THE RELATIONSHIP OF EFFICIENCY AND SUSTAINABILITY IN AGROFOOD: SOILLESS AGRICULTURE

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To my dear family and especially to my lovely mom Berrin.

ABSTRACT

Due to the rising global population and potential food shortages, ecological, sustainable and efficient alternative production methods are becoming potential solutions. The soilless farming is advocated for increasing efficiency through the technological advancements and highlighting its sustainable features. This production method stands out due to characteristics such as water efficiency, energy savings, human control, and shortened harvest periods. This thesis aims to understand the concepts of sustainability and efficiency, which are cited as the reasons for the preference of soilless agriculture, and to analyze the relationship between these two concepts. In this context, the views of Haraway, particularly the concept of "cyborgization," will shape the framework of the study, and the feasibility of the future envisioned by Haraway through soilless farming will be examined. In line with this, a netnographic approach was employed to examine the internet pages of fourteen soilless farming producers worldwide, who were selected using a snowball sampling method. Field notes from the examinations were used for coding, and numerical data derived from these codes were analyzed. It was determined that the primary reason for the preference of soilless agriculture is profitability, and the relationship between sustainability and efficiency is mainly intertwined from an economic perspective. Notably, solutions predominantly target production systems while sidelining distribution and consumption processes, raising queries about resultant power dynamics. In conclusion, with the influence of technology, there has been a distance from Haraway's vision of a cyborg, equal, just, and classless world, and that the existing economic system has exacerbated inequalities.

ÖZET

Küresel nüfusun hızla arttığı ve gıda ihtiyacının karşılanamayacağı öngörüsü ile, ekolojik, sürdürülebilir ve verimli olduğu söylenen alternatif üretim yöntemleri çözüm olarak ön plana çıkmaktadır. Bu yöntemlerden biri üretiminde teknolojik gelişmelere yer vererek verimliliği arttırdığı savunulan ve sürdürülebilir özellikleri ön plana çıkarılan topraksız tarımdır. Aynı zamanda topraksız tarım su verimliliği, enerji tasarrufu, insan kontrollü olması ve hasat sürelerinin kısalmasını sağlaması gibi özellikleriyle de öne çıkmaktadır. Bu tezin odak noktası topraksız tarımın tercih edilme nedeni olarak gösterilen sürdürülebilirlik ve verimlilik kavramlarının anlaşılması ve bu iki kavram arasındaki ilişkinin çözümlenmesidir. Bu bağlamda Haraway'in görüşleri, özellikle de "cyborg"laşma kavramı çalışmanın çerçevesini oluşturacak ve oluşturulan tartışma alanında Haraway tarafından tasavvur edilen geleceğin topraksız tarım üzerinden mümkün olup olmadığı sorgulanacaktır. Bu doğrultuda netnografiden yararlanılarak kar topu yöntemiyle elde edilen Dünya genelinde on dört adet topraksız tarım yapan üretici ve üreticilere ekipman sağlayan şirketlerin internet siteleri incelenmiştir. Incelemeler sonucunda çıkarılan saha notlarından yararlanılarak kodlama yapılmış, daha sonrasında bu kodlamalardan elde edilen sayısal veriler analiz edilmiştir. Çalışmanın sonucunda, topraksız tarımın tercih edilme sebebinin öncelikle karlılık olduğu ve sürdürülebilirlik ile verimlilik arasındaki ilişkinin daha çok ekonomik bir perspektiften birbirine bağlandığı tespit edilmiştir. Bu noktada çözüm için geliştirilen yöntemler konuşulurken, problem olarak üretim sistemine odaklanıldığı ve dağıtım ve tüketim gibi diğer alanlardan özellikle uzaklaşılmak istendiği sonucuna varılmıştır. Aynı zamanda üretilen çözümle beraber değişen ya da derinleşen güç ilişkileri sorgulanmıştır. Tam da bu sebeplerle Haraway'in cyborg, eşit, adil ve sınıfsız dünyasından teknolojinin etkisiyle beraber uzaklaşıldığı ve mevcut ekonomik sistemin yarattığı eşitsizliklerin daha da derinleştiği sonucuna varılmıştır.

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CHAPTER 1

INTRODUCTION

The other day, I found myself in front of the television, watched in Netflix's "Beyond the Sea" episode from the Black Mirror series, featuring Aaron Paul. The subject matter immediately captured my attention, especially given my recent involvement in this field. In the episode, two astronauts stay aboard a spacecraft for an extended period as part of a mission. Thanks to replicas created while they are on Earth, the characters frequently visit the planet to continue their daily lives. They continue to spend their time with loved ones and do their daily works like cutting woods or having breakfast. Simultaneously, in the spacecraft, their body are attached to machines to make this connection. With a tremendous contribution from technology, these human replicas coexist on Earth just like regular people, seamlessly integrating into their own realities. Of course, there was also a group within society that opposed these replicas, uncomfortable with the intertwined coexistence, fearing that this unity might harm humanity and disrupt the balance. A world where technology and humans are intricately interwoven, living together as cyborgs, maintaining their conflicts alongside their coexistence.

In this episode, we also see the astronauts' garden in their spacecraft. While disregarding all sensory pleasures associated with food, its importance for human survival cannot be understated. However, this garden differs from conventional ones; it's a soilless cultivation system. Within the designated area of the spacecraft, both from above and below, plants are cultivated to maximize space utilization, allowing production to take place throughout the entire room. Besides being everywhere in this room, there's the added aspect of it occurring within the confines of a room and

even in space within the spacecraft itself. This production method offers people the opportunity to production without the need for soil, and remarkably, it can be achieved without being tied to Earth's surface. In a segment so intertwined with technology, the depiction of food is also presented in conjunction with technology. Considering the context of being in space, it's apparent that this method holds valid reasons and appropriately matches specific needs.

For Earth, at this point, the appropriateness and alignment of soilless agriculture with the right reasons and needs remain a question mark. With many areas currently dedicated to traditional soil-based farming, there might be potential for enhancing and making these spaces more efficient in terms of sustainability. At this juncture, while I think that soilless agriculture could offer an alternative for production in areas unsuitable for traditional farming, I don't consider it to be a solution to the perceived problem of a growing global population. The fundamental issue isn't primarily a deficiency in production; rather, it's the unequal distribution and allocation of existing resources and produced food. In this context, highlighting the increased efficiency and sustainability of soilless agriculture could potentially only feed certain segments of society, and I think it could exacerbate concepts such as inequality, social injustice, food insecurity, and hunger. In this sense, I think that the sustainability aspect needs to be examined within economic, environmental, and social frameworks.

A world intertwined with technology and a production system where the distinction between technology and humans no longer exists, leading to the elimination of inequality and injustice within this integration. In this intermingled existence, there's no special value or distinction attached to gender or even the

concept of being human. It's a universe where "everything" becomes cyborg. (Haraway, 2016, p. 7). Within this cyborg world, everyone and everything attains the right to live in harmony and justice, a realm where hunger or scarcity ceases to exist. In this alternate reality, there would be no opposition to replicas like we see in the series; rather, the interconnectedness would be embraced by all. In this cyborg world, agriculture heavily involves technologies such as biotechnology, artificial intelligence and automation. Genetic engineering and biotechnology can be used to plants and animals more resilient, nutrious and productive. In this cyborg world, plants and animals interact more closely with humans and technology. Humans and machines collaborate to manage production processes. Vertical farming can only be just one example of this hybridization. Even further, perhaps there would be no need for soilless agriculture either, as other technologies would ensure that the outputs of traditional agriculture are distributed to everyone, achieving a sustainable and efficient soil-based production system while minimizing the environmental costs of production process. This scenario aligns closely with Haraway's vision of a world—a world where equality and fairness prevail, a world of cyborgs. (Haraway, 2016, pp. 8–10). It's what I would imagine to be a reflection of Haraway's concept. With this work, I seek to understand whether Haraway's vision of an equal, just, cyborg world is feasible, and to question this idea through the lens of soilless agriculture technologies and their relationship with sustainability and efficiency.

Soilless agriculture, as an alternative production method, has emerged in response to traditional agriculture, which rapidly depletes nature while trying to meet the growing food needs of the population. Soilless agriculture is a farming method where plant roots are grown in water and other nutrient solutions instead of

traditional soil. This allows plant roots to directly access the necessary nutrients from these solutions. In controlled environments with human-regulated humidity, temperature, and water levels, plants can grow faster and potentially be more productive. Soilless agriculture can be employed in areas where soil quality and productivity are low, in urban spaces, or in regions with limited agricultural land. Additionally, soilborne diseases and pests are less prevalent in soilless agriculture, and water usage can be more efficient. (Yılmaz, 2019, p. 5). What concerns me here is whether this production method, which seems to criticize and marginalize traditional agriculture, is as innocent as it appears. At this point, I wonder if this production method, soilless agriculture, which is supposed to be environmentally friendly, sustainable, and efficient, is truly as sustainable and efficient as we think it is. When we look into the literature, we can assert that soilless agriculture, based on numerical data, is more efficient, environmentally sustainable in terms of conserving natural resources, and can reduce the negative environmental impacts of agricultural production. However, this reality can shift a bit when considering the human factor. This is because human interests and even human existence can sometimes take precedence over nature and the existence of plants.

