Consumers perception of genetically modified horticultural food: an interview study

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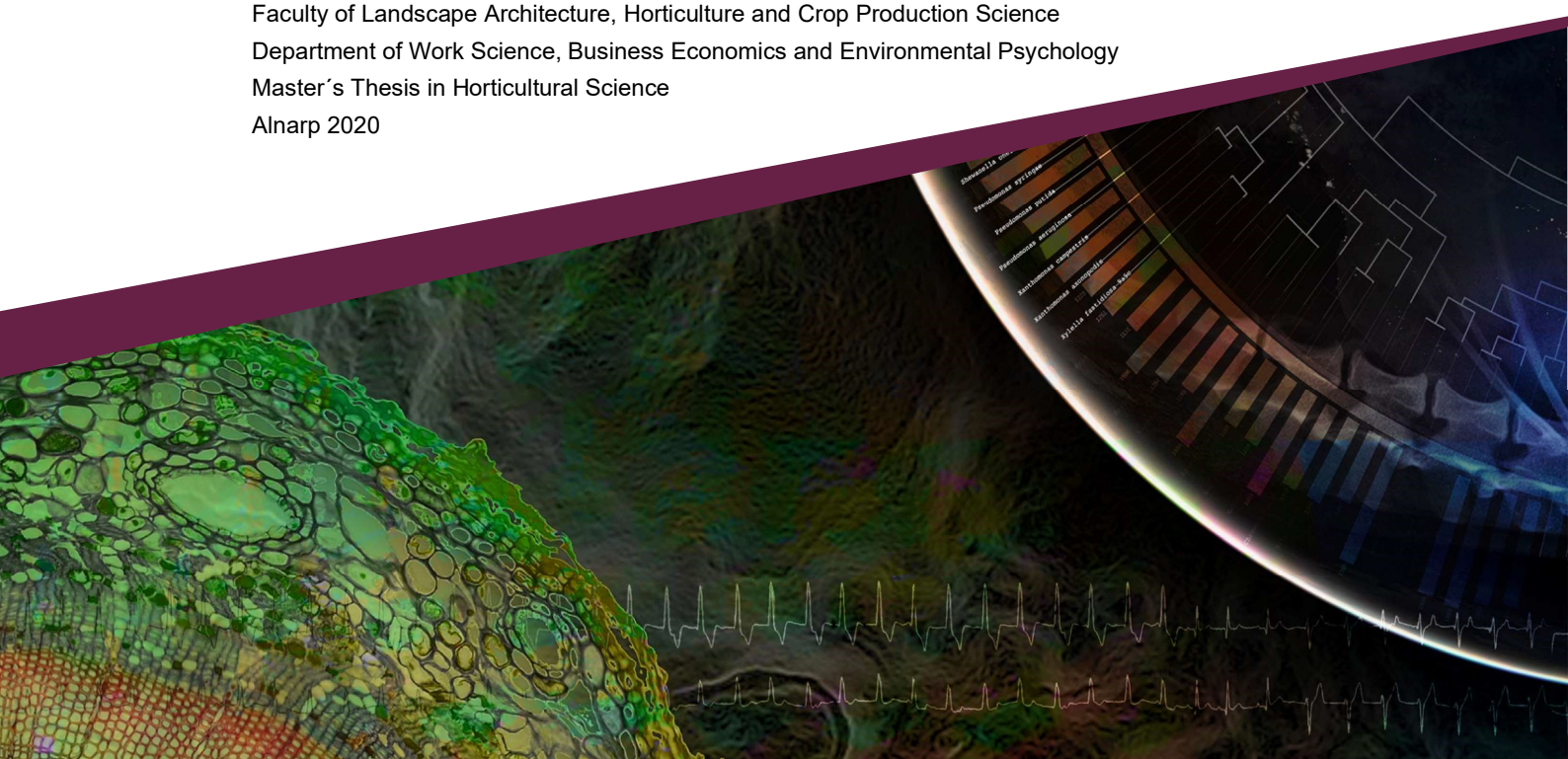

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Abstract

Genetically modified food within the horticulture sector is strictly regulated in the European Union today. In a future where the question of whether to adopt biotechnology, regarding genetically modified or gene-edited horticultural products, the perception of such technology is of importance. This study aimed to investigate the perception regarding genetically modified food and the underlying thoughts that drives these statements. Also, the perception of related technology, the gene-editing technology CRISPR/Cas was investigated. This gene-editing technology is one of the most promising technologies and with precision alter DNA in crops today, and therefore, perception towards this technology is highly relevant to investigate. This study was based on interviews including 8 participants that were interviewed for 1 hour, regarding the perception of genetically modified- and gene editing technologies. The participants were interviewed with a semi-structured approach which allowed discussions to take place. The material was then analyzed, discussed, and compared with results and conclusions of available literature regarding this topic, to strengthen the findings in this study. A special focus was to see if there were any links between statements and positions regarding gender, age, and knowledge level. The results showed that there was no clear link regarding education level and position towards the concept of GM food. However, there was a connection between both gender and age and the position and attitude towards GM food. Furthermore, gene-editing technology seemed to be more accepted than traditionally gene-modified technologies. There was also an observed knowledge need amongst the participants. The clearest connection towards a positive perception towards GM food seems the perceived knowledge regarding the understanding of the technology and was concluded in this study. An expression such as, unnatural and health hazards were mostly observed of those who rejected GM food. This study contains a relatively few numbers of participants, which means that the results don't reflect the perception of the public, which in turn points to the importance of more research in the area.

Acknowledgement

My interest in sustainable food production is a strong driving force to me. That was the main reason for me to start studying at the Swedish university of agricultural sciences, SLU. Under my studies I have become particularly interested in the use of genetically and gene editing technologies as a step towards a more sustainable food production. Other countries and regions are already adopting these technologies, but Europe and Sweden still ban this type of technologies. In a future with, assumable increased pressure on EU´s regulation bodies regarding this question, the perception considering these technologies seemed very interesting. However, my personal thoughts regarding the adoption of GM or GE technologies are still to this point uncertain. Yet, throughout this study, the input of statements and underlying thoughts regarding the position in this question has led to more insights and views, which resulted in a richer picture of my own perception. In addition, all literature that has been processed in this thesis has led to a great amount of knowledge regarding both perception and technical understanding of these technologies, which I am thankful for. I am also thankful for my two supervisors, Sara and Dennis, that have guided me through this process with great knowledge and expertise, which made this thesis possible. I also want to thank all participants that are included in this study. I am grateful for the time and well-formulated thoughts regarding your perception of this subject. My surrounding family has played a huge role for me completing this thesis, considering giving a father of two time and space to write, even during these hard times regarding covid-19. A special thanks go to my partner Joanna, which has done a tremendous job by taking care of home and family a bit extra, during this period.

List of acronyms

CRISPR	Clustered regularly interspaced short palindromic repeats
DSB	Double strand break
GE	Gene edited
GM	Genetically modified
GMO	Genetically modified organisms
mRNA	Messenger Ribonucleic acid
RNA	Ribonucleic acid
TALEN	Transcription activator-like effector nuclease
WHO	World health organization
WCRF	World Cancer research fund
ZFN	Zinc finger nuclease

Contents

1. Introduction

In this chapter, the concept of GMO´s is defined. The current regulations regarding the concept are described, as well as hurdles for the technology to be adopted in the European Union (EU). The problem formulation along with the aim and the research questions are included in this chapter.

1.1. GMO in the European Union

Genetically modified organisms (GMOs) are according to the EU defined as organisms (i.e. plants, animals, or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination (Directive 2001/18/EC, 2003). The technology is often called "modern biotechnology" or "gene technology", sometimes also "recombinant DNA technology" or "genetic engineering". It allows selected individual genes to be transferred from one organism into another, also between non-related species." (WHO, n.d.). Food that is produced by using these technologies are called genetically modified food, usually abbreviated to GM food (WHO n.d.). The way conventional food is produced today is many times seen as unsustainable, due to greenhouse gas emissions, pollutions, over fertilizations, and pesticide use that are related to it (Brodeur & Candioti, 2017; Hundey et al., 2016; Verma, 2018; Vetter et al., 2017). In addition, soil erosion and habitat destruction cause prolonged damage to the original landscape and biodiversity (Baldock, 1990; Montgomery, 2007). Genetically modified (GM) and gene edited (GE) food might be of advantage and contribute to a more sustainable future food production.

But, what about the perception of GM food? Would people eat GM food even if it was fully adopted and implemented in the Swedish food production system? Does the perception affect the regulations or is it the other way around? In this study, the perception of edible horticultural GM products (fruit, vegetables, and berries) is explored by using qualitative semi-structured interviews. This is done to compare and further understand the underlying causes of statement regarding GM food. Some questions are targeted directly towards new technologies in related areas such as gene editing, more precisely the CRISPR/Cas technology, to see if the perception of such products is viewed differently.

1.2. Problem formulation

Horticulture products such as fruits, vegetables, and berries have a generally lower environmental footprint compared to meat-based products (Macdiarmid et al., 2016). These products also often hold good nutrition content which in turn is more healthy and therefore more sustainable for the human body (Patel et al., 2017). According to the world cancer research fund (WCRF), diets with a high content of fruit and vegetables and a reduced intake of processed meat reduces the risk of several cancer diseases (World cancer research fund, WCRF, 2018). To achieve a more sustainable food production, a larger share of the diet content, most certainly, will have to be plant-based. Such an increase in demand for horticultural products also increases the pressure in the production systems which in turn creates a need for more sustainable solutions. By genetically modify crops, outcomes such as increased resilience against pests and larger yield without irrigation during droughts might be a reality (Douris et al., 2020; Shi et al., 2017). Other beneficial examples of effects by adopting these techniques could be less use of fertilizers and more tolerant crops in a changing environment (Holman, 2019). And with an expected growing global population, the environment might benefit from the usage of GM food. Altogether, advantageous properties that these techniques bring, is also a tool to secure food security for a growing population (Georges & Ray, 2017). However, GM foods are strictly regulated in many parts of the world today (Bruetschy, 2019; Feng & Yang, 2019; Shukla et al., 2018). Swedish GMO law follows the same regulation as the rest of the European Union (EU), with certain specific provisions where EU law allows it (Jordbruksverket, 2020), and only a few food items exist on the Swedish market today (Livsmedelsverket, 2020). The resistance against these technologies is due to ethical, social, and economic questions, which causes hurdles for the technology to be fully adopted and used (Directive 2001/18/EC, 2003). The complexity of GM food within the EU is explored in a study by Ingelbrecht et al. (2015), in specific how food manufacturers and retailers defend their exclusion of GM labeled food and how their perception of the EU business environment regarding GM content in food affect their strategies. According to Inghelbrecht et al. (2015:65), "serious disagreement exists between the EU Member States concerning the values, priorities, and problems of GM crops and their applications, we can even question the very existence of an 'EU perspective' on GM crops and their applications. The high level of conflict, complexity, and discord involved in GM crop applications creates a highly complex EU business environment in which companies are required to operate whilst being closely monitored by numerous stakeholders." (Ibid., 65). An example of this is that some of the EU state members such as Germany and France allow GM-free marketing of

5 animal-derived products, where animals have been fed with GM fodder, e.g. egg or milk, and are not allowed at all in other countries. Retailers and manufacturer, as in this paper referred to as gatekeepers, also seems affected by the environment surrounding these products. Some of the gatekeeper's claims that their products are GM-free even though some products contain animal-derived products or GM crops compound below 0.9% which is a way around the GM labeling requirements and used as a tool for business strategy. The literature study reveals that leading retailers influenced the EU market of GM food that resulted in a ban on GM food. The reason behind this was to ensure the value of their products and brands, which they also presented as a much better alternative from both health end ethical aspects. This behavior was soon copied by additional retailers. As claimed by Inghelbrecht et al., (2015:67) "Another market barrier for the commercialization of GM-labelled products on the EU market, besides the mentioned segregation costs, image protection, and strategic behavior, is the perception and/or belief that EU consumers will not buy these products" (Ibid., 67). The study by Inghelbrecht et al. (2015) reveals that "GM crop applications can highlight gatekeepers' perceived level of business uncertainty and it can explain their actual strategic behavior. Food manufacturers had a rather self-contained GM business strategy, whereas retailers almost systematically framed their GM strategy as a part of the company's overall corporate policy on sustainable and/or healthy food products. In both cases, corporate values such as trustworthiness, credibility, and safety were strong internal compelling determinants on how gatekeepers perceive the structured arena for GM-labelled food products on the EU market. Inghelbrecht et al. (2015) also mean that the EU market is, in some way, incident to retailers and food producers´ attitudes towards GM products which is determent by perceptions.

