*. Retrieved March 29, 2023, from https://dictionary.cambridge.org/dictionary/english/shelf-life

Campbell, B. C., Beare, D. J., Bennett, E. M., Hall-Spencer, J. M., Ingram, J., Jaramillo, F., Ortiz, R., Ramankutty, N., Sayer, J., & Shindell, D. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecology and Society*, *22*(4). https://doi.org/10.5751/es-09595-220408

Canali, M., Amani, P., Aramyan, L., Gheoldus, M., Moates, G. K., Östergren, K., Silvennoinen, K., Waldron, K. W., & Vittuari, M. (2016). Food Waste Drivers in Europe, from Identification to Possible Interventions. *Sustainability*, *9*(1), 37. https://doi.org/10.3390/su9010037

Carlsson-Kanyama, A., & Lindén, A. (2001). Trends in food production and consumption: Swedish experiences from environmental and cultural impacts. *International Journal of Sustainable Development*, *4*(4), 392. https://doi.org/10.1504/ijsd.2001.001558

Cederberg, C., Persson, U., Schmidt, S. J., Hedenus, F., & Wood, R. D. (2019). Beyond the borders – burdens of Swedish food consumption due to agrochemicals, greenhouse gases and land-use change. *Journal of Cleaner Production, 214*, 644–652. https://doi.org/10.1016/j.jclepro.2018.12.313

Chambers, S., Lobb, A. E., Butler, L. T., Harvey, K., & Traill, W. B. (2007). Local, national and imported foods: A qualitative study. *Appetite*, *49*(1), 208–213. https://doi.org/10.1016/j.appet.2007.02.003

Chapa, J., T, M. B. S., Kipp, S., Cai, H., & Huang, J. (2019). A comparative life cycle assessment of fresh imported and frozen domestic organic blueberries consumed in Indiana. *Journal of Cleaner Production*, *217*, 716–723. https://doi.org/10.1016/j.jclepro.2019.01.237

Chien, S., Prochnow, L. I., & Cantarella, H. (2009). Chapter 8 Recent Developments of Fertilizer Production and Use to Improve Nutrient Efficiency and Minimize Environmental Impacts. In *Advances in Agronomy* (pp. 267–322). Elsevier BV. https://doi.org/10.1016/s0065-2113(09)01008-6

Clark, M. R., & Tilman, D. (2017). Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice. *Environmental Research Letters*, *12*(6), 064016. https://doi.org/10.1088/1748-9326/aa6cd5

Conte, A., Cappelletti, G. M., Nicoletti, G., Russo, C., & Del Nobile, M. (2015). Environmental implications of food loss probability in packaging design. *Food Research International*, *78*, 11–17. https://doi.org/10.1016/j.foodres.2015.11.015

Corbo, M. R., Del Nobile, M. A., & Sinigaglia, M. (2006). A novel approach for calculating shelf life of minimally processed vegetables. *International Journal of Food Microbiology*, *106*(1), 69–73. https://doi.org/10.1016/j.ijfoodmicro.2005.05.012

Cordova-Buiza, F., Paucar-Caceres, A., Quispe-Prieto, S., Rivera-Garré, A. P., Huerta-Tantalean, L. N., Valle-Paucar, J. E., De León-Panduro, C. V. P., & Burrowes-Cromwell, T. (2022). Strengthening Collaborative Food Waste Prevention in Peru: Towards Responsible Consumption and Production. *Sustainability*, *14*(3), 1050. https://doi.org/10.3390/su14031050

Correia, M. S. (2019). Sustainability: An overview of the triple bottom line and sustainability implementation. *International Journal of Strategic Engineering (IJoSE)*, *2*(1), 29-38.

Cvijanović, D., Ignjatijević, S., Tankosić, J. V., & Cvijanović, V. (2020). Do Local Food Products Contribute to Sustainable Economic Development? *Sustainability*, *12*(7), 2847. https://doi.org/10.3390/su12072847

Dean, M. (2020). Multi-criteria analysis. In *Advances in Transport Policy and Planning* (Vol. 6, pp. 165-224). Academic Press.

Detzel, A., Krüger, M., Busch, M., Blanco-Gutiérrez, I., Varela, C., Manners, R., Bez, J., & Zannini, E. (2021). Life cycle assessment of animal-based foods and plant-based protein-rich

alternatives: an environmental perspective. *Journal of the Science of Food and Agriculture*, *102*(12), 5098–5110. https://doi.org/10.1002/jsfa.11417

Do Nascimento Nunes, M. C., & Emond, J. P. (2002). Storage Temperature. In *Postharvest physiology and pathology of vegetables* (2nd ed., pp. 209–228). CRC Press.