1.1 Research Question

In my research, I will question the reasons why soilless agriculture is preferred and its relationship with sustainability. I will also explore the connection between sustainability and efficiency in soilless agriculture. Throughout my study, I will contextualize these questions within Haraway's world to establish a theoretical framework. I think these questions are crucial because they help us understand whether the envisioned and designed sustainability and the future built upon soilless

agriculture are feasible or not. They are essential for comprehending the kind of production system, food security, and agriculture that lie ahead for us. Understanding the answers to these questions can shed light on how agriculture might shape itself in the future, what it will be based on, and how it will function. Grasping the reasons behind the preference for soilless agriculture could open a door for us to comprehend the growth potential of this production system and the future it might offer. Given the increasing global population and environmental impacts, understanding the motivations behind the solutions presented to mitigate agriculture's negative effects on the environment and ensure sustainable food security is equally important. I want to understand how much and to what extent this production system that has emerged in response to the need for providing food to a growing population actually serves this purpose. I'm aware that the problem isn't solely about production; it's also intricately tied to the unequal distribution of what's already produced. In this case, I think it's important to recognize who benefits from seeking solutions in production and from which perspectives. From this standpoint, my research, framed within Haraway's ideas, can potentially shed light on how soilless agriculture can be evaluated in social, economic, and environmental contexts, and how this new form of agriculture can present structures for a sustainable future. Understanding how this production system aligns with addressing the demand for food in a growing population is essential. I also acknowledge that the issue involves more than just production; it's about equitable distribution as well. Considering Haraway's concepts, my research can help elucidate how soilless agriculture can be assessed in terms of its social, economic, and environmental implications. This could provide insights

into how this innovative agricultural approach might contribute to a more sustainable future.

1.2 Outline of the Chapters

To investigate this issue, I turned to producers and decided to examine the perspectives of soilless agriculture producers. Although I initially limited my study to Turkey, as I wasn't able to directly reach a sufficient number of producers, I expanded the scope of my research. In this regard, I analyze the statements of companies engaged in soilless agriculture by examining their websites. For this purpose, I selected 14 companies involved in soilless agriculture or producing soilless farming materials from different countries. I did not use any specific method for this selection; rather, I searched for "soilless agriculture" along with the names of the countries on the Google search engine to access these companies' websites. After accessing the websites, I carefully examined them and took field notes based on the content. These field notes will be further analyzed after being coded to draw meaningful insights from the data.

In chapter 2, I examine the existing literature on topics of the research. To understand what soilless agriculture is and how it is perceived, I plan to examine soilless agriculture in two parts: agricultural history and the studies conducted in the field of social sciences. I initially aimed to explore agricultural history that I think is crucial because the reasons behind the existence of agrarian practices, including non-traditional methods like soilless farming, are deeply rooted and formed in these historical contexts. Understanding this historical background enables us to comprehend the reasons, methods, underlying factors and contextual circumstances that have led to the emergence of soilless farming. This historical perspective aids in

unravelling the motivations behind exploring alternatives like soilless agriculture, which might be responses to challenges such as land scarcity, environmental concerns or the need for more efficient resource utilization. Additionally, studying the historical continuum of agriculture provides us to understand the relationship between technological advancements, cultural shifts, and economic forces that have contributed to the adoption of innovative farming methods. Finally, comprehending the historical context empowers us to contextualize soilless agriculture within larger narrative of agricultural process. In the second part of this literature, I analyze studies in the field of social sciences. However, since I couldn't find any research specifically related to soilless agriculture in the social sciences, I focus on studies conducted in the fields of economics and agriculture. Then, I delve into the literature on sustainability and efficiency concepts within the agricultural context. This helps me to understand how these concepts are positioned and defined in the context of agriculture and enable me to establish their definitions within my own study. Finally, I analyze Haraway's cyborg concept and incorporate it into my study. To do so, I examine Haraway's works to gain a deeper understanding of her ideas and integrate them into my research.

Chapter 3 discuss the processes of my research. This includes the timeframes of my study as well as the methods I used to explore the concepts of efficiency and sustainability in the context of soilless agriculture, and how they are employed and positioned within this field. I employ netnography as a method to analyze various aspects of each web page. This analysis includes examining titles, slogans, photos, videos, blog posts, product content, and description texts to gain insights into the marketing strategies and communication styles. Additionally, I investigate page

redirects, preferred colour schemes, and the overall perception they aim to create for the consumers. While conducting netnography as a research method, I engage in observing and analyzing contents and activities on websites as research techniques. By utilizing netnography, I aim to better understand how these web pages engage with their audience and how they portray themselves in the digital space about their perception of sustainability. I elaborate on the methods I employed while questioning the usage and placement of the efficiency and sustainability concepts in soilless agriculture. This involves analyzing the selected websites and explaining the codes I used and their meanings in this context. Furthermore, finally I discuss the limitations that have defined the scope of my study and highlight the frameworks necessary to advance my research.

In chapter 4, I discuss the findings of my research and elaborate on the numerical data that emerged in relation to sustainability and efficiency aspects. I explain the results and how they align with the concepts of sustainability and efficiency in the context of soilless agriculture. I will also discuss how the emerging results could align within Haraway's universe, highlighting where there are parallels while also addressing areas where Haraway might have been mistaken.

Finally, chapter 5 provides a comprehensive summary of my study and discuss the implications of the findings in the existing literature. And also I try to open a gap for further studies about the type of future producers which can be a good and specific point.

CHAPTER 2

LITERATURE

In this section, previous academic studies will be examined, and then Haraway's concepts that form the framework of my study will be explained. The literature review will continue with studies on soilless agriculture, followed by an explanation of the concepts of sustainability and efficiency.

First and foremost, I would like to give information about agricultural history. Providing a general overview of agricultural history will help establish a historical context for the existence and emergence of soilless agriculture. This will facilitate an understanding of why soilless farming emerged as an alternative method of production, including its motivations, processes and significance in historical, social and economic circumstances. Then secondly, studies on soilless agriculture will be examined. It has been observed that these studies mostly focus on the cost of soilless agriculture and economic studies interested in this field. However, in examining these studies, there is no research in the social sciences that examined the social structure and ecological effects of this agricultural production method. As my study focuses on soilless agriculture, I preferred to examine the studies conducted in this field in order to understand what soilless agriculture is and what it aims to achieve, without associating it with other concepts or topics. We can say that soilless agriculture is an alternative production method, which plants can be nourished by taking their nutrients through water or air, unlike from soil, without being exposed to external environmental risks. Generally, it can be stated that this production method can increase production quality and quantity for areas where climate and soil

structure are not suitable. (Tüzel et al., 2019, p. 7). However, there is a lack of an ecological framework in these studies.

Subsequently, I examined studies related to the concepts of sustainability and efficiency. In this context, first, I examined research on agricultural sustainability, followed by research on agricultural efficiency. In order to understand what sustainability and efficiency mean in agricultural dimensions, I examined the studies conducted in this field. According to these studies, sustainability can be considered as a variable concept depending on the time, place, and situation. Generally, we can define sustainability as predicting how long we can produce with existing resources. For agricultural sustainability, we can define it as producing more while feeding more people, and protecting natural resources and the environment at the same time. (Arora, 2018, p. 217). In the field of efficiency, while in some cases it may be perceived as productivity, the broadest definition refers to increasing production while using resources efficiently. Generally, efficiency refers to the ability to do something with the minimum amount of resources or effort, while achieving maximum output or results. On the other hand, in the context of agricultural efficiency, specifically refers to the ability of agricultural producers to use their resources efficiently in order to maximize output or yield. This includes efficient use of land, labor, capital, and other inputs to produce crops. (Ogundari, 2014, p. 690).

Within the theoretical framework of my study, I intend to delve into the complex concepts put forth by Donna Haraway, especially the concept of cyborgization and then also the concepts of situated knowledge, forced life and Plantationocene. Haraway's concepts which have gained the dynamic and profound relationship between technology, identity, human and knowledge, serve as

foundational basis for my research. Through a comprehensive exploration of Haraway's studies, I aim to establish a solid foundation that bridges the realms of theory and practical application. The concept of cyborgization, which includes the fusion of organic and artificial elements, provides a lens through to examine the alternative production method of soilless agriculture. By embracing technology like hydroponics and vertical farming, soilless agriculture embodies the cyborgization between human creativity and innovative agricultural techniques and also blurring the boundaries between producer, consumer, human, robot, woman, man or more like farmer and scientist. As I explore this theoretical terrain, I think that the intersection between Haraway's concepts and the soilless agriculture are both compelling and enlightening.

In the subsequent sections of this study, these concepts will be brought together to facilitate a discussion. Considering all of these reviewed studies, I think that this study can fill an important gap in the social sciences literature. To deepen the study, additional research can be added to this section in the context of agroecology or development studies if desired.

2.1 Agricultural History

In this section, I discuss the history of agriculture worldwide leading up to the present and the advent of soilless agriculture. Initially, I explore the origins of agriculture on a global scale to gain insights into how it first came into existence. Following this, I discuss the motivations behind the emergence of soilless agriculture and its starting point, driven by technological advancements. Lastly, I draw upon my closer familiarity with the agricultural history of Turkey to provide examples. The choice of Turkey's agricultural history is not motivated by any particular reason, but

rather, it is due to my deeper understanding of the local culture and the notable impact of technological developments on the agricultural process and the transformation of farmers in this region. However, for example it is worth noting that the agricultural history of the Netherlands or any other developed country known for its advanced and well-established soilless agriculture practices could have also been chosen for illustrative purposes, as I believe it serves as a prime example of efficient and advanced soilless agriculture practices.

When we consider today's production mechanisms, including agriculture and food, it becomes evident that production constitutes an integral element of an economic system. I notice a certain parallel between the initial emergence of agriculture, Turkey's modernization processes in agriculture, and the discussion of soilless agriculture in this study. From this perspective, soilless agriculture, as a method of production, remains embedded within the same capitalist economic system. I can assert that with the emergence of agriculture, while some individuals focused on agriculture to meet everyone's food needs, others specialized and excelled in different fields. The specialization and advancement of individuals in these areas could contribute to the progress of societies. However, despite being a fundamental necessity, agriculture did not create a high-value production sector. This, in turn, can be attributed to the development of social and economic class distinctions. (Tauger, 2011, p. 1). Simultaneously, we can consider the beginning of humanity's dominion over natural processes and the establishment of control over plants as a result of these developments. Furthermore, we can see that it fulfilled the raw material needs in the industrial sector and laid the foundation for progress.