1.3. Aim and research questions

New technologies such as CRISPR may have many advantages in a future horticulture food production system but may never reach the market due to certain obstacles. The perception of GM food might be one of these obstacles even though it is not technically a GM food, rather a gene-edited food. Many studies that investigate the perception about GM food are quantitative and are often based upon surveys (Bredahl, 2001; Cook et al., 2002; Cui & Shoemaker, 2018). The underlying cause to exclude certain food items is probably, depending on several factors. As mention earlier, eating habits may be due to a wide range of underlying causes which suggests that it may be appropriate to study the phenomenon using a qualitative method, interviews.

This thesis aims to explore the perception of GM and GE food, with a particular focus on GM food and what underlying causes there are too expressed statements.

6 The goal is thus not necessary to challenge the conclusions from quantitative studies, rather to reach a deeper understanding of underlying thoughts for selected and identified statements.

In order to meet the aim, the thesis seeks to answer the following research questions:

- In what way does consumer attitude to GM and GE food differ due to education, knowledge, age, gender, and trust in authorities?
- What is of importance for consumers if they were to consume horticultural GM-products?
- Which opportunities and challenges do consumers identify for implementing the technology of gene modification in future food production?

2. Genetically modified-, gene edited organisms and perception

This chapter includes explanations of the concepts of genetically modified and gene-edited technologies and in what way these technologies differ. How the technologies could be used as well as pros and cons regarding these techniques are further described. The perception, in different contexts, towards these technologies is also presented in this section.

2.1. The concept of GMO´s

Genetically modified organisms, as mentioned earlier, are organisms that have genetic alterations that would not appear naturally through e.g. mating. To alter the plant genome has been something that humans have done for a long time, e.g. through the use of selective breeding and cross-breeding (Lederberg, 2015). In 1973 the first GMO was accomplished, a bacterium, and the following year the first animal was genetically modified. A decade later the first plant was genetically modified (Cohen et al., 1973; Fraley et al., 1983; Hanahan et al., 2007). The first GM food, the tomato Flavr savr, was available for consumers in 1994 and since then the usage of these technologies has changed rapidly. In 2017, 190 million hectares throughout the world were used as land for growing GMOs (Genetiknämnden n.d.; Krimsky & Gruber, 2014). How does GMO´s work then? To create a GMO a new protein, a piece of DNA such as a gene is put in a new organism's genome. This will lead to protein syntheses that didn't occur before or a knockout of another gene which results in a production loss of a specific protein. A new DNA-molecule has now been formed and it is often called recombinant DNA. If the piece of DNA is from the same species, or closely related with which it can hybridize, for both donor and recipient the name of the gene is called cisgene, if not, the gene is called a transgene. The goal of the procedure is to change the genome in such a manner that it favorably suits humans' use, for example, larger yields or more drought resistant crops. Gene editing is the technology that is used when creating mutations in the organism's own DNA. There are different ways to achieve mutations: clustered regularly interspaced short palindromic repeats (CRISPR/Cas), Transcription activator-like effector nucleases (TALENs) and

Zinc-finger nucleases (ZFNs) are examples of techniques that cause targeted 2. Genetically modified- & gene edited organisms 8 mutations. By using radiation and chemicals, random mutations could be achieved (Primrose & Twyman, 2009, 2013). Technologies that cause targeted mutation are relatively new molecular techniques which are more precise and effective. It also facilitates to generate more genetic diversity for the breeder to work with (National Academies of Sciences, 2016). Legally speaking, genetic modification and gene editing are different terms in the sense that GM is a set of different technologies that result in a regulated organism (GMO) in the EU, whereas gene editing is a technical umbrella term that includes a different set of technologies that may or may not result in a GMO (Directive 2001/18/EC). However, most consumers tend to not be aware of this difference, and many consumers may not even have heard about the techniques of gene editing that have developed lately (Hefferon & Miller, 2020).

2.2. Different technologies

There are different methods to achieve genetically modified organisms. To genetically modify plants, three different techniques, dominates: a)TALENs, b)ZFNs, and c)CRISPR/Cas. Amongst these, the CRISPR technology is by far most frequently used (Modrzejewski et al., 2019). TALENs and ZFNs are extremely precise and have tail-like proteins that bind to a specific sequence of nucleotides in the DNA. In the case of the TALENs technology, these proteins are called transcription activator-like effectors and for the ZFNs technology, they are called zink fingers. Usually, these proteins bind to 9 or more nucleotides at both sides of the DNA. At the end of this tail-like structure an enzyme, called Fok-1 (originally found in the bacteria flavobacterium) is attached. When proteins from these structures bind on both sides of the targeted gene it is commonly the enzyme Fok-1 that cuts both DNA strands in a staggered way. For CRISPR/Cas, it is not a protein but a guide RNA (ribonucleic acid) that serves to target the edit to a particular locus, followed by a double-strand break by the Cas (CRISPR-associated) protein. The results will vary depending on if a new gene is inserted or if the intention is to silence a gene (Mackay & Segal, 2010; Modrzejewski et al., 2019). As described earlier CRISPR is, by far, the most applied technology to genetically edit plants today but works in a different way compared to the other technologies described.

2.3. CRISPR/Cas

The CRISPR/Cas technology may be more prone to off-target alterations than the TALENs or ZFNs technologies but have other advantages. The systems were first found inside a bacterium, more precise, inside the Escherichia coli genome

throughout a study of genes participating in phosphate metabolism (Bailey, 2019). 9 The first observations were done in the late 1980s and since then the technology has made great progress. The CRISPR/Cas system is used by bacteria to defend themselves against viruses. Examples of bacteria that have this defense mechanism are Escherichia coli and Streptococcus pyogenes (Li et al., 2015; Stockwell, 2017). When surviving a virus infection these bacteria save a small fragment of the virus genome and plant them in their own genome, which then serves as a protector next time the same virus attacks the bacteria. Each of these fragments of virus genomes is placed in the bacteria genome in something called CRISPR locus which contains CRISPR repeats. These are sequences of organic bases, and virus genomes in between the repeats that the bacteria previously have been infected with. The CRISPR locus is then transcribed into mRNA which in turn are divided into several smaller pieces containing just a CRISPR repeat and a virus genome, called CRISPR RNAs (crRNA). The crRNAs are located in the cytoplasm of the bacteria where it binds to transactivating CRISPR RNA (tracrRNA). This new complex is allowed to bind to the Cas9 enzyme. If the bacteria now get infected by the same virus as before, it has a good defense system. The system will now recognize the attacking virus and is able to dock its DNA because of the crRNA which has a complementary piece of the intruding virus DNA. The Cas9 enzyme will then cause a double-strand break (DSB) and work as a scissor to chop up the intruding virus DNA and neutralize it. The Cas9 enzyme is a nuclease enzyme and doesn't need a receptor to bind to. This means that the Cas9 enzyme will cause a DSB was every location it is guided to (Li et al., 2015; Singh & Dhar, 2020; Sontheimer & Doudna, 2014). Because of the attribute, to target DSB, this is a very versatile system and could be used not only in bacteria but in other organisms as well such as e.g., plants or humans. If the desired gene is known, there are possibilities to alter the gene expression, either by silence the gene or by the insertion of another. It should be mention that there are other Cas enzymes that work similarly but Cas9 is the most widely used enzyme with this system (Li et al., 2015; Singh & Dhar, 2020).

2.4. Genetically modified food

Humans have altered genomes for a long period of time and the food we eat today, most certainly, has been modified sometime during its history. For example, cows didn't exist 10,000 years ago, but is a result of wild aurochs that have been selective breed and cross breed for thousands of years. This also applies to a large amount of other domesticated animals (Gustafsson & Haapoja, 2015). Fruits and vegetables that are available on the market today would, with great probability, not exists if not humans had altered their genome (Kingsbury, 2009). In the process of domestication, plants have acquired traits that would never appear without human intervention, such as loss of seed shatter and other mechanisms of dispersal, very

large seeds/fruits, etc. However, old ways of altering genomes, such as selective 10 breeding and cross-breeding are not defined as GMO (Tagliabue, 2016). Compared to new methods, these technologies are also very time-consuming. Novel technologies e.g., the CRISPR/Cas method shorten the time of altering genomes drastically. Today most of the GM food available globally originates from the plant kingdom, but in the future, we are likely to see GM food from other organisms such as insects, microorganisms, fish, and mammals. Most of the GM food that is available today has been enhanced mostly to improve the resistance against pests, provide tolerance to herbicides, and increase yields. In the future, products with improved nutritional continent and products with less high allergenic components are likely to be seen. The expected larger yields and the reduction in food losses due to GM foods follow up with anticipated price drop for horticultural products (WHO n.d.).

2.5. GMO and horticulture

GMOs can have many different impacts on horticulture. Today genetically modified horticultural plants are used for many reasons. Some plants are modified to have greater resistance against drought and other extreme weather such as e.g. heavy rains (Haq & Hussain, 2020). Examples of horticultural crops that are altered to meet future demands for possible climate changes. In 2001, Zhang and Blumwald, (2001) found that GM tomato plants, unlike conventional tomato plants, could grow and produce fruit even during the drought-related situation with a reduced amount of fresh water and a high sodium environment. Possible higher temperatures allow pests to thrive and spread geographically (Thomson et al., 2010). GM crops could be an effective way to prevent a scenario of invasive pests and at the same time more environment friendly (Phipps & Park, 2002). Due to this, horticultural crops may have better resistance in the future with expected further climate changes. GM technologies are already today contributing to fewer food losses (Taheripour & Tyner, 2017). Some GM crops are targeted to produce larger yields than conventional crops of the same species. Between 1996 and 2015 GM crops estimated to contribute to 357 million tons of corn (Klümper & Qaim, 2014) this could also be considered to contribute to food security for a growing population if these technologies are implemented in regions with such problems occur. At the same time, farmers and retailers gain extra income from this which in turn creates more jobs and a stronger economy (Raman, 2017). Some genetically modified crops are enhanced in such manner that the resistance against pest such as, insects and pathogens, are improved which have contributed to less use of pesticide and therefore also to the biodiversity (Raman, 2017).