Donati, M., Menozzi, D., Zighetti, C., Rosi, A., Zinetti, A., & Scazzina, F. (2016). Towards a sustainable diet combining economic, environmental and nutritional objectives. *Appetite*, *106*, 48–57. https://doi.org/10.1016/j.appet.2016.02.151

Ekelund, L., Fernqvist, F., & Tjärnemo, H. (2007). Consumer preferences for domestic and organically labelled vegetables in Sweden. *Acta Agriculturæ Scandinavica*. https://doi.org/10.1080/16507540701800665

Elkington, J. (2004). Enter the Triple Bottom Line. In *The Triple Bottom Line: Does it all add up?* (pp. 1–16). Earthscan.

FAO. (2015). *Food-based dietary guidelines - Sweden*. https://www.fao.org/nutrition/education/food-based-dietary-guidelines/regions/countries/sweden/en/

FAO. (2023). *Sustainable Food and Agriculture*. https://www.fao.org/sustainability/en/

FAO Food Price Index | World Food Situation | Food and Agriculture Organization of the United Nations. (2023). https://www.fao.org/worldfoodsituation/foodpricesindex/en/

FAO, IFAD, Unicef, WFP, & WHO. (2021). *The state of Food Security and Nutrition in the World*. FAO, Rome. https://www.fao.org/3/cb4474en/online/cb4474en.html

FAO, IFAD, Unicef, WFP, & WHO. (2022). *The state of Food Security and Nutrition in the World*. FAO, Rome. https://www.fao.org/3/cc0639en/cc0639en.pdf

Forbes, H., Quested, T., & OConnor, C. (2021). Food Waste Index United Nations Environment Programme.

Fraval, S., van Middelaar, C. E., Ridoutt, B. G., & Opio, C. (2019). Life cycle assessment of food products. In *Encyclopedia of Food Security and Sustainability* (pp. 488-496). Elsevier.

Gasparatos, A., & Scolobig, A. (2012). Choosing the most appropriate sustainability assessment tool. *Ecological Economics*, *80*, 1–7. https://doi.org/10.1016/j.ecolecon.2012.05.005

Government offices of Sweden. (2023, April 17). *Government presents 2023 Spring Fiscal Policy Bill* [Press release]. https://www.government.se/government-policy/economic-policy/#:~:text=Sweden%E2%80%99s%20economy%20is%20in%20recession%2C%20with%20the%20highest,agreement%20between%20the%20Government%20and%20the%20Sweden%20Democrats.

Grafton, R. Q., Daugbjerg, C., & Qureshi, M. E. (2015). Towards food security by 2050. *Food Security*, *7*(2), 179–183. https://doi.org/10.1007/s12571-015-0445-x

Hackshaw, A. (2008). Small studies: strengths and limitations. *The European Respiratory Journal*, *32*(5), 1141–1143. https://doi.org/10.1183/09031936.00136408

Hamed, I., Jakobsen, A. N., & Lerfall, J. (2022). Sustainable edible packaging systems based on active compounds from food processing byproducts: A review. *Comprehensive Reviews in Food Science and Food Safety*, *21*(1), 198–226. https://doi.org/10.1111/1541-4337.12870

Harvest House. (n.d.). *Innovation | Harvest House*. https://www.harvesthouse.nl/en/harvest-house/innovation

Hebrok, M., & Boks, C. B. (2017). Household food waste: Drivers and potential intervention points for design – An extensive review. *Journal of Cleaner Production*, *151*, 380–392. https://doi.org/10.1016/j.jclepro.2017.03.069

Henley, J. (2022, December 5). 'Sweden has a poverty problem': the social stores offering food at rock-bottom prices. *The Guardian*. https://www.theguardian.com/world/2022/dec/05/sweden-has-a-poverty-problem-the-social-stores-offering-food-at-rock-bottom-prices

Hitchcock, J. H., & Davis, A. C. (2022). Mixed methods in survey research. In *International Encyclopedia of Education* (4th ed., pp. 666–677). Elsevier. https://doi.org/10.1016/B978-0-12-818630-5.11067-X

Hobbs, J. E. (2020). Food supply chains during the COVID-19 pandemic. *Canadian Journal of Agricultural Economics-revue Canadienne D Agroeconomie*, *68*(2), 171–176. https://doi.org/10.1111/cjag.12237

Högberg, J. (2010). *European Tomatoes - Comparing global warming potential, energy use and water consumption from growing tomatoes in Sweden, the Netherlands and the Canary Islands using life cycle assessment* [MA thesis]. Chalmers.