Moreover, we can identify another parallel in this process, which is the mechanization of agriculture. With the integration of technology into agriculture, the workforce required for agricultural activities may diminish, leading to increased productivity. Although the living standards of those engaged in agriculture have likely improved however, a critical issue arises in that these technological tools do not necessarily belong to the same individuals involved in farming. Consequently, power dynamics are reshaped, and farmers may lose their say over their own production and, at the same time, their economic independence. (Tauger, 2011, p. 102). In this context, I found it pertinent to mention the agricultural transformation process in Turkey during the period when Marshall Aid was provided.

Examining soilless agriculture, which is the focus of my thesis and another phase in this process, I can observe a similar trajectory. The individuals and companies producing technologies for soilless agriculture are not the same as traditional farmers. In this context, similar processes may occur as technological advancements enter agriculture. Production quantities can increase, the number of people needed to work in agriculture can decrease, and power dynamics may shift, potentially leading to the empowerment of specific groups. From these considerations, I think that understanding and highlighting of these agricultural history processes and parallels is essential in recognizing the significance of the current economic system in determining the role of agriculture. Through this study, I aim to comprehend the relationship between soilless agriculture and the concepts of sustainability and efficiency. I also think that the outcome of this discussion can provide guidance on what solutions are presented, what they are not, and what they cannot be in terms of addressing these issues.

2.1.1 Agriculture in World History

The need for sustenance, particularly food, has been an enduring presence wherever humans have inhabited. The origins of agriculture, as we know it, are thought to have emerged initially in the Old World, followed by the New World. This transformative shift began in Asia, subsequently spreading to Africa and Europe, and eventually in America. The transition to agriculture followed the shift to settled living and the advancement of civilizations. In earlier periods, humans sustained themselves through gathering, hunting, and fishing, meeting their plant-based dietary needs with the grains and fruits they gathered. Later on, as the harsh ice ages came to an end and the climate gradually warmed, humans ventured out of their caves, where they had sought refuge from the cold, to live in the open air and began cultivating wild plants that grew naturally in their surroundings. They transitioned from a nomadic lifestyle to a settled one, developing primitive agricultural methods to meet their food needs. The first cultivated crops included grains such as wheat, barley, oats, and rice. Subsequently, a variety of root vegetables like onions and potatoes were also cultivated. (Tauger, 2011, p. 4).

Mesopotamia, in the Middle East, often regarded as the cradle of agriculture and is at the same time one of the earliest settled regions. Although there is no single definitive reason explaining why humans transitioned from hunting and gathering to a sedentary way of life, this shift is commonly associated with the conclusion of the Ice Age and the subsequent growth of the human population. (Tauger, 2011, p. 5). Tauger, in his book, said that “agriculture was the component that made civilization possible”, actually, the existence of agriculture and farming can be considered as the starting point for all the developments that have brought us to where we are today.

Forms of governance, the establishment of states, educational systems, military structures, trade, and all the systems that come with civilization fundamentally rely on the presence of agriculture. Certainly, civilizations also need to have a surplus of food and this surplus freed up a group of individuals from the task of food production, enabling them to develop various specialized roles and skills. (Tauger, 2011, p. 13).

It's evident that the growth of the human population has consistently exerted influence on the natural world and, consequently, agricultural practices. While we historically observed the effects of this population growth during pivotal moments like the transition to agriculture and the shift towards sedentary living, in the contemporary context, we are observing this through technological innovations such as vertical farming or hydroponics.

2.1.2 Vertical Farming

Vertical farms had never been constructed on a commercial scale before 1900s. In 1909, Life Magazine featured an article on vertical farming, while the term 'Hydroponic' was introduced in a science magazine in 1937. Furthermore, emerging evidence suggests the existence of hydroponics in Armenia before 1951. Subsequently, after the conclusion of the Second World War, hydroponic systems gained widespread adoption on a larger scale. (Velmurugan & Vignesh, 2022, p. 14)

Soilless farming techniques, encompassing hydroponics, aeroponics, and related methods, emerged during the mid-20th century, concurrent with the progression of modern agricultural technology and scientific exploration. Originally utilized for laboratory experiments and research objectives for space science, these methodologies were subsequently refined for practical implementation within the

agricultural domain. Soilless farming practices, notably hydroponics and aeroponics, were conceived and gained prominence throughout this era. We have an interesting example of news of lettuce grown in space. According to this news, when the researchers analysed the DNA sequences of the bacteria found in lettuce, they found that the diversity of microorganisms in lettuce grown in both environments was similar. In fact, the nutritional values between the two lettuces were also very similar. Moreover, lettuce grown in space tended to be richer in antioxidant elements such as potassium, sodium, phosphorus, sulphur and zinc. (Ak, n.d., p. 9)

To give specific example for the transformation created by the articulation of technology to agriculture, I picked the example of Turkey's agricultural history by focusing technological investments.

2.1.3 The Example of Turkey's Agricultural History

At the beginning of the Republican era, the agricultural sector started to take shape through efforts to modernize and increase efficiency. In the early years, agricultural schools were established for peasants, and endeavors were made to disseminate modern farming techniques. Land reforms were carried out, breaking up large landholdings owned by prominent landowners, and distributing these lands to peasants. Additionally, irrigation infrastructure was developed, and irrigation cooperatives were established. (Doğan et al., 2015, p. 33).

The 1940s and 1950s were the years when the Green Revolution, signifying a significant transformation in agriculture, took place. High-yielding varieties were introduced, leading to substantial increases in agricultural production due to the widespread adoption of chemical fertilizers and pesticides. During this period, cereal production notably increased. Simultaneously, organizations like Agricultural Credit

Cooperatives were established to provide support to farmers. (Doğan et al., 2015, p. 33).

The "Marshall Plan," particularly from 1948 onwards, had a notable impact. The plan provided financial aid to Turkey and other European countries, assisting them in rebuilding their economies and fostering development. This aid program not only influenced Turkey's agricultural sector but also had an impact on broader economic transformation and modernization efforts in the country. (Demirdöğen & Olhan, 2017, p. 3).

The financial assistance provided under the Marshall Plan has contributed to the modernization of the agricultural sector and the enhancement of productivity. These funds were used to acquire new agricultural machinery and equipment, develop irrigation infrastructure, and invest in soil reclamation projects. The aid allocated to the agricultural sector facilitated easier access to agricultural inputs such as seeds and chemical fertilizers. This, in turn, increased efficiency and boosted crop yields. Agricultural education and advisory activities also experienced growth. Agricultural schools and training programs were established to teach farmers about new farming techniques and modern agricultural practices.

On the other hand, the impact of the Marshall Plan wasn't confined solely to the economic sphere; it was also felt in the social realm. Particularly, rural inhabitants, farmers, and rural communities were influenced by this transformation. The agricultural inputs (such as seeds, chemical fertilizers) and technology obtained through Marshall Plan aid might have contributed to an increased reliance on imports rather than local production. (Demirdöğen & Olhan, 2017, p. 3). This could potentially weaken the capacity for future self-sufficiency in producing their own

goods. While agricultural modernization and increased productivity were achieved, these benefits might have disproportionately favoured larger farmers. This could lead to an increase in income inequality and the weakening of competitiveness for smaller farmers. (Demirdöğen & Olhan, 2017, p. 5). The push for modernization and increased technology use might lead to changes in traditional farming practices, potentially causing the erosion of certain cultural elements. Additionally, people from rural areas might migrate to urban centers, resulting in a decrease in rural population.

Then, during the 1960s to 1980s, emphasis was placed on technological advancements and agricultural policies in the agricultural sector. Mechanization and automation became more widespread. Large-scale irrigation projects were implemented, and soil reclamation efforts were undertaken. Organizations like Agricultural Sales Cooperatives (TMO) were established for the trade and marketing of agricultural products. Additionally, infrastructure was developed for the storage and processing of agricultural products. (Demirdöğen & Olhan, 2017, p. 7).

Between 1990s - 2000s, Turkey adopted economic liberalization and outward-oriented policies. The agricultural sector was also affected by these changes. Foreign trade became even more crucial in agriculture, and production geared towards exports was encouraged. Simultaneously, agricultural subsidies and supports were revised. However, it was also observed that small-scale producers faced challenges in international competition. (Demirdöğen & Olhan, 2017, p. 8).

In today's context, issues such as water resource management, increasing productivity, and environmental sustainability hold significant importance. Efforts are being made in areas such as organic farming, cultivation of alternative products,

and agricultural biotechnology. Additionally, digital agricultural technologies are increasingly being employed, which contribute to enhancing efficiency in production. In Turkey, soilless farming methods have been gaining increasing attention and implementation, especially in recent years. However, the history of soilless farming in Turkey is relatively new. The development of these methods in the country became more prominent starting from the 1990s. (Demirsoy et al., 2017, p. 72).

In particular, I wanted to give the example of the Marshall Plan in Turkish agriculture. Considering that technology may be an input that not every farmer can provide, I think that the results of this process may have similarities with today's soilless farming technologies. From this point of view, in this scenario, we are eliminating labour, the human being, if we only aim for productivity and products that are sufficient for the growing population. On the other hand, if we only focus on soilless agriculture as a sustainable and efficient way of farming, we miss the situation that soilless agriculture producers/companies also have interests as people, employers, investors, and that these interests can bypass the farmers interests. Soilless agriculture may evolve into a world where it is efficient and sustainable only for large-scale farm owners.

Soilless farming methods, with the increase in automation and technology use, have the potential to reduce the need for traditional farming labor. This could lead to job losses for those working in traditional farming fields. It might also bring about changes in local cultural and agricultural traditions. In some regions, this could result in the loss of local cultural values and community dynamics. Soilless farming often requires more capital investment, potentially enabling larger enterprises and

wealthier farmers to transition to these methods more easily, while smaller farmers and businesses might be left behind. It demands access to technology and infrastructure, which could pose challenges for economically disadvantaged or underdeveloped rural areas. Moreover, these methods can intensively use resources like water, energy, and chemical fertilizers, potentially exacerbating resource scarcity and environmental issues. At this point, the power once again lies with those who possess these technologies. While business owners become wealthier, the traditional farmers continue their search for what is more efficient and sustainable, along with the need for it.