2.6. GM food, cons and criticism

Genetically modified food may have many advantages and potential benefits, but it might come with costs. Disputes and discussions, about GM food, across many sectors in society are occurring today. Consumers, scientists, companies, governments, farmers, non-governmental organizations are tangled in questions concerning GM food (Bøhn, 2018; Finucane & Holup, 2005; Klintman, 2002;) Some of the most frequently used arguments against GM food concern health, environment and labeling. One of the top arguments for consumers not to eat GM food are whether GM food is safe to eat or not. The overall scientific assessment is that GM food is safe to eat according to the available literature in the field. However, new technologies, such as e.g. CRISPR/CAS, are still in their infancy which means that the long-term effect of food altered in this manner is not yet studied (Blair & Regenstein, 2020). Nevertheless, the correlation of a certain food item and health impact is generally difficult to study (Bleich et al., 2015). In the EU, all new GM food is separately tried and rigorously tested before the product reaches the market (Directive 2001/18/EC, 2003). GM crops that are cultivated in an open field may also have a negative effect on the environment. Pollen from these crops could potentially lead to a new plant with altered DNA competing with wild natural plants. Additionally, new GM crops may not be compatible as food, home, or breeding spots for inhibited insects which thus may threaten the biodiversity amongst insects too (Bøhn, 2018). The general level of knowledge among consumers about GM food might be considered as low. Several studies have additionally found a correlation between the level of knowledge, about GM food, and perception about GM food correlates (Hallman et al., 2003; Klerck & Sweeney, 2007; Wunderlich & Gatto, 2015). In other words, the more knowledge about GM food the more optimistic is the perception. Media, in general, has a low level of knowledge considering this topic, and their perception about GM food also contribute to an increased negative overall perception amongst people with low knowledge of the subject (Sarathchandra & McCright, 2017; Zhu et al., 2018).

3. Theoretical framework

3.1.1. General perception

Several articles illustrate that consumers in several regions of the world have a generally negative attitude towards GM food. Even though a small group is positive towards the technology and is willing to buy GM food, the majority has a negative attitude against GM food (Cui & Shoemaker, 2018; Lucht, 2015; Tas et al., 2015). Common concerns, that cause a negative perception of GM food, are related to health and environmental concerns. Among consumers, negative perceptions towards GM food are due to beliefs that gene-edited food, both the production and the product, are related to hazards and risk to the overall health and the environment (Arvanitoyannis & Krystallis, 2005). Factors that contribute to the negative perception of GM food additionally seem to be mistrust against the scientific community and to government bodies.

3.1.2. Education level and Knowledge level

A low level of education also correlates with a negative attitude towards these technologies (Arvanitoyannis & Krystallis, 2005; Cui & Shoemaker, 2018; Lucht, 2015; Marques et al., 2015; Tas et al., 2015). The knowledge level about GM technologies seems to have a big impact on attitude. People with a higher understanding of the process of GM food have a significantly higher acceptance and a more positive attitude towards GM food (Cui & Shoemaker, 2018; Tas et al., 2015). However, there are examples of studies showing that a positive perception of GM food could be found in regions with low knowledge about GM technologies and low education levels (Gatica-Arias et al., 2019). Since a majority of these studies are conducted through the use of questionnaires, less is known about the consumer arguments underpinning these attitudes and perceptions towards GM food. It should however be highlighted that consumer attitude towards food and the behavior around food and diets depends on countless factors. These types of factors will, most certainly, also have a big impact on the perception of GM food. A good example of this is that peoples who expressed a positive attitude towards new technologies and willingness to try new food also had a more positive view of GM food (Arvanitoyannis & Krystallis, 2005).

3.1.3. The importance of the public perception

In a study by Geall & Ely (2019) results show that the public plays a crucial role when new socio-technical systems are being implemented. Both by the public impact on governance and by the direct agency. The study also points out the complexity in a socio-technical shift which includes many factors such as, e.g. cultural and political. Geall and Ely (2019) also say that the agri-food sector pays, relatively low attention to the public perception about a transition in that sector, compared to other industries, which might contribute to a negative attitude toward technologies within the agricultural food industry. When Geall and Ely (2019:26) focused on the literature regarding GM crops and agri-food transition in Europe, they found that "increased information and improved levels of technical understanding will lead to greater public acceptance of a novel technology". This is described as the deficit model, the more scientific knowledge and technical understanding the more acceptable are the new technologies (Geall & Ely, 2019). However, Geall & Ely (2019) found that later studies showed that skepticism of agricultural biotechnology was not linked to objective knowledge that could be increased through scientific education. Rather, surveys (INRA (Europe) - ECOSA, 2000) showed that "those with the highest level of education are more assertive in their opinion", either for or against the technology (Eurobarometer, 1999).". Geall and Ely (2019) also found, that the more engaged the public becomes in GM technology and increases their understanding of the technology, they harden their attitude towards it because of the risk assessments. However, the willingness to see potential benefits, at the same time, increased. These new insights have led to a discussion of a different approach, from a deficit model to one focused on public engagement in science and technology (Geall & Ely, 2019). Furthermore, to gain knowledge in the area of GM food besides the technology aspect, was of most importance for "both personal and policy judgments, and highlighted the validity and value of lay knowledge in guiding decision-making, especially under uncertainty" (Geall & Ely, 2019:27). Trust in involved governmental bodies also had a big impact on the general perception concerning GM food. Low trust seemed to correlate with a negative attitude towards GM products. Geall and Ely (2019) also investigated perceptions about GM crops amongst Chinese citizens. Most studies showed that Chinese citizens have a more positive attitude towards GM food and technologies. This may due to the approach of Chinese governance and media coverage. E.g." One study of two official, national newspapers, the People's Daily and Guangming Daily, from 2002 to 2011, concluded that Chinese reporting of GM crops had emphasized the benefits of transgenic organisms and that no articles had portrayed GM crops in a negative light" (Geall & Ely, 2019). In the interview part of their study, 3 focus groups with 15 individuals were interviewed by a semi14

structured approach. Pros and cons of using GM food were discussed amongst the respondents. According to Geall and Ely (2019) “Many respondents’ concerns centered around distrust of the regulatory system of both GM and organic foods. An organic farmer said, “I don’t trust regulation broadly.”. Furthermore, some of the participants thought GM food was linked to hazard and health risks, which was a common statement throughout all focus groups (Geall & Ely, 2019). A common perception was also that GM crops would benefit farmers economically. There were also indications that “that educational level did not necessarily correspond with trust or acceptance of GM foods; some respondents with higher educational level expressed distrust about uncertainties and regulatory failures around GM foods”. Other indications were that media and social media heavily influenced their thoughts about GM food, were ordinary media led to a more positive view on GM crops and social media had the opposite effect (Geall & Ely, 2019).

3.1.4. Medias effect on perception

Considering the media and the government's role regarding the effect on public perception of GM food, a study from South Korea points at its importance. Media coverage has a significant impact on people's perception of GM food and tends to highlight the negative aspects of technology (Kim et al., 2015). Due to the governmental strategy and the media´s approach regarding GM food, people, in general, has e slightly negative attitude towards GM food according to Kim et al., (2015). Often, coverage from media is published in public magazines or through the TV without an understanding of the content. The translation from science and governmental bodies to mainstream media can easily be angled, incorrect, and misinterpreted (Kim et al., 2015). Kim et al., (2015) interviewed two types of journalists, a) general journalist that sporadically reported about the GM food and b) science-journalist that was specialized in technologies regarding GM. According to Kim et al., (2015:a 1880) “Both groups of journalists have important effects in risk communication with the public through various outlets of media. The difference in the extent of knowledge and information for GM foods may contribute to the difference in their attitude or perception of risk towards GM foods.”. Four main questions were asked to the two groups. The groups were then compared largely concerning risk perception, approach to obtaining information about GM technology, and response to government announces regarding GM food (Kim et al., 2015). Following for question was asked and discussed to the two groups;

1. “*What are the reasons for rejecting GM food purchase?”*

2. *“What is the most critical issue that needs to be resolved or addressed in order to successfully commercialize and market GM foods?”*

3. *"How do you obtain information regarding GM foods? Which route do you use to seek information?"*

4. *"If GM foods are in the process of making a major inroad to the world market, what do you think the Korean government should do to respond & prepare for this?"*

Regarding the first question, the groups differed markedly. The reason the rejecting GM food purchase by general journalists since they experienced vague anxiety about GM food, which was in line with the public perception (Kim et al., 2015). The science-journalist stated that if there was a reason to reject GM food, the distrust of the technology was the reason. Some of the technologies involved in GM food production are in their infancy, which concerned them (Kim et al., 2015). Considering the second question, "What is the most critical issue that needs to be resolved or addressed to successfully commercialize and market GM foods?" group one, the general journalist answered that, consumer acceptance was of most importance to commercialize GM food. While group two answered that food safety was the most important factor (Kim et al., 2015). Regarding question number three, how the groups obtained information about GM food, group one answered that mass media was their source of obtaining information. Group two answered that mass media was one source, but scientific journals and magazines also were a source to obtain information about the topic (Kim et al., 2015). Question number four, "If GM foods are in the process of making a major inroad to the world market, what do you think the Korean government should do to respond & prepare for this?", group number one stated that "government should provide comprehensive information on GM foods to the public through effective risk communication channels since the public considered that they have the right to know and prefer to make informed choices on GM foods. General journalists argued that it is the government's role to develop an effective risk communication network between the media, the public, and policy-makers and the media can only play an effective intermediary role in disseminating the right information of GM foods to the public when policy-makers provide an efficient risk communication framework." (Kim et al., 2015). According to Kim et al., (2015) government bodies already have this role but are still presented with a negative tone by general media due to lack of knowledge causing misinterpretations. Group two argued that government should ameliorate the process regarding safety and tests of GM food production to prevent disbelief and misinterpretations of GM food by the public. Kim et al., (2015:1881) also state that "Building trust has become a critical success requirement for risk communication. Source credibility does appear to be an important factor in building effective risk communication with the public. Government typically makes a major announcement on food safety issues through media broadcasting and newspaper 16

publishing. Although it is the government that provides information on GM foods, the media is the direct contact to the public as the media is the one that provides information to the public through its medium. Thus, how media disseminate information on GM in its medium have a significant impact on the public opinion and attitude towards sensitive issues such as GM foods".