Hortidaily. (2022a, February 15). The Netherlands: Natural gas - why are the costs increasing so much? *Hortidaily*. https://www.hortidaily.com/article/9397550/the-netherlands-natural-gas-why-are-the-costs-increasing-so-much/

Hortidaily. (2022b, September 1). One of Sweden's largest tomato growers to stop cultivation during winter. *Hortidaily*. https://www.hortidaily.com/article/9455310/one-of-sweden-s-largest-tomato-growers-to-stop-cultivation-during-winter/

Hospido, A., Canals, L. M. I., McLaren, S., Truninger, M., Edwards-Jones, G., & Clift, R. (2009). The role of seasonality in lettuce consumption: a case study of environmental and social aspects. *International Journal of Life Cycle Assessment*, *14*(5), 381–391. https://doi.org/10.1007/s11367-009-0091-7

Hunt, T. (2017, December 2). Fruit and veg come in their own natural wrapping. Why do we smother them in plastic? *The Guardian*. https://www.theguardian.com/sustainable-business/2017/jun/28/fruit-vegetables-plastic-packaging-food-relationship-pollution

Ibrahim, I. D., Hamam, Y., Sadiku, E. R., Ndambuki, J. M., Kupolati, W. K., Jamiru, T., Eze, A. A., & Snyman, J. (2022). Need for Sustainable Packaging: An Overview. *Polymers*, *14*(20), 4430. https://doi.org/10.3390/polym14204430

Jain, N. (2021). Survey Versus Interviews: Comparing Data Collection Tools for Exploratory Research. *The Qualitative Report*. https://doi.org/10.46743/2160-3715/2021.4492

Juric, B., & Worsley, A. (1998). Consumers' attitudes towards imported food products. *Food Quality and Preference*, *9*(6), 431–441. https://doi.org/10.1016/s0950-3293(98)00027-5

Kader, A. A. (1996). MATURITY, RIPENING, AND QUALITY RELATIONSHIPS OF FRUIT-VEGETABLES. *Acta Horticulturae*, *434*, 249–256. https://doi.org/10.17660/acta-hortic.1996.434.30

Kaiser, K. (2012). Protecting confidentiality. *The SAGE handbook of interview research: The complexity of the craft*, *2*, 457-464.

Kanter, D. R., Musumba, M., Wood, S. L. R., Palm, C. A., Antle, J. M., Balvanera, P., Dale, V. H., Havlik, P., Kline, K. L., Scholes, R. J., Thornton, P. K., Tittonell, P., & Andelman, S. J. (2016). Evaluating agricultural trade-offs in the age of sustainable development. *Agricultural Systems*, *163*, 73–88. https://doi.org/10.1016/j.agsy.2016.09.010

Kopteva, L., Shabalina, L., & Prorokov, A. (2018). Modern trends in the world food security. *MATEC Web of Conferences*. https://doi.org/10.1051/matecconf/201817001054

Kristersson, U. (2022). *Statement of Government Policy*. the Rikstag, Sweden. https://www.government.se/speeches/2022/10/statement-of-government-policy/

Kumar, A., & Morya, S. (2019). Packaging of fruits and vegetables. In *Advances in Horticultural Crop Management and Value Addition* (pp. 363–374). Laxmi Publications. https://www.researchgate.net/publication/343212306_Packaging_of_Fruits_and_Vegetables

Lavrnić, S., Zapater-Pereyra, M., & Mancini, M. (2017). Water Scarcity and Wastewater Reuse Standards in Southern Europe: Focus on Agriculture. *Water Air and Soil Pollution*, *228*(7). https://doi.org/10.1007/s11270-017-3425-2

Lindfors, A. (2021). Assessing sustainability with multi-criteria methods: A methodologically focused literature review. *Environmental and Sustainability Indicators*, *12*, 100149. https://doi.org/10.1016/j.indic.2021.100149

Linell, A., Richardson, M., & Wamala, S. P. (2013). The Swedish National Public Health Policy Report 2010. *Scandinavian Journal of Public Health*, *41*(10_suppl), 3–56. https://doi.org/10.1177/1403494812466989

Livsmedelsverket. (2023). *Eating habits and dietary guidelines*. https://www.livsmedelsverket.se/en/food-habits-health-and-environment/dietary-guidelines

Mahmood, I., Imadi, S. R., Shazadi, K., Gul, A., & Hakeem, K. R. (2016). Effects of Pesticides on Environment. *Springer eBooks*, 253–269. https://doi.org/10.1007/978-3-319-27455-3_13