In conclusion, when we examine agricultural history, technological advancements, and the example of Turkey's agricultural history, we can say that population growth has always been a contributing factor to change. However, the evolving economic system has played a significant role in shaping the dynamics and direction of these changes and also shaping this discussion area.

2.2 Soilless Agriculture

In a study by Sait Engindeniz on greenhouse cucumber production from an economic perspective, he compared soilless agriculture to conventional production systems. Engindeniz argued that soilless production in greenhouses is a new and sustainable approach to agriculture in Turkey. (Engindeniz, 2004, p. 7). The study aimed to investigate the economic viability of greenhouse cucumber production using soilless agriculture. Engindeniz explained that the risks of outdoor diseases have led to the search for alternative production systems. Soilless agricultural production, where plants receive their nutrients from a nutrient solution, could be a good alternative to soil-based production. (Engindeniz, 2004, p. 5). To promote the

development of soilless agriculture, producers need to be informed about the technical and economic aspects of this system. (Engindeniz, 2004, p. 7). Engindeniz provided a general overview of soilless agriculture, defining it as "the cultivation of plants in nutrient solutions, without the use of soil". (Engindeniz, 2004, p. 6). In Turkey's greenhouses, organic aliments such as perlite, vermiculite, bark, and volcanic tuff are preferred for soilless production. (Engindeniz, 2004, p. 8). Engindeniz separated the costs of soilless agriculture into four categories: initial investment costs, variable costs (including labor, fertilizer, seed, electricity, marketing, and all inputs), fixed costs (such as administrative costs and initial costs), and land rent. (Engindeniz, 2004, p. 9). The study showed that soilless agriculture has several advantages, such as the ability to produce high-quality food in places where weather and soil conditions are not suitable for production. It also provides efficiency in space, water, and plant nutrients. However, the initial costs are higher than other production types because of its specialized equipment system, such as heating and irrigation technology. The advantage of this system is the possibility of getting two crops per year, which helps to divide the costs in two. (Engindeniz, 2004, p. 10). Soilless agriculture also has economic benefits, such as a fast and flexible cropping period that allows producers to change their production according to market demand. Moreover, producers can increase or decrease their product depending on prices and can plant other crops if the price is not satisfactory. However, Engindeniz underlined the expensive specific requirements of soilless agriculture, including the higher initial investment costs than other methods. (Engindeniz, 2004, p. 15). In conclusion, Engindeniz's research provides guidance for those searching for new ways to produce high-quality crops and understand their feasibility.

Engindeniz and Gül have discussed similar ideas in another research where they analyzed the economic aspects of soilless and soil-based cucumber production in Turkey. One notable point that caught my attention was the need for specific labor, which reflects the changing structure of producers. (Engindeniz & Gül, 2009, p. 612). Throughout their study, they highlighted that while the initial investment costs for soilless production were higher than soil-based production, the higher quality of crops and multiple harvests per year ultimately reduced costs.

I find it noteworthy that Engindeniz and Gül's studies emphasize the importance of efficiency, as higher investment costs ultimately lead to higher crop yields. These are essential points that potential investors would be interested in, and their research serves as a guide for those interested in soilless agricultural production. However, I also observed that the ecological aspects of soilless agriculture are not discussed in depth.

In a survey comparing soilless agriculture with greenhouse systems in Turkey, the researchers aimed to assess the advantages and disadvantages of soilless agriculture and analyze its current situation in the country. (Gül Aydoğan et al., 2009, p. 565). They found that commercial soilless cultivation progressed slowly from 1995 to 2007, with most enterprises interested in soilless agriculture being small-scale. (Gül Aydoğan et al., 2009, p. 567). This slow development was attributed to high installation costs compared to soil agriculture and a lack of educated labor. However, soilless agriculture was seen as a good alternative to soil sterilization and was shown to increase water use efficiency, allow for cultivation of non-arable land, and improve plant growth and crop quality. The researchers highlighted the employment structure, noting that small-scale companies are often

family-run while medium and large ones employ agricultural engineers and technicians. (Gül Aydoğan et al., 2009, p. 567).

The changing structure of employment is an aspect that aligns with my research interests, and I also want to explore the social implications of this change. While the financial aspects of soilless agriculture were the main focus of the survey, I am curious about the ecological considerations at the investment stage, as companies are generally focused on efficiency. Understanding the relationship between sustainability, efficiency, and soilless agriculture is crucial to my research.

In Özkan's Master's Thesis, he examined the status of soilless agriculture in Turkey between the years 2012-2013, especially for the productions of tomatoes and strawberries, and made predictions about the future of soilless agriculture. In the summary of his study, he discussed the misuse of resources in the world and the increasing population, which has led to increased studies focusing on improving efficiency. He compared soilless agriculture with traditional soil agriculture and stated that soilless agriculture is more efficient and cost-effective. He conducted a cost analysis to emphasize the importance of soilless agriculture in the Mediterranean region of Turkey. Furthermore, he added that this production system is being implemented on productive lands, which can make these areas unproductive. (Özkan, 2014, p. 6). Özkan mentioned that the yield obtained from soilless agriculture is due to the investment made in this field. He also mentioned that if the same investment is made in soil agriculture, efficiency can be achieved there as well. He said that soilless agriculture can be a good method for evaluating unproductive soils. In his work, I observed that he was discussing the investor rather than the farmer. He also stated that his work could serve as an example for investors. (Özkan, 2014, p. 18).

Unlike Özkan's study, my study will focus on the relationship between sustainability and efficiency. This aspect will fill a significant gap in the literature. However, Özkan's work has been a useful guide for my study, as it contains valuable insights into the changing role of producers in this field.

Çakmak's Master Thesis focused on studying the yield and quality of crisp lettuce by considering the sowing dates and the application of organic fertilizers in soilless agriculture. The research found that the efficiency and quality of lettuce increased when organic fertilizers were used. In addition, the vitamin C content and pH value also improved through organic fertilization. (Çakmak, 2011, p. ii).

It is noteworthy that this study only considered soilless agriculture as the production method and did not include other production methods. Therefore, the factor that distinguishes the efficiency and quality of products is organic fertilization and an organic production system. Hence, my research can contribute to the existing literature by filling a gap in terms of exploring the relationship between efficiency and sustainability in the field of soilless agriculture.

In his Master Thesis, Ozan Tarı examined the efficiency and quality of four different strawberry varieties under soilless agriculture conditions, using coconut peat as the plant growing medium. He concluded that the Sabrina variety was the most efficient and recommended it for soilless agriculture. (Tarı, 2021, p. ix). The study was focused on strawberry production in Turkey, where soil-based pathogens are a common problem. Tarı identified soilless agriculture as a viable alternative solution. (Tarı, 2021, pp. 3–4). Additionally, he highlighted the environmentally-friendly nature of soilless agriculture and its cost-effectiveness. (Tarı, 2021, p. 4).

This study underscores the importance of recognizing that efficiency does not necessarily equate to sustainability. Rather, efficiency is often associated with saving money and increasing profits. Moreover, Tarı's study focuses on a single product, strawberries, while my study aims to provide a more comprehensive understanding of the soilless agriculture production system itself, from a broader and more distant perspective.

The "Journal of Agricultural, Food and Environmental Sciences" highlights various soilless agriculture systems used in vegetable production, tracing the emergence of soilless agriculture. The authors discuss the advantages of soilless agriculture, including the absence of soil-based pathogens, soil disinfection, high yield and quality, controlled nutrition, and protection of the environment from nutrient leaching. (Tüzel et al., 2019, p. 7). They also provide details on different types of soilless agriculture such as open and closed systems, through culture, container culture, bag culture, aeroponics, and deep flow technique. The authors suggest that soilless agriculture production will increase in the future, especially in regions where soil is not suitable for production or where water is limited. They also mention that soilless agriculture is more reliable for consumers in terms of traceability, health, and the environment. (Tüzel et al., 2019, p. 11).

This study provides a general overview of soilless agriculture, including its advantages and different types, without focusing on any specific region or product. Although it does not explicitly mention sustainability or efficiency, it is still important for my study as it offers valuable content and insights.

In Yarşı and Çelik's article, "Silifke'de Topraksız Tarım", the authors introduce soilless agriculture and then discuss the general situation of soilless

agriculture in Silifke, as well as the problems encountered in this region. These problems include high installation costs, the inability to construct modern greenhouses, inadequate ventilation, a lack of specialists and quality seedlings, diseases and pests, and inadequate marketing. (Yılmaz, 2019, p. 8). The authors note that while soilless agriculture can produce efficient and high-quality products, it may not be necessary in fertile and disease-free soils. They suggest that soilless agriculture could be even more advantageous if these aforementioned problems are solved, but they only criticize the strawberry cultivation in Silifke. (Yılmaz, 2019, p. 9).

This study, like the previous ones, focuses on the production of efficient and high-quality products through soilless agriculture. While the authors discuss the problems and potential benefits of this production mode, they do not examine its environmental, economic, and social sustainability aspects. Thus, my work may contribute to filling this gap in the literature.

2.3 Sustainability and Efficiency Notions

In this section, I will delve into studies that address the concept of sustainability as a primary focus, followed by research dedicated to the notion of efficiency.

2.3.1 Sustainability

Paul B. Thompson, in his article titled "Agricultural Sustainability: What It Is and What It Is Not," explains that sustainability is a dynamic notion that varies depending on place, time, and conditions. Different groups have distinct interpretations of what sustainability means. For instance, major corporations in the fertilizer, seed, and equipment industries equate sustainability with their continued

profitability, while small-scale farmers in Nebraska associate it with their ability to farm at a manageable level. Latin American peasant advocates view sustainability as a means of achieving social justice for these communities. (Thompson, 2007, p. 6). Thompson poses a thought-provoking question in place of asking what sustainability means, the question could be reframed as to what kind of system should be established to guarantee the presence of a farmer to continue farming. Additionally, he notes that sustainability can be viewed at two levels: the system level and a more personal ideal level. (Thompson, 2007, p. 7). While sustainability is often conceptualized as a problem of resource sufficiency, Thompson suggests that we must estimate the amount of resources we use and the stock of resources available. Therefore, sustainability is a prediction of how long a production or practice may continue given the available resources. (Thompson, 2007, p. 8). Adopting an ontological perspective towards sustainability has provided me with a fresh viewpoint for my work. It is crucial to acknowledge that sustainability is perceived diversely by different societies, under varying conditions, with distinct depths and expectations.