3.1.5. Gender and perception

A study from Elder et al., (2018) also found that women are more skeptical in their perception of GM food compared to men. One explanation of this might due to the fact that men are more willing to take risks (Harris & Jenkins, 2006). It was also shown that women that are parents had an even higher skeptical attitude towards GM food (Elder et al., 2018). Bray & Ankeny (2017) investigated which factors that affect the perception, attitude, and associated values of GM food amongst women in Australia. Factors such as education level, level of convenience, nutritional perception, and health effects, with a special focus on the difference of perception by education level (Bray & Ankeny, 2017). According to Bray & Ankeny (2017:2) "women's concerns about risk, rather than the effect of information, may explain the gender difference identified in some studies." Besides, women have the role of food gatekeepers in Australia and are responsible for the majority of household food purchasing. Which combined contributed to the particular focus on women in this study. Furthermore, Bray & Ankeny (2017) also states that those with university-level science experience were more likely to accept new biotechnologies, which pointed out the interesting part with comparing people with different education background and professional roles. The following two research questions were analyzed by Bray & Ankeny (2017).

1. *"How do level of education and professional roles in "science" shape the understanding of risk and the use of evidence for assessing risk associated with GM foods?"*

2. *"Is avoidance or acceptance of GM foods related to ideas about consuming GM foods, or about broader issues and social values involved in their production (the product/process distinction)?"*

The result showed that all of the women have an understanding and worked within the field of technology were unconcerned about eating GM food. One underlying cause to this was that these women knew that they probably already consumed food contained GM ingredients to some extent which dint bother them because of no adverse effect. Bray & Ankeny (2017) also noticed that groups which included some women with postgraduate qualifications in nutrition and health science indicated they would avoid GM food" one of the reasons was that these women 17

lack knowledge about the technique itself and related the products to health hazards. Bray & Ankeny (2017) identify four themes that stood out as a common cause that was of importance and influenced their food of choice; "(1) "natural," predominantly described as "unprocessed"; (2) local; (3) "healthy"; and (4) additive-free food" (Bray & Ankeny, 2017). However, the women included had different opinions and knowledge about were GM technologies was involved in these themes, which according to Bray & Ankeny (2017) highlights the complexity of food chose, especially including GM products. Furthermore, the women in group one, with the highest competence regarding GM technologies, dismissed the statement that GM food is related to health risks, but was aware that a common this was a common perception. The women in group 1 rather described GM plants "as an extension of traditional plant breeding" and was critical against media's coverage (Bray & Ankeny, 2017). Participants in group two and three were more concerned about health risks regarding consuming GM food. The concern was mostly about uncertainty and unknown events by eating GM food. One of the women in group 3 made this statement "because we don't quite know what we're messing with and if they're modified it wrong the plant might end up producing toxins or something. I guess there's a lot of unknowns and so I'm not happy knowing we're eating them because of that." which highlights what uncertainty leads to (Bray & Ankeny, 2017:13). Bray & Ankeny (2017:18) concludes that "Recognizing that both support for and opposition to GM food/crops are deeply intertwined with a wide range of social values, and are not primarily or only about "the science" associated with genetic modification, will enable the development of better public engagement practices with diverse publics and across different sciences.".

3.1.6. Age and perception

There is a diverse understanding of how age affects the perception of GM food. when Huang & Peng (2015) investigated the perception of GM food in consumers they found no significant impact and that a positive or negative picture towards GM food was independent of age. However, Costa-Font & Mossialos, (2007) found that the perceived beneficial benefits with GM food was higher in an older population and correlated with age.

3.2. Dietary patterns and eating habits.

Eating patterns are governed by many things, both external, internal, physical, and mental factors affect the food intake of humans, which makes it very complex and hard to map. Eating patterns can additionally be affected by social factors e.g. what friends or colleagues brings for lunch at the office (Vartanian et al., 2008). Food 18

intake during childhood has a major impact on adult food choices. The effect is not only affecting the customization of the taste buds for certain food items but also in relation to what types of food that are acceptable considering ethical, moral, and religious questions (Birch et al., 2007; Birch et al., 1995). Perception of our bodies and the influence of media and social media has in recent years played a huge role in eating habits. Pictures of "perfect bodies" flood the content of coverage of many media platforms which cause a strive towards a healthier diet. This effect seems to increase eating disorders (Santarossa & Woodruff, 2017). In poor regions of the world eating habits are affected negatively by not being able to afford nutritional food. In these regions, people seem to eat more unhealthy food, such as fast food and ultra-processed food (Kalenkoski & Hamrick, 2013). In extreme poverty, conditions such as malnutrition and starvation occur. But even in wealthy regions, unhealthy eating habits are occurring. The western diet with much processed food, which is high in calories and has a low content of fiber, vitamins, and minerals, are very common in wealthy regions of the world. Other factors may be the driving force in these regions such as convenience, media, and input from food companies (Cordain et al., 2005). Veganism and vegetarianism may depend on moral or ethical questions as to why exclude animal products in their diets. Arguments including animal rights and environmental impact due to animal food production may form the basis of these statements, leading to changes in eating habits (Huemer, 2019). Due to policy provisions such as e.g. regulation of GM food, creates hurdles for food items that otherwise could be consumed. In a future with a predicted increase in population and a food production that already causes lots of environmental damage changes in consumer eating habits towards more sustainable alternatives may be something to strive towards (Bahadur et al., 2018; United Nations, 2020). One important tool in developing a more sustainable food consumption is to increase the consumption of horticultural products, such as fruits and vegetables, (Bahadur et al., 2018). An increased intake of these products will be one way to fight the obese pandemic that is occurring today. This will additionally support health among the population which in turn may reduce the need for food-related healthcare and associated financial costs (Meldrum et al., 2017). Horticultural food has a lower environmental impact compared to animal food production (Baroni et al., 2007) yet there is probably much more that could be done from a sustainability point of view. Studies have shown a clear link between knowledge and education level, and a healthier diet (Hiza et al., 2013) this might be a good incitement to enlighten and educate the population to change the perception of food and food technology where the knowledge level is low. In the future, an educated population might contribute to lower hurdles for sustainable technologies. obviously, there are a large variety of factors that influences diets and food choices. Furst et al. (1996) investigated the complexity regarding this question by conducting interviews and

use existing literature. In the study the found that for 19 every food choice there were many aspects involved and that process behind selecting food was complex.

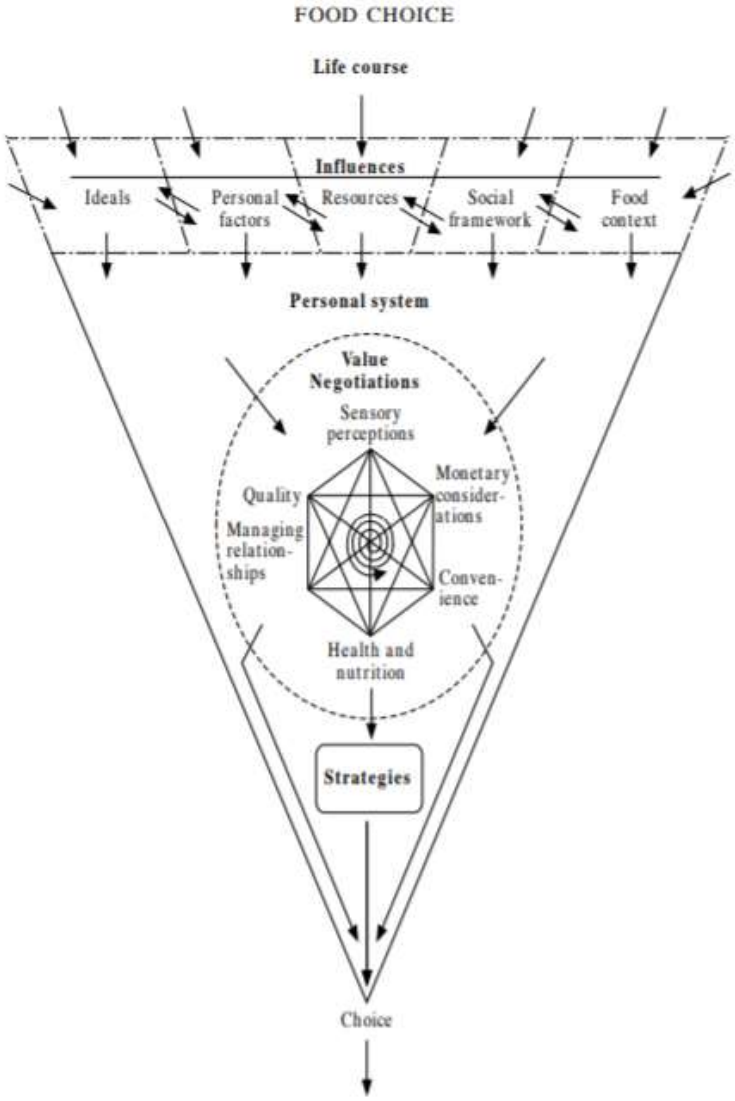


Figure 1: Illustration of factors that influence food choices (Furst et al., 1996:251)

3.2.1. Consumers food choices and GM food

In a study by McCarthy et al., 2016 factors contributing to the adoption of green innovations regarding organic-, certified food were explored, in specific consumers' perceptions toward GM food. McCarthy et al., (2016) highlight that "the complexities of consumer behavior need to be examined". Marketers need to know whether the GM-free claim is important to buyers of certified food". Results showed that markers such as age, gender, education level, and income all had an impact on consumer behavior regarding organic and certified food. Low education

level, rising age, and low income correlated negatively with the willingness to purchase these products (McCarthy et al., 2016). Men also seemed to be more likely to purchase these products along with small households. Out of 16 options, “Green food will improve the future health of my family” and “Does not contain genetically modified ingredients.” were the two highest ranked reasons to buy these products, which indicate that the participants might relate GM food to health hazards (McCarthy et al., 2016). According to McCarthy et al., (2016), all of the participants had heard of GM food, but as many as 83% rejected GM food. The main reasons put forward were thoughts that GM food was harmful to the human body, that it was not healthy and that uncertainty about the products was too high.

3.2.2. Labeling of food items

Labeling information seems to affect the perception regarding perception and willingness to pay for GM food according to Zhan et al., (2020). The prominence of the position of label information negatively impacts consumer willingness to pay for GM foods at the 5% and 10% significance levels, respectively. This suggests that the more concerns consumers have about the position of enhanced GM food labels, the lower is their willingness to pay for GM foods. The main reason is that concerns about the position of the labels reflect consumer risk perceptions about GM foods, which significantly reduces their willingness to pay for such foods.” (Zhan et al., 2020).

4. Methodology

The method chapter describes the research design and the chosen qualitative method (interviews). The chapter additionally outlines the process of selecting participants, data collection, themes, data analysis, ethical considerations, and finally delimitations.

4.1. Research design

Much of the research in the area regarding perception and GM food are investigated through a quantitative approach, which often is based on questionaries. In this study, the aim is to investigate, not only the perception regarding GM food but also underlying thoughts that are the foundation of that particular perception. Since questionaries don't allow further discussions to understand these underlying thoughts a semi-structured interview approach was selected for this study. With this approach, all questions could be discussed separately which is beneficial to understand an individual's perception and underlying thoughts (Michael Bloor & Fiona Wood, 2006).