Mangaraj, S., Goswami, T. K., & Mahajan, P. V. (2009). Applications of Plastic Films for Modified Atmosphere Packaging of Fruits and Vegetables: A Review. *Food Engineering Reviews*, *1*(2), 133–158. https://doi.org/10.1007/s12393-009-9007-3

McWilliams, A., Parhankangas, A., Coupet, J., Welch, E. W., & Barnum, D. T. (2016). Strategic Decision Making for the Triple Bottom Line. *Business Strategy and the Environment*, *25*(3), 193–204. https://doi.org/10.1002/bse.1867

Medicine, N. a. O. S. E. A., Affairs, P. a. G., Policy, C. O. S. E. M. a. P., Information, B. O. R. D. A., Sciences, D. O. E. a. P., Statistics, C. O. a. a. T., Analytics, B. O. M. S. A., Studies, D. O. E. a. L., Board, N. a. R. S., Education, D. O. B. a. S. S. A., Statistics, C. O. N., Sciences, B. O. B. C. a. S., & Science, C. O. R. a. R. I. (2019). *Reproducibility and Replicability in Science*. National Academies Press.

Michaliszyn-Gabryś, B., Krupanek, J., Kalisz, M., & Smith, J. (2022). Challenges for Sustainability in Packaging of Fresh Vegetables in Organic Farming. *Sustainability*, *14*(9), 5346. https://doi.org/10.3390/su14095346

Ministry of Finance. (2022). *Budget Bill for 2023* [Press release]. https://government.se/press-releases/2022/11/budget-bill-for-2023--reforms-to-strengthen-sweden-in-challenging-times/

Mojtahed, R., Nunes, M. B., Martins, J., & Peng, A. (2014). Equipping the Constructivist Researcher: The Combined use of Semi-Structured Interviews and Decision-Making maps. *The Electronic Journal of Business Research Methods*, *12*(2), 87. https://academic-publishing.org/index.php/ejbrm/article/view/1318

Mosier, A. R., Syers, K. J., & Freney, J. R. (2005). Agriculture and the nitrogen cycle: assessing the impacts of fertilizer use on food production and the environment. *Choice Reviews Online*, *42*(10), 42–5837. https://doi.org/10.5860/choice.42-5837

Napolitano, A., & De La Hamaide, S. (2022, September 22). Europe's vegetable farmers warn of shortages as energy crisis bites. *Reuters*. https://www.reuters.com/world/europe/europes-vegetable-farmers-warn-shortages-energy-crisis-bites-2022-09-22/

Narancic, T., Cerrone, F., Beagan, N., & O'Connor, K. (2020). Recent Advances in Bioplastics: Application and Biodegradation. *Polymers*, *12*(4), 920. https://doi.org/10.3390/polym12040920

Navarre, N., Schrama, M., De Vos, C., & Mogollón, J. M. (2023). Interventions for sourcing EAT-Lancet diets within national agricultural areas: A global analysis. *One Earth*, *6*(1), 31–40. https://doi.org/10.1016/j.oneear.2022.12.002

Nikravech, N., Langer, N., Bendisch, F., Ziesemer, F., Abels, S., Schrader, U., & Fischer, D. (2022). The Food Waste Lab: Improving food waste reduction behavior through education. *Journal of Cleaner Production*, *370*, 133447. https://doi.org/10.1016/j.jclepro.2022.133447

Panke, D. (2018). *Research Design & Method Selection: Making Good Choices in the Social Sciences* (1st ed.). SAGE Publications Ltd.

Persson, J. (2018). Trädgårdsproduktion 2017. In *Statistikmyndigheten* (No. 1654-4145 (Online)).

Powers, M. C. F., & Peeters, J. (2019). Sharing to Flourish: A Degrowth Approach to Provisioning for Prosperity. In *A workbook for social work practitioners* (pp. 172–193). KU Leuven.