In his article titled "Agricultural Sustainability and Food Security," Kumar Arora highlights the mounting pressure on the agricultural industry due to the increasing population. Despite significant technological advancements, such as the use of chemicals and fertilizers, millions of people still struggle with hunger. Hence, there is a need to increase food production while simultaneously protecting the environment. Arora defines agricultural sustainability as the employment and execution of farming techniques that not only augment crop production to meet the

demands of a growing population but also preserve and safeguard the environment and its natural resources. (Arora, 2018, p. 217).

In Jules Pretty's article, "Agricultural Sustainability: Concepts, Principles, and Evidence," she emphasizes the need to develop technologies that do not harm the environment or its natural resources while being effective for farmers and leading to improvements in food productivity. This increased productivity can be achieved through the integration of fertilizers and agricultural machinery with biological and ecological processes. Pretty gives examples of sustainable systems that minimize the use of non-renewable inputs that cause harm to the environment or to the health of farmers and consumers, make productive use of the knowledge and skills of farmers, and solve common agricultural and natural resource problems such as pest, watershed, irrigation, forest, and credit management. She defines sustainability in two terms, resilience, which refers to the capacity of systems to buffer shocks and stresses, and persistence, which refers to the capacity of systems to continue over long periods and address many economic, social, and ecological outcomes. (Pretty, 2008, p. 447). Pretty notes the notable and evident connections between the consumption of fertilizers, usage of agricultural machinery, irrigation area, agricultural land area, and arable land area with global food production. However, the ineffective use of some of these inputs has resulted in considerable environmental damage. The expansion of agricultural areas has significantly contributed to habitat loss, along with the loss of biodiversity and environmental services they provide. (Pretty, 2008, p. 449). Furthermore, Pretty mentions that there are many sustainable agricultural concepts, such as "biodynamic, community-based, ecoagriculture, ecological, environmentally sensitive, extensive, farm fresh, free range, low input,

organic, and permaculture." For instance, if a technology increases productivity for farmers and does not harm the environment, it can be considered sustainable. (Pretty, 2008, p. 451).

These articles of Arora and Pretty are important in terms of defining agricultural sustainability. As such, my research will aim to explore whether the perception of sustainability aligns with similar definitions within soilless agriculture context.

In Hansen's article, he provided various definitions of sustainability. According to him, sustainability means the ability to maintain, keep in existence, or prolong something. He also defined sustainability as an ideology or philosophy rather than a practice. As a set of strategies, it involves choosing hybrids and varieties, soil fertility packages, pest management approaches, tillage systems, and crop rotations to minimize the impact of farming on the environment and ensure sustained production and profits. Hansen stated that the notion of sustainability arose as an alternative to the negative impacts of conventional agriculture. It aims to address various problems such as non-renewable resource protection, soil degradation, the health and environmental effects of agricultural chemicals, inequity, declining rural communities, loss of traditional agrarian values, food quality, farm worker safety, decline in self-sufficiency, and decreasing number and increasing size of farms. Hansen noted that sustainability terminology includes practical concepts such as organic farming, biological agriculture, alternative agriculture, ecological agriculture, low-input agriculture, biodynamic agriculture, regenerative agriculture, permaculture, and agroecology. As a strategy, sustainable agriculture aims to reduce or eliminate the use of chemicals, fertilizers, pesticides, and their negative impacts on

the environment. Hansen emphasized that the question is not how to produce more food, but how to produce more food with minimal environmental damage. He pointed out that less developed countries generally relate sustainability to the need to increase productivity for growing populations. Hansen provided a definition of sustainability as a system that protects the environment, provides enough food, and maintains producer profitability. He also defined sustainability as a system's ability to continue through time. (Hansen, 1996, pp. 117–128).

In Lampridi, Sørensen, and Bochtis' review, the authors analyzed a methodological framework for conducting systematic literature reviews on agricultural sustainability studies. They noted that there are no universally accepted standards or norms for assessing the sustainability of farming practices. The authors also addressed the growing global population and the need to feed them. They pointed out that technological advancements have emerged as a solution to meet this demand, but these advancements have also contributed to the environmental footprint of agriculture, including the use of fertilizers, pesticides, water, and changes in land use. Lampridi et al. (2019) argued that agricultural sustainability encompasses three basic norms, namely environmental, ecological, and social. However, they found that there is no consensus on the standardization of agricultural sustainability measures. Instead, case-specific tools focused on resource use and their impact on the environment are more prevalent.

These studies by Lampridi, Sørensen, and Bochtis, and Hansen's article could be valuable for my research in terms of comprehending sustainability from various viewpoints.

In the article “Measuring Agricultural Sustainability”, the authors address the complexity of sustainability and the absence of a common viewpoint regarding its dimensions. They highlight that there are various parameters for measuring agricultural sustainability, which can be evaluated on national and farm levels in the context of socioeconomic and ecological situations. (Hayati et al., 2010, p. 73). The authors also discuss sustainability indicators suggested by different organizations, such as the OECD and the British Government, which cover issues ranging from farm financial resources to soil quality, greenhouse gases, and biodiversity. (Hayati et al., 2010, p. 75). However, the authors note that these indicators should be location-specific and contextualized within contemporary socioeconomic situations. Furthermore, the authors stress that sustainability is not a result but rather a direction or process, which makes it difficult to measure. (Hayati et al., 2010, p. 78). They conclude by stating that although measuring sustainability at the farm level is a more precise method, policies at higher levels have a greater impact on lower levels such as farms. (Hayati et al., 2010, p. 95).

In his article "Agricultural Sustainability and Technology Adoption," David R. Lee provided a definition of sustainability, which was given by the Food and Agricultural Organization (FAO), stating that it has "five major attributes: it is resource conserving (of land, water, plant, and genetic resources), environmentally non-degrading, technically appropriate, and economically and socially acceptable". Lee also mentioned that the scope of sustainability can change depending on the development level of countries. For instance, in developing countries, sustainability is often associated with food security for a growing population, while in the case of poverty and malnutrition, the definition of sustainability changes. The article

emphasized the importance of investments and policies to improve the adoption of technologies and systems in developing countries. Additionally, Lee stated that sustainable agriculture is often identified by the efficiency of the use of inputs. (Lee, 2005, p. 1325).

In his article "The Concept of Agricultural Sustainability," Neill Schaller attempts to understand the concept of sustainability and identifies two different perspectives of sustainable agriculture. The first perspective is in opposition to conventional agriculture, which is more attentive to natural resources and uses technological developments to reduce the negative effects of conventional agriculture. The second perspective advocates for more profound changes and extensive transformations of social values. This group extends the meaning of sustainability to social justice and protecting animal welfare, instead of just being conservative for natural resources and protecting the environment. (Schaller, 1993, p. 89). Schaller provides a great definition of sustainability, stating that it is not just a destination to reach but also special farming practices that lead us to that destination. (Schaller, 1993, p. 91). He presents three dimensions of sustainable agriculture: environmentally suitable and productive, economically reasonable, and socially desirable agriculture. (Schaller, 1993, p. 89).

2.3.2 Efficiency

Falavigna, Manello and Pavone (2013) conducted a study that aimed to examine the relationship between public funds and notions of environmental productivity and efficiency in the Italian agricultural sector. According to their findings, the widespread adoption of environmentally friendly production practices and technologies has contributed to an increase in environmental efficiency. The

authors also highlighted the potential of public funds in promoting productivity and environmental efficiency in the agricultural sector. (Falavigna et al., 2013, p. 73,79).

In his article, Ogundari analyzed agricultural efficiency in Africa and found that education, experience, extension, and credit are the criteria that affect agricultural efficiency levels on the continent. (Ogundari, 2014, p. 690). As in developing economies, agricultural development in Africa is mostly dependent on reducing poverty and hunger, which are the major problems in the region. At that point, improving efficiency levels has been identified as productivity growth. Ogundari also stated that no country has the chance to reduce poverty and food insecurity without making investments in institutional and industrial developments that are attached to increasing the level of agricultural efficiency and productivity. (Ogundari, 2014, p. 690). In conclusion, Ogundari suggested policies that encourage young and educated individuals to go into farming and the use of modern technology in the agricultural industry. (Ogundari, 2014, p. 700).

This article is important for my study as it distinguishes between agricultural productivity and agricultural efficiency. Furthermore, the mention of technology as a factor that can positively impact agricultural efficiency is significant.

Milovanovic analyzed the role and potential of information technologies (IT) in the agricultural industry and explained the advantages of using IT in many fields. He suggested that IT has the potential to support farmers and improve efficiency and productivity in agriculture. (Milovanović, 2014, p. 471). These technologies include the use of seeds, water, nutrients, and plant protection methods. He stated that promoting sustainable agricultural production requires farmers to adopt information-intensive and precise farming techniques based on knowledge. This requires farmers

to be aware of the benefits offered by the internet and other information and communication technologies (ICT) that provide valuable information services for managing agricultural production. The use of these technological developments will result in cost reduction and improved efficiency and productivity. (Milovanović, 2014, p. 472).

This research is also significant as it distinguishes between productivity and efficiency in agricultural production. Additionally, discussing technological developments is crucial to understanding the relationship between technology and agricultural efficiency.