4.2. Data collection

Data was collected through interviews administrated by the use of a semi-structured interview guide (see appendix 1). Interviewees were recruited either directly by the interviewer, or through an open invitation communicated on Facebook, Instagram, and Twitter. In the ad, the following message was delivered: "What is your perception of genetically modified food? I am currently conducting a study at the Swedish University of Agricultural Sciences (SLU) and need participants. If you have a perception or opinion about genetically modified food, you are welcome to apply. No other prerequisites are required. If you are interested you are welcome to send me an email for further instructions". When applicants applied for the study, they were informed that the main focus of the study was on GM horticultural products. None of the participants were given any compensation to conduct in this study. The ad was shared multiple times through social media and was additionally communicated through mouth to mouth. Initially, 20 persons signed up for 4.

Methodology 22 participating in the study, and out of these eight persons were elected to be included in the study. An overview of the participants, including age, gender, education level, and level of expertise in GMO, is presented in table 2. Inclusion criteria were set to persons who had a perception of GM food, which they wanted to convey and were between 20 to 70 years old. Persons with no knowledge of GM food and to whom GM was a new concept were excluded. Since the aim of the study was to increase understanding of societal underlying thoughts and illustrate diversity in opinions to GMO as a whole, applicants were selected to represent a broad range of education level, the expertise of the topic, age, and gender. The approach was expected to provide a wide and broad diversity of opinions, perspectives, and perceptions. Following this in the section process of interviewees, applicants with similar backgrounds (in comparison to already recruited persons) were deselected through the selection phase. One participant (P5) was however asked directly to be included in the study. This was done to secure the inclusion of a participant with an above general high level of GM-expertise (a Ph.D. in horticulture). Additional participants applied to be included in the study and were selected due to gender, age, and educational background. Eight persons were interviewed. Each interview lasted for one hour. The interviews were conducted between the 9th and the 23rd of October 2020. Due to the pandemic that was occurring and the geographic spread of the participants, the interviews were conducted through the video conferencing online tool, zoom. All participants gave permission in advance to record the interview and that collected data could be used as a basis for a thesis and/or a scientific publication. All participants were informed about secrecy and their anonymity. The interview guide included in this study was based on 4 themes; 1) Knowledge level, 2) Consumption, 3) Government and trust and 4) Production and future. The interview guide contained questions for each of the four themes.

Table 1: Overview of participating interviewees.

Participant (P)	Age (Years)	Gender	Education level	Level of expertise in GM food
P1	24	Male	High school diploma	Low
P2	42	Male	High school diploma	Medium
P3	61	Female	High school diploma	Low
P4	34	Male	2-year university degree	Medium
P5	36	Male	Doctoral degree	High
P6	35	Male	Master's degree	Low

P7	21	Female	High school diploma	Low
P8	44	Female	2-year collage degree	Low

4.3. Themes

Four themes with a preprepared interview guide were used in this study. All four themes included questions with the aim to understand underlying thoughts and perspectives surrounding GM food perception.

4.3.1. Theme 1: Knowledge level

In this theme, the objective was to explore participants' knowledge level about GM food, assumed availability among Swedish retailers of GM food, and their consumption of GM products. Following 4 questions were asked to determine the knowledge level;

1. Would you say that you know what genetically modified food means?

2. What is your level of knowledge on a scale of 1-5 (1 = no knowledge at all, 5 = very good knowledge)?

3. Do you think that there are genetically modified fruit, vegetables, or berries, available in stores in Sweden?

4. Do you think that you consume products that have been genetically modified or contain traces of it in Sweden?

4.3.2. Theme 2: Consumption

In this theme, question regarding consumption was covered to investigate what was of importance when the participant choose between food items. It also worked as a tool to see connections between food choices and perception regarding GM food. four questions were asked in this theme were follow-up questions and discussions also were a part of the interview. In this section, the associations to the concept GMO also were examined. How the perception was to eating GM horticultural products and how they thought their health was affected by consuming GM products were included as well. The following question were asked in this theme:

1. When shopping for food, what is important to you? What makes you choose one product over another?

2. What are your associations with the concept of GMOs?

3. How do you feel about eating genetically modified products, fruits, berries, and vegetables? Why?

4. How do you think your health is affected by eating fruit berries or vegetables that have been genetically modified?

4.3.3. Theme 3: Trust and authorities

In this section trust in authorities and dissemination of information was covered. The participants were asked if they trusted governmental bodies that regulated GM food and what the effect could be if there were no regulations at all. The participants were also asked if they thought governance bodies should provide the population with more information regarding GM food and why.

1. Do you trust authorities that regulate genetically modified food?

2. What effect do you think technology like this would have had if it became unregulated? In society, for producers, etc.

3. Do you think that the authorities should provide more information in this subject?

4.3.4. Theme 4: Future and production

In this section, the goal was to explore participants' views on how the technology of gene modification could affect future food production. In this theme all participants were given basic information about different GM technologies regarding food production. The following information was provided to the participants in this step: “there are different ways to create GMO. Traditionally, chemicals or radiation are used to create mutations in crops in a way that suits us. More recent technologies which are more accurate such as CRISPR/Cas is not technically a gene modify technology and is referred as a gene-editing technology” (Swedish Board of Agriculture, 2020). They were also provided with information explaining that there was basically no GM food available on the Swedish market today (Swedish food agency, 2019). This was done to obtain a more nuanced picture

25 of the participant's view of future food production in the EU and Sweden. The information was also given to separate concepts from each other as investigation about the CRISPR/Cas technology took place in this section. To clear out and distinguish concepts from each other was necessary to obtain more clear answers regarding the content of the included questions in this section. Therefore, the concept of CRISPR/Cas and traditional GMO´ were explained and distinguish. In this section, eight questions were included.

1. How do you think the use of genetic engineering can affect production (pos / neg)

2. How do you think genetically modified food (horticultural products) affects the climate and the environment? (reduction of pesticides, reduction of natural habitats, etc., etc.)

3. Do you think we will eat a lot of genetically modified food in the future? What is your approach to this?

4. It is almost impossible for European farmers to grow GM crops, and it is very costly to obtain a permit to sell a GM product (made in the USA, for example) in Europe. How do you look at that?

5. If your level of knowledge had been higher regarding GM food, do you think your perception of the technology would have changed then? Why?

6. Do you want to know more about these technologies?

7. This year's Nobel Prize in Chemistry went to the gene-editing technology CRISPR. This genetic engineering allows you to fine-tune the plant's own genes to compare with genetic modification (GMO) where you move genes between different organisms. Do you think it should be as strictly regulated as GMOs?

8. Can you imagine eating food that is improved with the gene-editing technology CRISPR, so that it has a higher nutrient content, needs less pesticides when it is grown, etc.?

4.4. Data analyses

Each interview was recorded both by audio and video. During the interviews, notes of key statement of underlying causes and thoughts regarding GM food perception

26 was taken. The recorded material and notes were analyzed through thematic analysis which allows the qualitative data to be examined by themes to see patterns or similarities (Evans, 2018). Each statement and underlying thought that was expressed by the participants were coded and/or ranked in an attempt to understand and reproduce the most accurate perceptions and underlying thoughts regarding their position in each question. The following 3 steps describe the thematic analyses in this study, 1) notes of key statements during interviews, 2) relistening, where statements and underlying thoughts were coded and ranked. 3) analyzed to see patterns or similarities. The analysis was then conducted in relation to the four themes.

4.5. Ethical considerations

The carefully selected literature in this study, many times, describes potential pros and cons with the use of both GM and GE technologies. Ethical questions have been discussed considering these technologies and are one of the most frequently used arguments against them. Awareness of the sensitivity regarding this factor has been taken into account. Furthermore, to protect the participant´s integrity by publishing this study, informed consent was gained by informing all participants that they had full anonymity and that original interviews and personal data not will be transferred to other parties.

4.6. Delimitations

The main focus in this study is to look at the perception of GM food within the horticulture sector. The perceptions are compared with other factors such as age, gender, and education level. Due to the time frame, other factors, such as income, religion, and political opinions that potentially could have an effect on the perception towards edible GE and/or GM horticultural products, were uninvestigated. Furthermore, the relatively few numbers of participants in this study were also limited by the timeframe, since the qualitative approach is heavily time consuming.

5. Results

The result is presented in accordance to four themes; 1) Knowledge level, 2) Consumption, 3) Trust and authorities and 4) Production, and future. Finally, the main findings in this study are compiled.

5.1. Results by themes

5.1.1. Knowledge level

There was a variety of knowledge levels regarding GM food amongst the participants. When the participants were asked if they would say if the know what genetically modified food means, the majority said they had some sort of knowledge, P3, claimed limited understanding at all, and said: *"...No, I wouldn't say I understand what it means, I think it is an experiment to produce food and it's not natural, but I have heard of it and I think it's bad".*

All other contributors gave also an explanation about their understanding of the concept. Even here there was a wide diversity of answers. E.g. P1 said that he had some understanding of the concept and claimed that "switching genes" was the main thing about the process of GM food. P2 and P4 claimed that they had a pretty good understanding about the concept and P2 explained that GM food is *"when we go in and cut and paste in the targets DNA strains".*

P6 and P7 showed uncertainty about the concept GM food but had heard of it before and claimed that they had limited knowledge in the area without further explanations. P5 showed in dept knowledge in the area and stated also that his level of knowledge about GM food was high. P8 gave an explanation about GM food close to the definition earlier mention from EU in this study, however, she also claimed her knowledge level was limited. When the participant was asked to put a number of their knowledge level in the area from 1-5, the outcome ranged from 1-5, see table 3.

Table 2:Participants ranking of individual knowledge level in the area of GM food (1= low knowledge, 5 high knowledge level).