Rani, L., Thapa, K., Kanojia, N., Sharma, N., Singh, S., Grewal, A. S., Srivastav, A. L., & Kaushal, J. (2021). An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of Cleaner Production*, *283*, 124657. https://doi.org/10.1016/j.jclepro.2020.124657

Raphael, D., & Bryant, T. (2006). The state's role in promoting population health: Public health concerns in Canada, USA, UK, and Sweden. *Health Policy*, *78*(1), 39–55. https://doi.org/10.1016/j.healthpol.2005.09.002

Reisch, L. A., Eberle, U., & Lorek, S. (2013). Sustainable food consumption: an overview of contemporary issues and policies. *Sustainability : Science, Practice and Policy*, *9*(2), 7–25. https://doi.org/10.1080/15487733.2013.11908111

Ritchie, H., & Roser, M. (2020, May 11). *Emissions per sector*. Our World in Data. https://ourworldindata.org/emissions-by-sector

Roberts, P., & Priest, H. (2006). Reliability and validity in research. *Nursing Standard*, *20*(44), 41–45. https://doi.org/10.7748/ns2006.07.20.44.41.c6560

Röös, E., & Karlsson, H. L. (2013). Effect of eating seasonal on the carbon footprint of Swedish vegetable consumption. *Journal of Cleaner Production*, *59*, 63–72. https://doi.org/10.1016/j.jclepro.2013.06.035

Ross, P. T., & Zaidi, N. L. B. (2019). Limited by our limitations. *Perspectives on Medical Education*, *8*(4), 261–264. https://doi.org/10.1007/s40037-019-00530-x

Roswall, N., Eriksson, U., Sandin, S., Löf, M., Olsen, A., Skeie, G., Adami, H., & Weiderpass, E. (2015). Adherence to the healthy Nordic food index, dietary composition, and lifestyle among Swedish women. *Food & Nutrition Research*, *59*(1), 26336. https://doi.org/10.3402/fnr.v59.26336

Schlimme, D., & Rooney, M. K. (1994). Packaging of Minimally Processed Fruits and Vegetables. In *Springer eBooks* (pp. 135–182). Springer Nature. https://doi.org/10.1007/978-1-4615-2393-2_4

Scholz, K., Eriksson, M., & Strid, I. (2015). Carbon footprint of supermarket food waste. *Resources, Conservation and Recycling*, *94*, 56–65. https://doi.org/10.1016/j.resconrec.2014.11.016

Secondi, L., Principato, L., & Formentini, M. (2022). Special Issue - Food Loss and Waste Management during COVID-19: Exploring the Major Challenges and Future Directions along the Food Supply Chain. *Socio-economic Planning Sciences*, *83*, 101375. https://doi.org/10.1016/j.seps.2022.101375

Shnayder, L., Van Rijnsoever, F. J., & Hekkert, M. P. (2015). Putting Your Money Where Your Mouth Is: Why Sustainability Reporting Based on the Triple Bottom Line Can Be Misleading. *PLOS ONE*, *10*(3), e0119036. https://doi.org/10.1371/journal.pone.0119036

Soma, T., Li, B., & Maclaren, V. (2020). Food Waste Reduction: A Test of Three Consumer Awareness Interventions. *Sustainability*, *12*(3), 907. https://doi.org/10.3390/su12030907

Spada, A., Conte, A., & Del Nobile, M. A. (2018). The influence of shelf life on food waste: A model-based approach by empirical market evidence. *Journal of Cleaner Production*, *172*, 3410–3414. https://doi.org/10.1016/j.jclepro.2017.11.071

Sridhar, K., & Jones, G. L. (2013). The three fundamental criticisms of the Triple Bottom Line approach: An empirical study to link sustainability reports in companies based in the Asia-Pacific region and TBL shortcomings. *Asian Journal of Business Ethics*, *2*(1), 91–111. https://doi.org/10.1007/s13520-012-0019-3

Stancu, V., Haugaard, P., & Lähteenmäki, L. (2016). Determinants of consumer food waste behaviour: Two routes to food waste. *Appetite*, *96*, 7–17. https://doi.org/10.1016/j.appet.2015.08.025

Stein, A., & Santini, F. (2021). The sustainability of "local" food: a review for policy-makers. *Review of Agricultural, Food and Environmental Studies*, *103*(1), 77–89. https://doi.org/10.1007/s41130-021-00148-w

Sterling, T. (2022). Gas crisis hits Dutch greenhouses. *Reuters*. https://www.reuters.com/world/europe/no-tulips-amsterdam-gas-crisis-hits-dutch-greenhouses-2022-09-07/

Streefkerk, R. (2023, January 23). *Primary vs. Secondary Sources | Difference & Examples*. Scribbr. https://www.scribbr.com/working-with-sources/primary-and-secondary-sources/

Svenskmärkning – Från Sverige. (2023, March 3). *Om Från Sverige – Från Sverige*. Från Sverige. https://fransverige.se/svenska-ravaror-all-varldens-mat/vad-ar-fran-sverige/

Swedberg, R. (2020). Exploratory Research. In *The Production of Knowledge: Enhancing Progress in Social Science* (pp. 17–41). Cambridge University Press. https://doi.org/10.1017/9781108762519