In his article, "The Population/Biodiversity Paradox," Trewavas discussed the increasing human population and its impact on the environment and the need for food. He highlighted India as an example, where traditional farming methods are used by 70% of the population, and by 2025 it will be the most populated country in the world. To meet the demands of its population, radical improvements are needed in Indian agriculture, transport, and food preservation. (Trewavas, 2001, p. 174). Trewavas described this paradox as resulting from technological improvements that cause problems related to biodiversity. As the population grows, so do the negative environmental impacts, such as the loss of the world's forests. To prevent the present ecosystem from collapsing and increase food production, he argued that we need to use the same areas to produce more products with technological improvements. This means increasing the efficiency and productivity of land use, which he suggested as a conscious strategy to reduce environmental impacts. (Trewavas, 2001, p. 176). Trewavas proposed technological use and improvement as a solution to the problem. He suggested that we should remove the side effects of pesticides and soil erosion to

retain their benefits. He used the example of using pesticides as a technological tool to improve yield and save wilderness. Without pesticides, 70% of the world's food crop would be lost, and even with pesticides, 42% is destroyed by insects and fungal damage. (Trewavas, 2001, p. 177).

This research provides a valuable example of the interplay between technology, population growth, and agricultural efficiency, which is highly relevant to my own study.

Wang and Rungsuriyawiboon's research is important in terms of understanding the effects of economic reforms on agricultural productivity and efficiency in China. They showed that the increasing population in China has put pressure on the state to produce more food, and this has led to transformations in the structure and volume of agricultural production. Moreover, they highlighted the importance of technological improvements in agricultural practices, which small farmers have been eager to adopt. (Wang & Rungsuriyawiboon, 2010, pp. 207–208).

This article may be technical and focused on China, but it provides valuable insight into the distinction between efficiency and productivity and their connection with technology. It is crucial to comprehend efficiency as a structure and volume of agricultural production, and this study provides that understanding. Additionally, the authors discuss the impact of economic reforms on agricultural production, as well as the eagerness of small farmers to adopt technological improvements, which could be useful in my research.

2.4 Haraway

In a podcast with Donna Haraway, she talked about the concept of situated knowledge as knowledge production is always situated in a specific social and

cultural context, and therefore, all knowledge is not neutral, objective, and universal. People can base their understanding of the world on their social, cultural, and individual experiences, which influence the production and comprehension of knowledge. The nature of knowledge is shaped by the identity, experience, and location of those who produce it. This concept also draws attention to power relations in knowledge production. Since knowledge is produced and controlled by people in certain social and political positions, it can always be used for specific social or political purposes. Therefore, power dynamics in knowledge production and the purposes of knowledge use should also be considered. It is important to recognize the residency of knowledge and the ways in which it is shaped by power relations and social hierarchies. (*Transcript*, 2019). Haraway's concept of situated knowledge is closely related to her feminist politics, which make an effort to challenge the dominant forms of knowledge that have been produced by white, Western, male perspectives. By admitting and valuing diverse forms of knowledge and the perspectives of marginalized communities, we can challenge dominant knowledge systems and work for more equitable ways of knowing and being in the world. (Haraway, 2013, p.183-188).

This concept of situated knowledge is in relation with technology because it is not a neutral tool because it is shaped by social, cultural, and political factors and also technology influences and shapes these values. The emergence of technology is driven by specific interests and goals that reflect the values, beliefs, and biases of those who develop it, of that societies. On the other hand, while it erases these boundaries it also creates some designs to serve the interests of certain groups while excluding or marginalizing others. At this point, we can say that technology creates

two options. On the one hand, the technologies can blur boundaries between different communities and different actors, while on the other hand, the producer of the technology may come from a certain cultural, socioeconomic, and class, making them more powerful than other actors. At this point, with Haraway's situated knowledge concept in mind, we should also consider the criticality of technology production and use, we must provide to be producible and usable for everyone, so it can be more fair and equitable.

Furthermore, there is a great link between the concept of situated knowledge and soilless agriculture. Similarly to the relation of situated knowledge and technology, there is a same dual situation in relation to technology used in soilless agricultural production system and the concept of situated knowledge. When we consider traditional agriculture through situated knowledge, we can think of alternative farming methods, such as soilless agriculture, as going beyond situated knowledge. At the same time, the technologies used in soilless agriculture can increase our knowledge of plants and their needs. With this knowledge, the relationship between humans and plants can be reshaped. The important thing to consider here is whether these technologies serve the purpose of truly reshaping the relationship between plants and humans, and redefining the limitations between them. When we look at alternative farming methods like soilless agriculture, we may find that the purpose of these production methods is to provide food for the increasing population more efficiently. There is some point missing. We can consider the example of soilless agriculture, which changes the known facts of traditional soil-based production and offers a new path. This method assumes that by being more in harmony with nature, existing resources can be shared more fairly. On the other

hand, in a broad perspective, we can say that only certain societies can produce these soilless agricultural technologies and in a narrower perspective, they are produced by certain groups and individuals within these societies who have certain socio-economic power. In this case, in terms of human-human relationships, because of the production and usage of these technologies, power can stay concentrated in specific groups. Moreover, looking at the human-nature relationship, although the demands of plants can be more understandable to some extent, we can see the human desire to dominate nature when we think that this method is unnatural. However, knowing that these technologies of production method are produced by certain groups in accordance with Haraway's concept of situated knowledge, can strengthen our urge to find new ways to reverse this situation. From another perspective, within the context of the technology- human relationship, there inherently exists a hierarchical dynamic. Technological elements, by their nature, remain products of human creation, viewed from the standpoint of both creator and creation. While it can be argued that the boundaries of their relationship might blur, fundamentally, human occupy the position of creator and owner of these technologies. It is also possible to say that human agency drives technological innovation and, technological knowledge, yet technology reciprocates by shaping human experiences, capabilities and societal structures. At this point I am curious about who is the decision-maker in this context.

In the same podcast, when Haraway was asked about her article "Cyborg Manifesto," she referred to it as a situation that emerged in the mid-20th century, claiming that we have become cyborgs with the developments such as systems sciences, digital apparatuses, digital coding, the war, the electronic battlefield, the

Bell Telephone System, and other communications apparatuses, the biomedical transformation of the organism. Haraway also states that the result of such a fusion could be used to increase freedoms. In the "Cyborg Manifesto," Haraway critiques Marxist, Western-centric, white feminism. (*Transcript*, 2019).

In Cyborg Manifesto, Haraway defines the cyborg as: " A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction." (Seidman, 1994, p. 83). She says that Foucault's concept of biopolitics can be seen as an anticipatory glimpse of the expansive realm of cyborg politics. Haraway argues that with the late twentieth century, we have all become chimeric beings which means hybrids of machines and organisms. In essence, we are all cyborgs and our existence as cyborgs shapes our understanding of the world. (Seidman, 1994, p. 83). In this world, she thinks a world without gender, not only making difference between male and female but also between each little organisms. (Seidman, 1994, p. 84).

Haraway criticizes dualisms that have been deeply ingrained in Western thought and culture. She argues that these dualisms, such as self/other, mind/body, culture/nature, male/female, civilized/primitive, active/passive, right/wrong, truth/illusion, total/partial, God/man, are not only false but also oppressive and limiting. (Haraway, 2016, pp. 59–60). Instead, she proposes a new way of thinking that embraces the complexities and hybridity of the world, where boundaries between human and non-human, natural and artificial, physical and digital, are becoming increasingly blurred. In this new way of thinking, the cyborg becomes a symbol of resistance against the traditional dichotomies and a vision of a more fluid and inclusive future. With the development of high-tech culture these boundaries

became more fluid. For example Haraway says that modern high-tech culture blurs traditional boundaries and dualisms between humans and machines, as well as between the mind and body. In this context, it is not always clear who or what is controlling or being controlled in the relationship between humans and machines. Additionally, as machines become more complex and reliant on coding practices, the traditional distinctions between mind and body become less clear. She says that human found itself as cyborgs, hybrids. (Haraway, 2016, p. 60).

In the concept of agricultural technologies, I can consider the blurring of boundaries between human-non human. In this case, my work can discuss which dualisms are reduced or are they really reduced or not reduced by the technologies used in soilless agriculture. The consequences of these technologies can also be addressed. The use of advanced technologies in agriculture can blur the boundaries between human and non-human actors, such as machines, plants, and animals. It can become less clear what is natural and what is artificial, as technological interventions become more sophisticated and integrated with the natural world. I can say that the relationship between technology, society, and the environment is redefined again.

Haraway argues that the impact of new technologies on hunger and food production is significant. The Green Revolution technologies, combined with other high-tech industrial production, have transformed the gender division of labor and influenced patterns of gender migration.(Seidman, 1994, pp. 107–108). This Haraway's idea can be related to soilless agriculture technologies by considering how they have the potential to change gender divisions of labor.

In another section of the Cyborg Manifesto, Haraway discusses the significant consequences of not declaring cyborgs as our enemies. She emphasizes the

importance of not separating ourselves from them as something different than us. Haraway says “The machine is us, our processes, and an aspect of our embodiment. We can be responsible for machines; they do not dominate or threaten us. We are responsible for boundaries; we are they.” (Haraway, 2016, p. 65). We can say that Haraway has envisioned a more peaceful and equitable order with this alliance. In my study, I will also discuss how the technology used in soilless agriculture opens up new networks of relationships and how these networks create a context for labor, as well as the perception of efficiency and sustainability in food production resulting from the use of these agricultural technologies.

In the same podcast, the host reminds Haraway's statement: “forced life is not the organization of the forces of life and death for flourishing, but rather for extractive profit. It's about ecological obliteration through turning all of the earth into nothing but a resource for keeping human beings alive and growing." (*Transcript*, 2019).Can we think about this situation in relation to plants produced in soilless agriculture? There is a very fine gap between eliminating boundaries and bringing together while at the same time one species dominating the other. This concept of “forced life” refers to the manipulation and control of natural life by external factors or purposes. This term emphasizes where life is organized to serve specific human interests or economic gains. “Forced life” implies the redirection or alteration of natural life through external influences. According to Haraway, such an organization of life goes against the dynamics of nature and is driven primarily by certain goals or interests. In soilless agriculture, the plant-human relationship involves the cultivation and utilization plants by humans. These technologies are employed to optimize plant growth and enhance productivity. However, the concept of “forced life” can be

applied if plants are grown solely to fulfil human desires and economic goals. If plants are grown without consideration for their natural cycles and adaptation mechanisms, and if the focus is on achieving maximum yield or economic gain, it can be perceived as a form of manipulation or coercion within the plant-human relationship. This concept suggests that technologies like soilless farming have the potential to shape the natural lives of plants to align with human interests or economic objectives. At this point, the integrity of natural life, ethical considerations and ecosystem balance can play a crucial role.