Participant	Knowledge level
P1	2
P2	3
P3	2
P4	3
P5	4-5
P6	2
P7	1
P8	2

All of the participants except P5 answered that they believed that GM food was available in Swedish stores today. Fruit was the food item that the participants believed was the most common and most available in Swedish stores but even berries and vegetables were mentioned amongst the participants. Similar results were shown when the participants were asked if they think they consume products that have been genetically modified or contain traces of it in Sweden. Except for P5 and P8, every other person in this study believed that that already consumed GM products in Sweden. R8 just included ecological alternatives, which she knew was GM-free, in her diet and P5 knew that no GM food was available for human consumption in Sweden. Furthermore, even though 6 out of 8 people in this study thought that they already consumed GM food there still was a factor of uncertainty for some of the participants e.g. P2 said: *"...I am unsure if GM products have to be labeled in a certain way. This makes me unsure about if I do eat GM products, but I will still say I do eat products that are genetically modified or other products that contain traces of it".*

There was also an example of no uncertainty regarding this question, e.g. claimed P4 that *"...yes, I believe I eat GM products, most products are genetically modified today"*

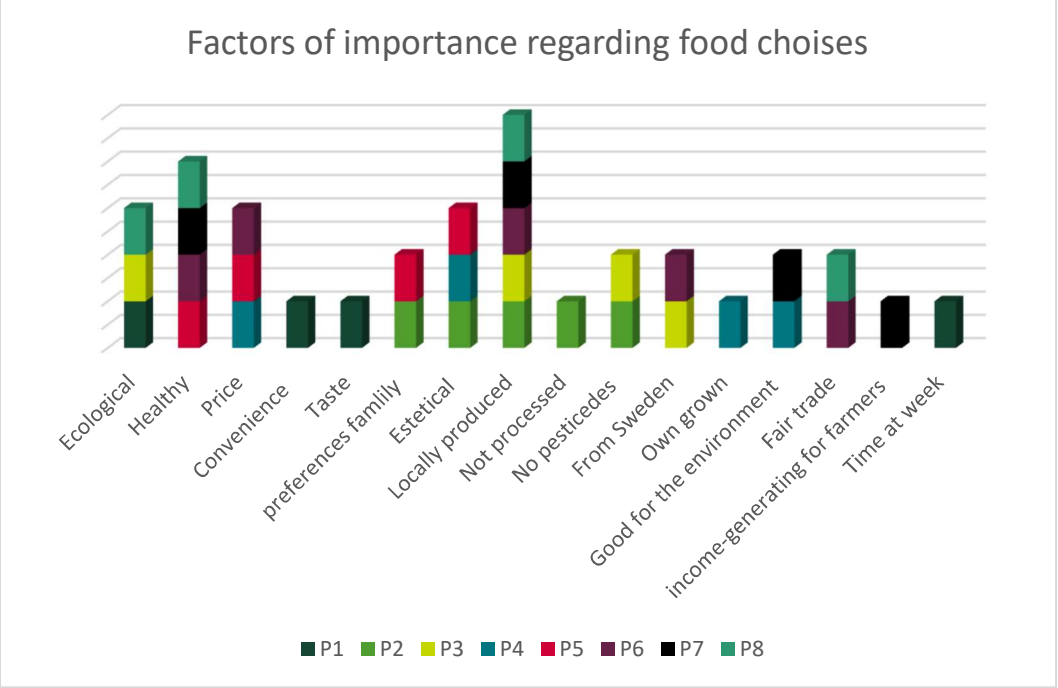
In the interview's discussions regarding GM fodder to cattle were discussed as a siding to some of the questions. Were the participants understood that products from these cattle, such as meat or milk, could be consumed.

5.1.2. Consumption

When participants were asked what was of importance when they bought food in general, it turned out that local food production, health, organic, price and

aesthetical qualities were the most mentioned qualities (see figure 1 for a complete compilation).

Table 3: Factors of most importance when choosing food amongst the participants.



When associations towards the concept of GMO was raised overall, the concept of GMO was perceived as negative by the participants. Five out of eight participants meant that the concept GMO was associate with what was described as a bad tone or something unnatural, which according to the persons interviewed, was a negative thing. P3 stated: *"I think it's sad that we need this. I think it will bring something bad with it. This technology will disturb the natural order in nature, we are upsetting the natural balance." (P3).*

Another participant (P2) expressed that the initial thoughts and associations with the concept of GMO were that the technology was a way to cheat and that pictures of Belgian blue came to his mind. However, after further considerations he thought that it might be some beneficial consequences with the technology e.g. more sustainable food production. P1 expressed e.g. that he would definitely choose "natural" products over GM food. P8 said that mother nature beats everything, and that we should be careful with what we are experimenting with. Three participants (P4 & P5, in addition to P2) expressed a positive attitude towards the GM-technology. P4 stated that GMO´s are just a development of existing products, which he was positively set to. The following statement additionally illustrates a more positive attitude: *"GMO sound to me as an advancement in technology to produce food, it is more convenient to grow, less exposed to diseases and insects*

and could give maximum yield which in turn is economical beneficial for producers." (P5).

A compilation of attitudes is presented in Table 4. One participant, P7, had limited knowledge of the concept GMO and said that the association was neither positive or negative, more relatively neutral.

Table 4:Associations to GMO

Participant	Positive	Negative	Neutral
P1		X	
P2	X		
P3		X	
P4	X		
P5	X		
P6		X	
P7			X
P8		X	

When the participants were asked how they would feel about eating GM horticultural products, the outcome was mixed. Two participants (P4 & P5) would, without hesitation consume GM products such as fruit, vegetables or berries. They believed that these products, most certain, are beneficial both from an environmental perspective and for their own health. Three of the participants P1, P3 and P8 strongly dissociate themself from GM products. The argument behind these statements was that these products could lead to health issues (P1), these products may not be god for us humans (P3) and that it feels unsafe (P8). The last three participants P2, P6 and P7 were more unsure about their decision. P2 stated that, as long as it sustainable from many perspectives and that the finished products are better than before, e.g. more nutritious, consumption of GM horticultural food could be an option. P6 expressed a preference for "natural" products before GM products such as big blueberries, (which P6 believed to be of GM-origin). However, P6 didn't refuse to consume such products if he e.g. was offered such food at a dinner o similar. P7 could consider to consume GM horticultural products but only after some research on google to investigate if it was safe to consume or not.

Table 5:Attitude towards eating GM horticultural food

Participant	Positive	Negative	Unsure
P1		X	
P2			X
P3		X	

P4	X		
P5	X		
P6			X
P7			X
P8		X	

A majority of the expressed associations of health in relation to eating fruit berries or vegetables that have been genetically modified were negative. Examples ranged from statements such as: GM food has bad consequences for the health and that it is poisonous (P1) and that consuming GM food, such as fruit vegetables and berries, on regular basis would lead to diseases (P3). P6 wasn't sure about any consequences but that it might be worse to eat GM products than regular food. P8 said that consuming GM horticultural food felt unsafe due to the fact that GM crops can kill insects and was unsure if that will lead to human health hazards as well. P2 didn't think health was affected negatively by consuming GM horticultural product and said that it might even be better for the health due to better nutritional content and was willing to buy such products. P4 also had a positive attitude towards these products. He thought GM horticultural crops might be less harmful to human bodies due to less use of pesticides. P5 didn't think that GM horticultural food was hazardous and wasn't concerned to consume such products. P7 thought that these products might have a positive effect on human health because of higher nutritional content.

Table 6: Perception how GM horticultural food affect human health

Participant	Positive	Negative	Unsure
P1		X	
P2	X		
P3		X	
P4	X		
P5	X		
P6		X	
P7	X		
P8		X	

5.1.3. Trust and authorities

When the participants were asked if they trusted governmental bodies that regulate GM food in the EU, the overall assessment was that the general trust towards these bodies was low. P1 explained; *"I never trust governance bodies blindly, I want to check it up my self" (P1).* Further described: *"I want to believe that this is handled*

correctly by agencies and governmental bodies, but I am unsure, I think there are some cheating involved too." (P3).

Additional statements suggest that the general trust against governmental bodies was low, so to trust agencies that regulate GM food was very uncertain (P4). Mistrust to financial motives was also raised suggesting that, money probably controls most decisions which may cause some sort of cheating in the system regarding the regulation of GM food. Several respondents explained that they generally had a high trust towards regulations bodies regarding GM food in Sweden.

The majority, 7 out of 8, participants were positive to GM technology regulation and thought the technology could be misused and applied on both humans and animals if there were no regulations at all: *"It's difficult to anticipate the full effect of this scenario, but if there were no regulations, the technology could be misused and be applied on animal or cause an overproduction of food." (P6).*

P5 had a positive attitude to regulations too and said that he believed that the end products, of GM food will be better than conventional products, and the food production will be more sustainable than it is today if there were less regulations towards GM food. But at the same time, the natural landscape will suffer negative consequences that's why regulations regarding these techniques are positive.

One of the participants, P7, believed that there was no concern if these technologies were unregulated. She stated that, if there was no regulation, society will just keep enhancing crops but on a bigger scale. The technology will probably not be misused.

5.1.4. Production and future

Since a majority of the participants didn't know the difference between GM food and traditionally used plant breeding methods this section included a part describing the method. This was done to clear out and distinguish concepts from each other which was seen as necessary to obtain more clear answers regarding the content of the included questions in this section.

All participants believed that gene technology could increase food production in Sweden. However, the were mixed answered whether the consequences by adopting the technology were positive or negative*: "I think there will be an increase in food production but it will be at the expense of nature" (P1).*

When P1 was asked in which way nature will be affected arguments related to statements such as "*everything has its price*" and "*if you produce more it will cost more*", meaning that such a development will be at the expense of something else and that the products enhanced by GM technology will cause environmental damage.. Participants additionally stated that the consequences by adopting gene technology into Swedish food production would be positive but only if it was regulated in a right manner (P2). Otherwise, the technology was expected to possibly be misused which could lead to negative consequences. Concern for the consumer was raised by several interviewees and that an increase in food production, through gene technology, would be at the expense of consumers. Arguments were raised that more available GM food will cause more health issues to those individuals that consume such products*: "I think gene technology will have a huge impact of food production in Sweden in the future. I believe that the food production will be even more industrialized and we will see much more indoor farming such as e.g. vertical farming and hydroponic farming, which in turn will have beneficial consequences as more locally produced food and food with less treatment with pesticides" (P4).*

Positive outcomes of applying gene technology in a Swedish context were e.g. increased production rate and increase in tolerance levels towards environmental variations. It should however be noted that these aspects were mainly raised by an interviewee with an above level of GM-knowledge (P5).
P5 also expressed that the increased resistance towards environmental changes in crops was only one of many advantages by adopting gene technologies such as e.g. the CRISPR/Cas system and that larger yield and more sustainable food production were other reasons. Additional positive outcomes were an increase in Swedish food production and that these new gene modified products will outcompete natural products due to the cheaper price that also will come with more GM food, which according to the respondent (P6), was a negative aspect of this scenario. Respondents expected an increase in Swedish GM-food production and that such a development could result in positive consequences for the climate and the environment: *"It might lead to an increased food production because of the reduced impact of insects that causing food losses. Still, I don't think that this increase asset in food will reach out to those who need it most such as poor and starving people*" *(P8).*

When the participants were asked how they thought gene modified horticultural products may could affect the climate and the environment, the answers were many times quite similar as the previous question as the discussion often was about what consequences these technologies might have on the environment. However, some of the participants gave a more detailed picture about how they believed a future

could look like if these technologies were fully adopted. Environmental and climate benefits were raised, but these benefits were often overshadowed by expected negative effects of nature and a fear of mankind affecting nature. Contradictory interviewees additionally claimed that the usage of GM crops in horticultural food production is probably more environmentally friendly than conventional methods. Even though respondents expressed a positive hope that these technologies will have long-term positive effects for the environment and climate some respondents still felt very doubtful. Doubt seemed to be driven by fear of these technologies and that it might lead to something indefinably bad, leading to an overall negative attitude towards the usage of gene technology. Several respondents report on what appears to be an inherent duality in attitudes to gene technology manifested in an opinion that include both positive and negative consequences by adopting gene modified horticultural products in Sweden. GM food production was claimed to result in a more sustainable way to grow fruit vegetables and berries due to reasons such as reduced irrigation, less use of pesticides and that the procedure will be more land efficient. Respondents additionally link gene technology to indoor cultivation, expressing that: *"by adopting this technology more of the horticultural food production will be indoor farming as well". (P4).* Additional negative effects of such a change were expected to be destruction of natural habitat for e.g. insects due to greater resistance in the crops, and that the natural landscape will be transformed. When P5 was asked the same question, he pointed out the CRISPR/Cas system as the gene technology that might have the future prospects to affect the environment in a positive direction. If the technology was fully adopted, there will be many advantages, e.g. reduced emissions connected to the global food production due to less use of fertilizers, reduced food losses and less ecosystem damaging agriculture compared with todays´ agriculture. Fear was also raised that the genetically modified crops would outcompete natural plants in nature in the long run. It was additionally argued that the discussion of today will fade out and that GM food will be a normal part of future human food consumption, mainly due to positive effects on the environment and climate.