SydGrönt. (n.d.). *Svensk odling av grönsaker och frukt - SydGrönt*. https://sydgront.se/svensk-odling

The United Nations. (2015). *THE 17 GOALS | Sustainable Development*. https://sdgs.un.org/goals

The United Nations. (2022). *The Sustainable Development Goals Report 2022*. https://doi.org/10.18356/9789210018098

TooGoodToGo. (n.d.). *Save Food - Help The Planet*. https://www.toogoodtogo.com/en-us

Tzachor, A., Richards, C., & Holt, L. A. (2021). Future foods for risk-resilient diets. *Nature Food*, *2*(5), 326–329. https://doi.org/10.1038/s43016-021-00269-x

Thyberg, K. L., & Tonjes, D. J. (2016). Drivers of food waste and their implications for sustainable policy development. *Resources Conservation and Recycling*, *106*, 110–123. https://doi.org/10.1016/j.resconrec.2015.11.016

Valmyndigheten. (2022, September 17). *Election results 2022*. https://www.val.se/servicelankar/otherlanguages/englishengelska/electionresults/electionresults2022.4.14c1f613181ed0043d5583f.html

Van Der Werf, H. M. (1996). Assessing the impact of pesticides on the environment. *Agriculture, Ecosystems & Environment*, *60*(2–3), 81–96. https://doi.org/10.1016/s0167-8809(96)01096-1

Van Gameren, V., Ruwet, C., & Bauler, T. (2015). Towards a governance of sustainable consumption transitions: how institutional factors influence emerging local food systems in Belgium. *Local Environment*, *20*(8), 874–891. https://doi.org/10.1080/13549839.2013.872090

Verghese, K., Lewis, H., Lockrey, S., & Williams, H. M. (2015). Packaging's Role in Minimizing Food Loss and Waste Across the Supply Chain. *Packaging Technology and Science*, *28*(7), 603–620. https://doi.org/10.1002/pts.2127

Viets, F. G., & Lunin, J. (1975). The environmental impact of fertilizers. *CRC Critical Reviews in Environmental Control*, *5*(4), 423–453. https://doi.org/10.1080/10643387509381630

Yang, S., Panjaitan, B. P., Ujiie, K., Wann, J., & Chen, D. (2021). Comparison of food values for consumers' preferences on imported fruits and vegetables within Japan, Taiwan, and Indonesia. *Food Quality and Preference*, *87*, 104042. https://doi.org/10.1016/j.foodqual.2020.104042

Zagheni, E., & Weber, I. (2015). Demographic research with non-representative internet data. *International Journal of Manpower*, *36*(1), 13–25. https://doi.org/10.1108/ijm-12-2014-0261

9 Appendix I

This appendix includes the survey that was handed out to the managers of the vegetable and fruit departments in ICA locations in Skåne. The survey was handed out in Swedish as suggested in the first orientation interview. A translation of the survey may be requested via email.

Enkät ICA Grönsakssvinn

Jag är en Masterstudent vid ekonomihögskolan i Lund som gärna vill ha er hjälp med att fylla i en enkät angående svinn av grönsaker i era butiker. Inga butiker kommer att hängas ut med namn i redovisningen, utan ni kommer alla att vara anonyma.

I min studie vill jag kvantifiera grönsakssvinnet och jämföra lokala och importerade grönsaker. Eftersom ICAs utbud av lokala grönsaker är jämförelsevis stort kommer denna studie genomföras på ett antal ICA butiker runtom i Skåne. Vi är medvetna om att utbudet kan skifta mellan butiker beroende på lokal efterfrågan. Vi vill även understryka att detta ej är en utvärdering över huruvida ICA butiker hanterar grönsakssvinn bra eller dåligt. Studiens mål är endast att utvärdera skillnaden i svinn mellan lokala och importerade grönsaker för att kunna dra någon slutsats om deras relativa miljöpåverkan.

Jag uppskattar er medverkan och hoppas att ni vill svara på frågorna så detaljerat som möjligt. Om ni saknar specifika data men har några kommenterar som kan hjälpa oss i vår analys får ni gärna dela dem under ”övriga anteckningar”.

Tack på förhand!