In her wording “Plantationocene”, she tells us that it highlights the imbalance in the relationship between humans and nature and can be seen as a reflection of a world order where capitalism, racism, and imperialism are intertwined with each other. At this point, we can say that there may be an intersection between Haraway's idea of technological progress eliminating boundaries and the concept of the Plantationocene. This intersection can be seen in the context of alternative agricultural methods such as hydroponics, which utilize advanced technology to cultivate crops without soil. These methods have the potential to challenge the exploitative and unsustainable practices of the Plantationocene, while also potentially creating more equitable relationships between humans and the natural world. And at the same time, as another element of the capitalist system, it can also create new forms of disorder and domination. (*Transcript*, 2019).

In an interview that Andrew Ross and Constance Penley made with Donna Haraway, the relationship between nature, technology and culture is mentioned, which is discussed in Cyborg Manifesto. Haraway talked about the structure of the science as historical and cultural production and our perception of nature according

to what counts as nature. (Penley et al., 1990, p. 8). She also told that she is influenced by Bruno Latour's actor-network theory which says that every minor things are actors. She explained that we just accept language-bearing actors as an agency which is conscious but she pointed out that agents are heterogenous and so not every actor have to have a language. (Penley et al., 1990, p. 9). If we just include what we understand because of the understandable language, it would be missing and wrong. In short, Haraway said "the subjects are cyborg, nature is coyote and the geography is elsewhere." (Penley et al., 1990, p. 10). She mentioned also a problem about Eurocentric or being Euro-American person because of having these technologies. She made emphasize to cultural impact on objects. (Penley et al., 1990, p. 10). Haraway talked about technology as a component of nature. With an example of Human Genome Project, she told that how we transformed a piece of text as a data which affect reproduction, and labor and life. (Penley et al., 1990, p. 12). She insisted on the idea that we are all cyborgs. (Penley et al., 1990, p. 17).

In another interview made by Nicholas Gane with Donna Haraway, she explained Cyborg Manifesto's aims as a provocation for new left movement network of people and told manifesto wording as a joking with Marx's "Communist Manifesto". (Gane, 2006, p. 135). Haraway described also her point of view to the organism, which is not a simple thing but an object of knowledge and or a system of production or a piece of energy. It is her interest of things non-humans so that Cyborg Manifesto emerged as the product of this interest. (Gane, 2006, p. 136). Gane asked as is it a little bit challenging to find that what counts as being "human" and Haraway mentioned that social relationships involved non-human things as socially active because of their impact. (Gane, 2006, p. 142). In the Cyborg Manifesto,

Haraway removed the boundaries between of humans and machines, and said that we all have the responsibility of these machines which cannot threaten us. That is why machines are already us, we are these machines or technologies. (Gane, 2006, p. 145).

In “The Companion Species Manifesto”, Haraway told us that cyborgs are derived from a need of survive. It may appear that these manifesto as a relation between human and dogs but more than that to analyze and giving an example of cyborg. She talked about dogs as an existence of technoscience. (Haraway, 2003, p. 5). She explained her curiosity and purpose of this article as understanding the relationship constructed between human and dogs and how they result in nature culture. (Haraway, 2003, p. 12). It is not about just dogs, however it is more likely an answer to her previous book Cyborg Manifesto. She told us also the definition of companion species as “whom make life for humans what it is or vice versa”. (Haraway, 2003, p. 15). She insisted on the idea that the article was more than the relation between human and dogs, they were like a reflection of a universe. She underlined the importance of cyborg and why it is, then she told how the impact on nature culture with this human-dog relation is. (Haraway, 2003, p. 21).

Here, the human-dog relationship is actually just an example. These relations exist throughout nature. As Haraway said, we have dogs and also dogs have us. It is also possible to think about this relationship in the same way for plant-human relationships or the relationships between human-plant productions technologies.

The dilemma here is which is nature and which is the perception of nature, and also which counts as an actor in this situation. In technoculture, it can be counted as political, ethical and emotional actions. (Haraway, 2003, p. 27). This relationship

showed us also the possibility of civilization. She gave an example of making a dog from a wolf which means from a free person to a servant. (Haraway, 2003, p. 28). This example made think and question the definitions of domestication and co-evolution one more time. We can say that two of them changed over this human-dog relationship. (Haraway, 2003, p. 30). Haraway found this relation which defined "unconditional love" and where human being saw the dog as its children, as abusive. (Haraway, 2003, p. 33). We can see lots of examples of this "unconditional love" in movies about dogs chasing after their owner who was moved or mourning the deceased owner. Haraway defined this relation as a "positive bondage" where they are trained by instructors under certain rules. (Haraway, 2003, p. 43). There are examples like playing game, bouncing off somewhere or beauty peagants.

When we think about the impact of technologies used in soilless agriculture, it seems similar to the relation between dogs and human. We can talk about the relation between plant and human, vegetables and the need for nourishment. These two actors influenced each other and are influenced by each other.

CHAPTER 3

METHODOLOGY

I conducted my study between September 2022 and September 2023. The aim of my study is to analyze the perspectives of producers working in soilless agriculture and also producers of soilless agriculture materials in terms of efficiency, and sustainability. To achieve this objective, I first conducted research on soilless agriculture using the Google search engine. The scope of this research was to gain a comprehensive understanding of the applications and preferences of soilless agriculture. While reviewing theses and studies, I found only a limited number of works related to soilless agriculture in the field of social sciences. This motivated me to work more in this area. Initially, I aimed to limit my research to Turkey and therefore investigated soilless agriculture companies in Turkey through the Google search engine. However, I was only able to reach a small number of soilless agriculture producers, and I was unable to find any associations, institutions, or organizations to which these producers were affiliated. This complicated my research to some extent. Additionally, I faced difficulty in directly contacting the producer companies I found in Turkey. At this point, I decided to expand my research beyond Turkey's borders and into a global context.

At this stage of my research, as I did not have any specific starting point or selection criteria, I preferred to use the snowball sampling method and searched the Google search engine for "soilless agriculture" and “soilless agriculture + country names” to examine various web pages. I used the snowball sampling technique, which involves identifying and recruiting initial study participants, and then asking them to refer other individuals who meet the criteria for the study. (Babbie, 2016, p.

188). In my study, since there were no participants involved, I utilized the snowball sampling technique by conducting a search on the Google search engine using the keyword "soilless agriculture." This allowed me to access soilless agriculture producer websites and navigate to other similar soilless agriculture producer websites. By using this method, I was able to expand my pool of potential participants through the connections and knowledge of the initial website contacts. I chose soilless agriculture companies from different countries without using any particular method of selection. The only criterion I used to select these websites was whether the companies were involved in soilless agriculture or producing materials for soilless agriculture. Besides that, I did not have any specific preferences regarding the companies' revenue sizes, establishment years, or geographical locations. I analyzed a total of fourteen web pages, and their country distributions are presented in Table 1. (Figure 1) (Table 1) Additionally, list of the names of web pages is given in Table 2. (Table 2). With the emergence of a sufficient common concepts, I decided to conclude the study at 14 producers' websites. Certainly, the study's scope could be deepened by expanding the geographical distribution of the websites.

I conducted my research using netnography, a qualitative research methodology that involves the observation and analysis of online communities, cultures, and social interactions. This methodology combines the principles of ethnography, which is the study of human cultures and societies, with the tools and techniques of digital research to examine social behaviours, beliefs, and practices in online contexts. (Kozinets, 2010, p. 60). I analyzed all the titles, slogans, photos and videos, blog posts, product content, and description texts on each web page and also

examined page redirects, preferred colours, and the perception they want to create for the consumer. I paid particular attention to where, how, and how frequently the concepts of sustainability and efficiency were used or implied, even if they were not explicitly stated. I was able to gain insights into the values, attitudes, and perceptions of producers in the context of sustainability and efficiency. Based on these analyses, I created field notes. From these field notes, I identified common topics across all web pages and created codes related to these topics. Since I observed no emerging concepts that differed from common topics across the fourteen web pages, I limited my research to the fourteenth webpage. These codes included “aim, soilless agriculture, values, clean food, gender, agricultural transformation, logo, business, slogan, sustainability, and sub-codes “economic sustainability, ecological sustainability, and social sustainability,” the problem, ecology, technology, social media, farmer profile, efficiency, and future." You can find how these codes were used and for what purposes in the "operationalization" section.

The main questions that formed the basis of my study were: “Is the reason for choosing soilless agriculture its relationship with sustainability? What is the relationship between sustainability and efficiency in soilless agriculture?”