When reflecting on differences in GM-regulation, between e.g. the EU and the US, differences were perceived as unfair and denying Swedish consumers access to such products. The present situation was expected to lead to unfair and unhealthy competition. Increased regulations in countries outside the EU were requested and seen as a solution to differences, as well as an international harmonization, in line with the European regulations. An increase in import of GM food, in the long run, due to price differences, with GM product was also expected, mainly due to less expensive GM products, compared to conventional. It was also suggested that European agricultural businesses will be outcompeted causing major regional problems, which in turn will force the EU to follow countries that are producing

GM food. Participants also believed that the EU would have a hard time withstanding pressure that will follow when more and more countries accept GM food: *"the EU will adapt sooner or later in order to compete or they will be lacking behind which will be a big disadvantage for the EU" (P5).*
Arguments for the opposite opinion, continuing not to allow GM in Sweden and not follow the development in e.g. the US, were also identified. Such a direction was seen as a consequence of the consumer's power and responsibility to buy natural products.

Discussions regarding knowledge level and perception of GM food revealed an uncertainty about whether the personal attitude would be different with increased knowledge. It appeared as if the present attitude (positive or negative) was stable. An answer by P3 exemplifies this: *"nobody knows the long-term consequences by these techniques. Scientists have been shown incorrectly millions of times before. Everything should have a natural order in nature and nature will regulate the asses of the food itself." (P3).* And: *" yes, it's good then you know more. But I think I will have a more negative picture of GM food".* (P7)

However, a few respondents did also believe that more knowledge could have a positive effect on individual attitudes and increase the support for decisions in favor of GM food.

When asked if they wanted to learn more about GM technology, all of the participants said yes. The two youngest participants were critical about why the school didn't teach these subjects because they thought it was of great importance. This knowledge was regarded as to be of major importance in the future. Additional activities concerned an increase in public debates, with an invited expert on the topic. And that addressing different opinions about the technology, positive or negative, would be a good way to obtain knowledge.

The two last questions in this section aimed towards the CRISPR/Cas technology and where the goal was to see if the perception about CRISPS/Cas technology were any different from a traditionally used method such as radiation and chemical methods.
The first question included whether or not they should be as strictly regulated as.
When exploring differences in attitudes towards CRISPR/Cas technology and conventional GMO technologies suggestions emerged to regulated these techniques differently: *"yes absolutely. In the wrong hands, this technology could have catastrophic consequences on the planet. And it might even be regulated more strictly than conventional methods." (P3)*

Regulation was seen as necessary due to concern of hos and to what the technique could be applied. Concern was related to ethical questions and fear of how the technology might be used on animals or even humans, as well as concern regarding class. The discussion created anxiety that more affluent countries and population groups could have access to this technology, in an initial phase, which could lead to a tremendous advantage over poor people. It was argued that due to the novelty of the technology strict regulation was seen as necessary, in line with conventional methods: *" Yes, it might be equally regulated because the technologies are at the same level."(P7)*
Mainly since the long-term consequences of this technology are unknown. It was argued that less strict regulations with the CRISPR/Cas system could lead to a misuse of the technology.

When asked about willingness to eat a food item that was enhanced with CRISPR/Cas technology participants statements reflect a great diversity. To some, more knowledge was necessary prior to making such a decision, others were very positive and others more cautiously positive. A difference between GM technology and CRISPR/Cas technology was also reflected: *"even though I am quite unoptimistic about GMO´s I could eat products that were enhanced with CRISPR/Cas technology" (P8).*

5.2. Main findings

Following are the main findings regarding the interviews in this study:

- There was not a clear link to the education level and position regarding GM food.
- The youngest and the oldest participants in this study seem to have a more negative attitude towards the concept of GM food.
- Negative associations are mainly due to fear of negative environmental impact, health hazards, and that it is unnatural.
- Positive associations are mainly due to a believed more sustainable food production which is more environmentally friendly and overall healthier products.
- Women seem to have a more negative perception towards the concept GM food.
- A majority of the participants already thought they consumed GM horticultural products.

- Perceived understanding of GM or GE technologies seems to correlate with a positive picture regarding associated products.
- The GE technology, seemed to be more accepted than traditionally GMO´s regarding horticultural food production

6. Discussion

This study aimed to investigate the perception of GM and GE food, with a particular focus regarding GM food and what underlying causes there are to these statements. Throughout this study, new insights and understanding of positions regarding these technologies were obtained. Even though a relatively small number of participants, which not represent the society, were included in this study, valuable information in view of the perception of GM and GE edible horticultural products was gathered. The variety of backgrounds amongst the participants considering age, gender, and education level might be the reason for the widespread attitude towards these products. There were some notable similarities between the individuals in this study but no overall unity. Since the aim was to investigate the perception of GM and GE food, many different opinions, statements, and underlying thoughts contributed positively to this study. However, to understand not only the attitude towards these products more qualitative studies in the area might be beneficial to understand a more general perception towards edible GM and GE horticultural products. Which suggests more research in the area.

6.1. The complexity and differences in attitudes

The overall results show that to map perception towards GM food is very complex. All participants in this study have their own picture of these technologies and how it will affect their health or the environment. A relatively high knowledge level in the area seems to result in a more positive view of the technologies. However, it seems that the actual knowledge level does not always represent reality. Almost all participants think they consumed GM food already today. Another misjudgment was that technologies were mixed with each other. Several participants mentioned words such as cut and paste when they described GMO´s which again point at perceived knowledge rather than actual knowledge regarding these technologies. Klerck and Sweeney (2007) are also pointing at the effect of objecting knowledge about GM food, where they saw a connection between reduced believed psychological risks and objective knowledge about the underlying technology. They also found that subjective knowledge impacted physical risk perception. Notable was also that, depending on what type of risk type, affect the willingness to search for information and also willingness to buy such products (Klerck & 6.

Discussion 38 Sweeney, 2007). This might point out the importance to educate within this area, especially in a possible future with increased production of GM or GE enhance food products. All participants in this study want to learn more about these technologies, partly because they believe in a future with more GM food. Many participants also think that the pressure on EU´s regulations bodies will be too high, which will lead to an adoption of GM food in Europe to, which in turn are an initiative to obtain more knowledge within the area. Two of the interviewed persons think that education, regarding technologies that enhance food, such as GM or GE, should be thought in school. They believe that the topic is of that importance and was inline and included with other important questions such as environmental questions and sustainability questions. Other participants think that debates, were representative from both sides, were arguing the pros and cons regarding GM technologies would be a good approach to take a position regarding whether to consume GM food or not. In a future where more GM food might be available, more general knowledge about GM food might be beneficial, for a population, for either favor or impede the development of GM food adoption. Since the majority believes in GM food availability and own consumption of such products today, labeling of GM content might be a good idea to implement already today. This might also affect trust against regulations authorities if everything included in the product are reported. Furthermore, if processed products contain less than 0.9% GM content there is no obligation to label that information. This may point at the consumer already actually eating GMO´s. This can possibly increase a possible mistrust against regulation authorizes. The fact that some consumers might consume secondary products that could be affected by GMO´s such as egg or milk, by cattle that consume GM fodder, without consumers knowing about it, may also cause tensions in this question. This may in turn affect the credibility of authorities. All participants favored the idea that responsible authorities should provide more information in the area, which could be a good way to reduce uncertainty and tensions regarding the subject. Considering age, it seemed that the oldest and the youngest participants had a more negative picture about the concept of GM food, and those participants between 34y and 42y had a more positive attitude towards the concept. One cause of this scenario might due to different media sources, where older participants prefer traditional media, where Kim et al., (2015) claims that coverage by such media often contains a high level of skeptics towards GM technologies. The youngest participants may be influenced by media where, according to, Geall & Ely, (2019) may affect the perception of GM food in a negative direction. In addition, in this study, the youngest participants seem to not have heard about the technologies that much, suggesting that the uncertainty might lead to a more restrictive attitude. Uncertainty in position and in decision-making often tends to affect the decisionmaker in a more restrictive direction. However, to increase the amount of knowledge in the 39 particular area have a reduced effect

on the level of uncertainty, which in turn makes it easier to take a position (Achrol & Stern, 1988).

It also seems that gender plays a role regarding attitude towards GM technology. No female participant had a clear positive attitude towards the concept of GMO. Bray & Ankeny (2017), described that, traditionally women had the overall control regarding the purchase of food in households and due to that, had a higher restriction towards potentially, believed hazardous products. This might be one of the explanations or reasons for the higher grade of resistance. Why male was more positive in their approach which might be due to the fact that men are more willing to take risks in general (Harris & Jenkins, 2006). However, there are most certainly more factors that can contribute to these statements. In view of food choices, it seems that those who are most positive to GM technologies in food production, values attributes such as locally produced, esthetically, no use of pest decides when deciding amongst horticultural products and other food items. This could be pointing out the importance of sustainable aspects of GM and GE food production where e.g. less pesticides might be needed due to these technologies. There are also aspects of health where these people might think that GM food might be healthier because of a possible higher nutritional level and the reduction of pesticides. On the other hand, those who had a more negative picture of these technologies also valued factors such as environmentally friendly food production and locally produced food and in addition ecological products.