Emy Maria Vijverberg,

Lunds universitet

1) På vilka sätt skiljer sig grönsaksutbudet hos er butik jämfört med andra ICA butiker i Skåne? (Välj en eller flera svar)

- o Ingen skillnad
- o Vi erbjuder fler lokala varor
- o Vi erbjuder fler ekologiska varor
- o Vi erbjuder fler säsongsvaror
- o Vi erbjuder fler lågprisvaror

- Vi erbjuder fler lågprisprodukter
- Vi erbjuder fler exklusiva varor
- Övrigt……

2) Ange uppskattningar av tillgången på importerade och lokalt producerade gurka under hela året. K står för kvantitet; ange mängderna i kilogram. Naturligtvis kommer en del av lådorna att vara tomma eftersom utbudet varierar över året.

Månad	K köpt av svenska produkter	K såld av svenska produkter	K köpt av importerade produkter	K såld av importerade produkter	Importerade produktens ursprung
januari					
februari					
mars					
april					
maj					
juni					
juli					
augusti					
september					
oktober					
november					
december					

3) Ange uppskattningar av tillgången på importerade och lokalt producerade isbergssallad (skörd) under hela året. K står för kvantitet; ange mängderna i kilogram. Naturligtvis kommer en del av lådorna att vara tomma eftersom utbudet varierar över året.

Månad	K köpt av svenska produkter	K såld av svenska produkter	K köpt av importerade produkter	K såld av importerade produkter	Importerade produktens ursprung
januari					
februari					
mars					
april					
maj					
juni					
juli					
augusti					
september					
oktober					
november					
december					

4) Ange uppskattningar av tillgången på importerade och lokalt producerade blomkål under hela året. K står för kvantitet; ange mängderna i kilogram. Naturligtvis kommer en del av lådorna att vara tomma eftersom utbudet varierar över året.

Månad	K köpt av svenska produkter	K såld av svenska produkter	K köpt av importerade produkter	K såld av importerade produkter	Importerade produktens ursprung
januari					
februari					
mars					
april					
maj					
juni					

juli					
augusti					
september					
oktober					
november					
december					

5) Ange uppskattningar av tillgången på importerade och lokalt producerade tomat under hela året. K står för kvantitet; ange mängderna i kilogram. Naturligtvis kommer en del av lådorna att vara tomma eftersom utbudet varierar över året.

Månad	K köpt av svenska produkter	K såld av svenska produkter	K köpt av importerade produkter	K såld av importerade produkter	Importerade produktens ursprung
januari					
februari					
mars					
april					
maj					
juni					
juli					
augusti					
september					
oktober					
november					
december					

6) Vad händer med grönsaksvinn? För varje kategori, uppskatta i procent (%).

Grönsaksvinnshantering	Andel som tas hand genom (%)
Anställda tar hem matsvinn	
Bortskänkes	
Sålt via ”too-good-to-go” eller andra matssvinns appar	
Slängs som matåtervinning	
Slängs som övriga sopor	
Annat…	

Övriga anteckningar…….

7) Anser ni att grönsakssvinn är ett problem hos er ICA butik?
   - o Ja
   - o Nej

8) Finns det/har det funnits något system/ansträngning för att minska grönsaksvinnet hos er ICA butik?
   - o Nej
   - o Ja.....
   - o Ja, men inte längre: ……

9) Vad är anledningarna till att importerade grönsaker ej säljs och blir grönsakssvinn? För varje kategori, uppskatta i procent (%).

Anledning	Andel som blir matsvinn pga. (%)
Kortare hållbarhetstid än uppskattat. (T.ex. på grund av problem under transport).	
Grönsak har kosmetisk skada eller är på annat sätt ej säljbar.	

Missbedömd efterfrågan av grönsaken.	
Billigare alternativ till varan finns.	
Annat…	

Övriga anteckningar……

10) Vad är anledningarna till att lokala grönsaker ej säljs och blir grönsakssvinn? För varje kategori, uppskatta i procent (%).

Anledning	Andel som blir matsvinn pga. (%)
Kortare hållbarhetstid än uppskattat. (T.ex. på grund av problem under transport).	
Grönsak har kosmetisk skada eller är på annat sätt ej säljbar.	
Missbedömd efterfrågan av grönsaken.	
Billigare alternativ till varan finns.	
Annat…	

Övriga anteckningar……

11) Anser du att det generellt sett under hela året är skillnad i hållbarhet (och därmed slöseri) mellan lokala, importerade och ekologiska grönsaker? (Välj en eller flera svar)

- o Lokala grönsaker håller längre
- o Lokala grönsaker håller kortara
- o Importerade grönsaker håller längre
- o Importerade grönsaker håller kortara
- o Ekologiska grönsaker håller längre
- o Ekologiska grönsaker håller kortara
- o Övrigt……

12) Finns det någon prisskillnad mellan importerad och lokal gurka? Om så, varför?