This suggests that there are similar factors that are of importance considering food choices for both those who favored these technologies and those who didn´t, which indicates that GMOs are valued widely differently and the effects due to these technologies. In view of the future production of horticultural products, the majority of the participants believed in an increased number of GM or GE food. They had different thoughts of this possible future scenario but since other countries and regions already have adapted these technologies the overall assumption was that the EU will follow due to an uneven competition. To obtain a future sustainable food production a shift from conventional farming might be necessary, where adoption of GM or GE technology might be one part to solve this question (Azadi et al., 2015; Gao, 2018). On the other hand, it might also lead to a constant flow of food for every region in the world which might allow the human population to increase to even higher numbers, which in turn might be devastating for the environment. However, another argument could be that the populations stabilize with the reduction of stress that is caused by the absence of food security. This is seen in many other structures in nature in e.g. when certain types of plants tend to grow more and also other animal populations when are exposed to stress (Ahmad et al., 2019; Barnawal et al., 2019; Koyro & Huchzermeyer, 2018; Mustaparta &

40 Stranden, 2005). However, if there are no available nutrients to allow the population to grow this will most certainly limit a population to further expand. It seems that the GE technology, CRISPR/Cas, were more accepted than GM technologies. This might due to the design of the question where it was explained how the technology worked and what the advantages might be. There were no pronounced disadvantages regarding this technology which as mentioned could be a factor for the response regarding CRISPR/ Cas technology. However, since the technology is in its infancy there are no long-term effects studies regarding horticulture or agriculture production systems. Regarding the long-term effect of adopting these technologies, there is little understanding of the negative effects of adopting large scale GE enhanced crops. There might be a possibility that this will bring even more damage to e.g. diversity both for plants and animals. It seems that many factors are contributing to the perceived perception of GM technologies. Factors such as age, gender, and education level may all have an impact on the perception of GM food. There are so many layers that could affect the perception regarding these technologies. The largest argument against GM food seems to be that this is an unnatural way to produce food and that we are disturbing the natural balance in nature, but today's crops for mass production such as e.g. corn or apples have already been a target for plant breeding or other human interference for a very long time (Beadle, 1980; Cornille et al., 2014; Pereira-Lorenzo et al., 2012). Maybe these early strategies for developing more wanted products in the horticulture sector is unheard of for many people or are not considered as a natural product. However, products such as e.g. conventional apples that could be bought in stores today would most certainly not exist without human interference. Which, in turn, could be seen as unnatural. Maybe new technologies such as CRISPR/Cas is one way to preserve the natural, nature. Conventional farming even if its ecological may also be seen as unnatural, monoculture is something that has never existed before human interaction (Andow, 1983; Michaels, 2011). To strive towards more sustainable agriculture and horticulture, these unnatural technologies may be necessary. Other factors that could affect the perception could be socio-economic factors, geographic and psychosocial, but were not covered in this study. Maybe information regarding such factors could bring more information and even more understanding of certain statements. However, the overall obtained information gathered in this study was very useful to understand underlying causes to position-taking concerning GM and GE food. Though, there is a chance that gathered information could be misunderstood and that key statements, and underlying thoughts that are reported in this study might be insignificant for the participant. There is also a chance that the number of participants is too small to draw any conclusions from.

6.2. Education level

Education level did not seem to have a big impact on the perception of GM food amongst the participants. It was rather the knowledge level, in the area of GM technologies, amongst the participants that affected the perception. There was a link between an understanding of GM technology and leaning towards a positive attitude toward GM food. It seemed that uncertainty was a key factor for a negative attitude towards these technologies. However, the willingness to learn more about these technologies was high, and almost all participants wanted to learn more in the area of GM food. This might lead to a generally higher acceptance of GM food or at least easier to take a position. Still, other studies e.g. from McCarthy et al., (2016), identified a connection between low education level and a more negative attitude regarding GM food. Though, the study didn't pick up the participants' knowledge level regarding GM food amongst the participants which might be an important factor for acceptance of GM technologies or take a position. There was a relatively large spread of experienced knowledge levels amongst the participants and the experienced knowledge level didn't always represent the reality. E.g. all participant except one, thought that GM food was available consumed already today. This might suggest that there is already a labeling demand for GM products and conventional products to reduce uncertainty and confusion regarding GM products and conventional products.

6.3. Age

It seemed that the youngest and the oldest participants had a slightly less positive view on GM food. That a higher age also was associated with a generally more negative picture were also supported by McCarthy et al., (2016). Media´s role was discussed by Kim et al., (2015) which might indicate that different age groups receive information from different media sources and that could affect the perception regarding e.g. GM food. The concept of "Gatekeepers" are described by Inghelbrecht et al., (2015), these gatekeepers may also have an affect public perception, by highlight more conventional products, which may have a different impact depending on age and source of information. However, all participants, no matter age was willing to know more about GM technologies. The CRISPR/Cas technologies seemed to be more accepted than previous technologies and all participants were willing to try such products.

Table 7:Accosiation to the concept of GMO by age

Age	Positive	Negative	Neutral
21			X
24		X	

34		X	
35	X		
36	X		
42	X		
44		X	
61		X	

6.4. Gender

There were some differences amongst the participants regarding gender. None of the females answered that they were positive set to the concept of GMO. 2 female participants were negatively set and one female had a neutral view. According to Bray & Ankeny (2017), women tend to function as gatekeepers regarding grocery shopping and traditionally have been seen as those with great power of the available food for households, which might lead to more cation when adopting new products. Considering the male participants, 3 out of 5 had a positive attitude towards the concept of GMO. Why men seem to have a higher acceptance towards GMO´s may due to their willingness to take more risks (Harris & Jenkins, 2006), or that the men included in this study had a perceived understanding towards the concept of GMO´s. Again, participants, no matter gender, consider trying products that been enhanced with the relatively new gene editing technology, CRISPR/Cas.

6.5. Further connections to existing literature

The literature point to the importance of public perception regarding accepting new technologies, and how public perception often affects political decisions. To receive public acceptance, education regarding the subject may be a way forward or at least take a position based on fact instead of beliefs. This might be of big concern when in a possible future have to deal with questions to implement GM food in Europe or not. Geall & Ely, (2019) also mention the complexity of a socio-technical shift which includes many factors such as, e.g. cultural or political which, most certain, also is affected by the perception of a particular socio-technical shift. The general perception about GM food may therefore have a huge impact on future regulations which points to the importance of understanding the public perception considering GM food. Geall & Ely, (2019) also found that greater technical understanding of a technology increased the acceptance of that technology. This is in line with the finding in this study, where an estimated higher understanding regarding GM technology also correlated with acceptance of products that were enhanced with such technology. Another compatible result, where that education level doesn't have a clear link to a more positive view of biotechnology, rather particular

knowledge and understanding of a technology, as earlier mentioned. Furthermore, 43 the perception that GM food may be beneficial for farmers financially that was observed by Geall & Ely, (2019) was also observed in this study. The statement that GM food was hazardous was one reason to reject such products for the respondents according to Geall & Ely (2019), which was a common thought to participants that rejected GM food in this study too. Distrust against authorities correlated with a more negative attitude towards GM food according to Geall & Ely (2019), which wasn't observed in this study. However, there were participants that didn't have trust against such bodies, and a study with more respondent's similar observation might be found. Regarding labeling information, Zhan et al., (2020) saw a connection between detailed labeling information reduced risk perception. In this study, almost all participants thought they already consuming GM horticultural products, which suggests that labeling of GM continent may already be of usage in Sweden even if such products don't exist at the moment. However, the participants consumed, what they believed were GM food, points to the fact that there is already an acceptance of GM horticultural products in Sweden to a certain degree. Yet, this might bring discomfort to the consumer, which again points out the benefits of more labeling information about GM content or more education provided to the public. Inghelbrecht et al., (2015) claimed that gatekeepers, such as larges retailers, promote GM-free products in the belief that is customer demand. This strategy may also affect public perception and create more resistance to these products. Many of the participants in this study believed that the EU soon will fall for the pressure that is caused by other regions or countries that are adopting GM and GE technologies. Some also claimed that if the EU doesn't follow, import of these products will sooner or later reach the EU market. If this is the future scenario these gatekeepers may fall behind due to late adoption. Bray & Ankeny (2017) claimed that according to previous studies the perception differs pursuant to gender, which again was found in this study, where, women seem to have a more negative perception towards GM technology and GM horticultural products. However, Bray & Ankeny (2017) also concluded that understanding of biotechnology increased the accepting and favored the attitude towards GM food which also was observed in this study. Kim et al. (2015) emphasize the importance of the media's role to affect the public perception of GM technology. Kim et al. (2015) also mean that there is a clear difference regarding coverage by general journalists and science journalists, where traditional media many times lacks understanding of biotechnology, which in turn usually means negative coverage regarding GM food. This lack of knowledge could lead to uncertainty, which is discussed earlier in this study, could initiate a more restrictive approach. To raise public acceptance concerning the adoption of GM food, education through authorities of GM technologies was claimed to be of most importance (Kim et al., 2015). In this study, the willingness to learn more was observed by all participants. The perceived understanding of technology was shown

to increase the rate of positiveness towards GM food, which is in line with the study 44 by Kim et al. (2015). McCarthy et al. (2016), found an, overall, large rejection of GM food, where such products were associated with health hazards. The majority of this study also related the concept of GM food with something negatively, where some participants claimed that it was a charged word and thoughts as taboo. There were also other similarities Kim et al. (2015), saw a pattern where the group who consistently bought and consumed sustainable and healthy food, had a more negative perception in view of GM food. The main reason was the possibility of health hazards that also was observed in this study.

6.6. Discussion method

6.6.1. Interviews

Theparticipants included in this study were interviewed for one hour with a semi structured approach. Due to that approach, every question could potentially lead to a discussion, which, in this case, lead to more understanding about the perception of GM and GE food. This was a good structure to obtain useful information. This means that information gathered by interviews may identify underlying thoughts causes to statements a greater extent than a quantitative approach were the findings usually are based on surveys. Furthermore, one hour of gathered information brought much information but was of great use to understand the participants' view of GM food. However, because of the amount of information that was gathered, identification of the most useful or important statements was a challenge. By reason of this, there was a chance of misunderstanding. On the other hand, every interview was recorded so that obtained data could be played again to minimize the risk of misunderstanding. The recording itself might cause a feeling of discomfort for the participants which might affect their statements, but it was a necessary tool to reproduce collected information in a way that minimizes the risk of misunderstandings. Furthermore, the way of recruiting participants, by using social media, may attract those who have a strong argument, either for or against these technologies. Another approach, that could be a good alternative is random selection e.g. asking people outside of stores. This might be a more neutral tactic which could be beneficial in an interview situation. When selecting between participants they were sorted due to age, gender, and education level, to obtain diversity amongst the respondents. This was assumably a strong causing factor the diversity in the perception of GM food. This seemed to be a good strategy to understand a diversity of underlying causes to a certain perception of GM food.

However, if these underlying causes or thoughts represent the societies view of these technologies are uncertain and more studies have to be done in the area.

7. Conclusion

The perception of GM food widely differed amongst the participants. However, both sides, those who were for and against the technology, want to achieve a more sustainable food production but had a different opinion if GM food will contribute to that or not. There was not a clear connection between preferable food choices and regarding their position towards GM food. Though, the youngest and the oldest participants in this study seem to have more resistance towards GM food. There was also a connection between perceived knowledge regarding GM technology and a more positive attitude towards GM horticultural products. Yet, perceived knowledge didn't always represent the reality. The women in this study seem to be less positive to GM food compared with the male participants. GE technology, CRISPR/Cas, tends to be potentially more acceptable than conventional GM food. They were many factors that contributed to different statements and points at the complexity regarding this question. The most decisive factor to take a position regarding this question seems to be knowledge regarding GM or GE technology, there was also a common interest to obtain more knowledge within these areas. The general perception regarding GM food may have a huge impact on future regulations which points to the importance of understanding the public perception considering GM food.

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