- Nej
- Ja, lokalt producerad är dyrare
- Ja, import är dyrare
- Ja, annan anledning……

Övriga anteckningar …….

13) Finns det någon prisskillnad mellan importerad och lokal isbergssallad? Om så, varför?

- Nej
- Ja, lokalt producerad är dyrare
- Ja, import är dyrare
- Ja, annan anledning……..

Övriga anteckningar …….

14) Finns det någon prisskillnad mellan importerad och lokal blomkål? Om så, varför?

- Nej
- Ja, lokalt producerad är dyrare
- Ja, import är dyrare
- Ja, annan anledning……

Övriga anteckningar …….

15) Finns det någon prisskillnad mellan importerad och lokal tomat? Om så, varför?

- Nej
- Ja, lokalt producerad är dyrare
- Ja, import är dyrare
- Ja, annan anledning……

Övriga anteckningar …….

16) Har ni själva reflekterat över ifall svinnet är större bland importerade grönsaker än lokalt producerade och har det påverkat era inköp?

17) Har ni några planer framöver på hur ni kan få ner svinnet?

Appendix II

This appendix provides a list of the interview questions per type of stakeholder. The interview questions are broad on purpose, to include the opportunity for follow-up questions and a certain focus if necessary. The interviews were all transcribed afterwards and coded in Nvivo based on the codes provided in figure 6. The transcribed interviews may be accessed by sending a request via email.

Questions producers (organizations)

1. What exactly do you produce and how?
2. For tomatoes and cucumber: who are your clients?
3. How does your supply and demand from the clients change throughout the year?
4. Why do your clients choose your company over another one?
5. Where does the energy used for lighting and heating come from? And why did you use this source?
6. Do you know how much energy is used on average on the coldest/darkest days of the season per tomato and cucumber and how much on the lightest/warmest days? Or the average?
7. (I read that your company decided to turn off the lights this past winter and therefore skip a growing cycle: what are the main implications for the Swedish vegetable market and will this trend continue or is the plan to produce vegetables year-round again?)
8. How much fertilizer do you use per unit of product?
9. Do you use any pesticides? How much per unit of product?
10. How much water do you use per unit of product?
11. Is there any market incentive to produce more sustainably?
12. Is there any benefit for Swedish consumers to buy local tomatoes and cucumbers versus Dutch or Spanish tomatoes?

Questions wholesaler

1. When it comes to cucumbers, tomatoes, iceberg lettuce and cauliflower, what are the shares of Swedish products versus imported and how does it change during the year?
2. What does the supply chain of imported and Swedish vegetables look like for vegetables consumed in Sweden?

3. What is important for Swedish consumers in general? Do they prefer Swedish produce and why/why not?
4. How do you keep the produce fresh? Is this different for imported and Swedish products?
5. How are the products transported? What factors are important when deciding the transport method?
6. How much products are wasted from farm to supermarket gate? Is there a difference between Swedish products and imports?

Questions Spain expert

1. How do tomatoes, cucumber, cauliflower and iceberg lettuce grow in Spain?
2. What are the main differences in production and produce compared to the Netherlands when considering energy use, and fertilizer and pesticide use?
3. What are the growing seasons for the listed vegetables in Spain?
4. How is the quality of the products and post-harvest food loss?
5. How long does it usually take until the harvested products are in the Swedish supermarket?

Questions packaging expert

1. What type of packaging solutions did Paptic develop for vegetables? In what ways is it competitive with established packaging solutions?
2. For which vegetables are there sustainable packaging options available currently?
3. What are the main properties that are required for vegetable packaging?
4. Are you able to express the difference in environmental impact between plastic foil and Paptic packaging?
5. What are the challenges for expansion for sustainable packaging?
6. Are there any plans to expand to the Swedish market?

Questions supermarket

1. Who determines what products are bought, what quantities of each product are bought and from which client it comes? What prices the products are offered for?
2. Do you have any idea if this is similar for other ICA locations? Are best practises shared?

3. Do you know how many steps are in between the producer and the supermarket for vegetables such as tomatoes and cucumbers? Probably a difference between Swedish and imported vegetables? How long are the products on the way to the supermarket?
4. What is the average shelf life of tomatoes, cucumbers, iceberg lettuce and cauliflower for Swedish and imported products?
5. When are cucumbers without plastic wrap sold? Do you note that it decreases shelf life / increases food waste?
6. Are there any other ICA locations that follow your example with Resurskocken?
7. How do you make sure that all personnel know how to work with the vegetables?