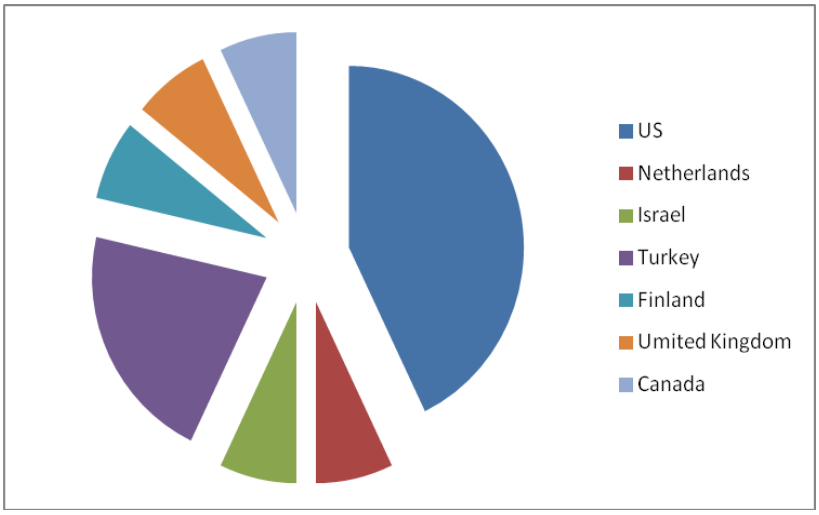

Figure 1
Distribution of web pages by country

Table 1
Numerical representation of the distribution of web pages by country

US	6
Netherlands	1
Israel	1
Turkey	3
Finland	1
Umited Kingdom	1
Canada	1

Table 2
List of the web pages and countries

Websites	**Cities**
Assence Grows	California,US
Artechno Grow Systems	Netherlands
Gotham Greens	New York, US
Haifa	Israel
Ironox	Texas, US
Mavruz	Çanakkale, Turkey
Netled	Finland
Resif Sera	Turkey
Seed Leaves	United Kingdom
Smart Bee Controllers	US
Ttfarm	Trabzon, Turkey
Urban Cultivator	Canada
Vegbed	New Jersey, US
Vertical Harvest	Wyoming, US

3.1 Operationalization

The descriptions of the codes used while examining fourteen web pages are provided in this section to clarify the content of the study.

Business: I chose this code because companies focus on offering profit-oriented work/plans to those who do not practice soilless agriculture or want to expand their business and target investors.

Sustainability: I divided this code into three sub-codes: ecological, economical, and social.

Ecological sustainability: I chose this code when companies mentioned considering environmental impacts while practicing soilless agriculture.

Economical sustainability: I chose this code when companies emphasized the economic costs of environmental impacts.

Social sustainability: I chose this code when companies mentioned improving the living conditions of the workers in the soilless farm.

Efficiency: I chose this code when the aim was to increase the amount of product obtained per unit area.

Gender: I chose this code when encountering a photo, job description, or discourse related to gender.

Aim: I chose this code when companies talked about their own organizational goals.

Soilless agriculture: I chose this code when companies talked about soilless agriculture.

Values: I chose this code when companies talked about their founding values.

Clean Food: I chose this code when they talked about clean and healthy food.

Agricultural transformation: I chose this code when companies talked about the transformation of agricultural production.

Logo: I chose this code when companies mentioned their logos.

Slogan: I chose this code when they shared any slogans.

The problem: I chose this code when producers or companies defined a situation as a problem.

Ecology: I chose this code when environmental impacts were mentioned, but no relation to sustainability was established.

Technology: I chose this code when technology was mentioned related to production.

Social media: I chose this code when companies talked about their social media accounts or social media posts.

Farmer profile: I chose this code when companies talked about people practicing soilless agriculture.

Future: I chose this code when there was a discourse about the future.

3.2 Limitations of the Study

Due to limited time, I was only able to review a limited number of websites, but the scope of the research can be expanded by increasing this number by extending geographical area of these websites.

In addition, I did not consider any criteria in selecting countries for the websites I analyzed. Separating countries into developed or developing countries in the field of soilless agriculture and conducting separate studies in these areas may provide different perspectives. Similarly, I did not take into account the socio-economic conditions of countries. At this point, I anticipate that different perspectives may emerge from countries with different socio-economic conditions.

My study conducted a discourse analysis on websites using netnography. Before reaching this stage, I went out to the research field with the desire to make interviews with soilless agriculture producers in Turkey, but I could not reach a sufficient number of producers. I believe that this was an important threshold in the evolution of my research methodology. At this point, I think that making interviews with soilless agriculture producers can provide a different and more profound perspective to the study.

Finally, my study is limited to the concepts of sustainability and efficiency in soilless agriculture as alternative production methods. However, I think that the changing profile of producers or farmers in this field that I observed during my research can also be included as a topic in the study.

CHAPTER 4

RESEARCH

4.1 Data of Soilless Agriculture Producers Websites with Coding

Based on the applied codes and analysis, the results obtained from the field notes of these fourteen web pages are as follows: there is a weak relationship between soilless agriculture and sustainability, there is a strong relationship between soilless agriculture and profitability. It can be observed that soilless agriculture is more focused on profitability rather than sustainability. Furthermore, efficiency is designed based on profitability rather than sustainability.

Among the nineteen codes used in the coding process, the most frequently used code, along with its sub-codes, was “sustainability”, which appeared 101 times. Following that, the code “business” was used 80 times, and “efficiency” was used 63 times. (Figure 2)

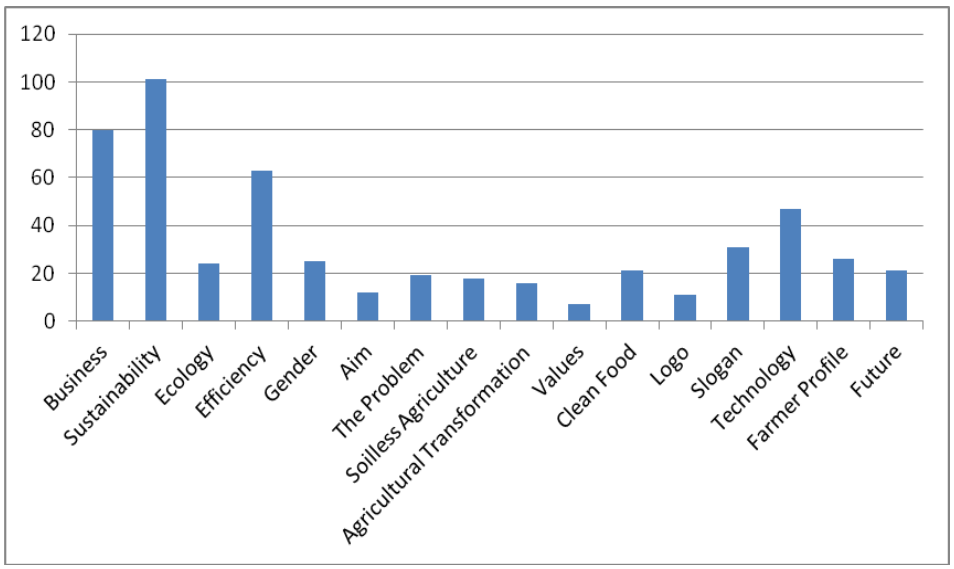

Figure 2
Distribution of all codes used

The code “business” was used 80 times among the fourteen field notes. Within this code, there were eight instances indicating that “vertical farming is a sector with growth potential”. Additionally, there were three instances stating that “it would provide support in the field of soilless agriculture for a sustainable future”. Seven instances mentioned “providing support in the field of technology within soilless agriculture”. Furthermore, there were ten instances highlighting “the profitability of soilless agriculture”. Two instances indicated “the support of greenhouse installation and product supply”. Twenty-four instances mentioned “selling products through websites or other sales channels”. Finally, there were nine instances expressing “the desire of companies to provide support based on their experiences in the field of soilless agriculture”. (Figure 3)

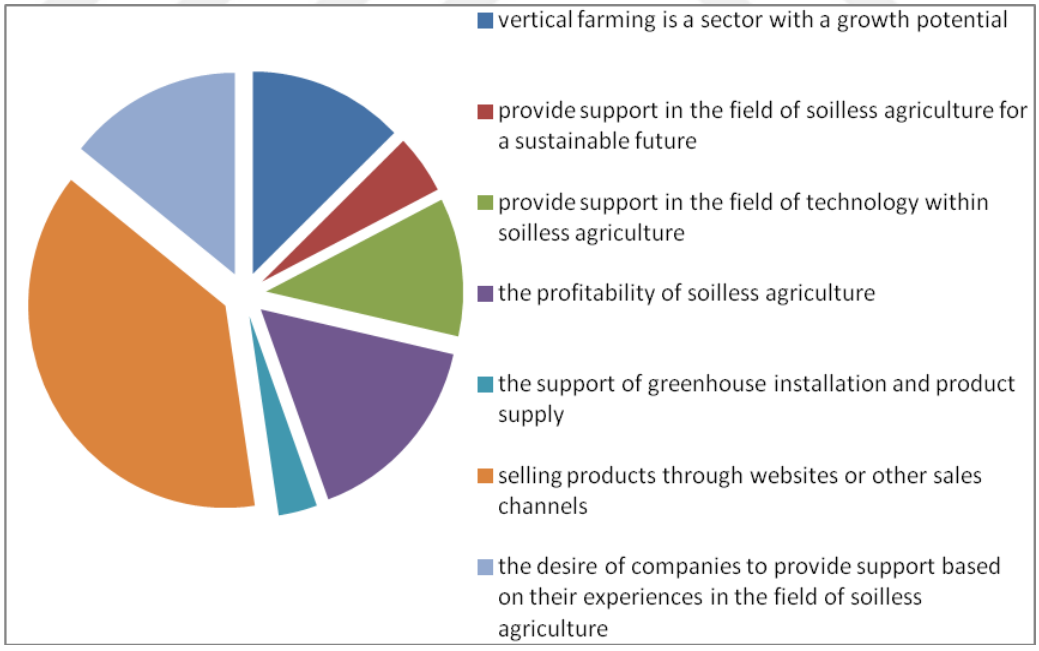

Figure 3
Distribution of business code

The code “sustainability”, along with its three sub-categories, was used 101 times. Among these, 34 instances were coded with the sub-code “ecological”, 18 instances with the sub-code “economical”, and 11 instances with the sub-code “social”. (Figure 5) These sub-codes defined sustainability as follows: five instances defined it as “good farming and pesticide-free farming”, seven instances as “low input cost”, sixteen instances “as a sense of responsibility towards the future and social situations”, six instances as “the preference for diversity of natural resources”, eight instances as “being associated with the presence of technology”, sixteen instances as “the preference for the quantity of natural resources”, twenty-four instances as “the environmental impacts of agricultural production”, fourteen instances as the “reconnection of production and consumption”, and fifteen instances as “controlled waste”. (Figure 4)

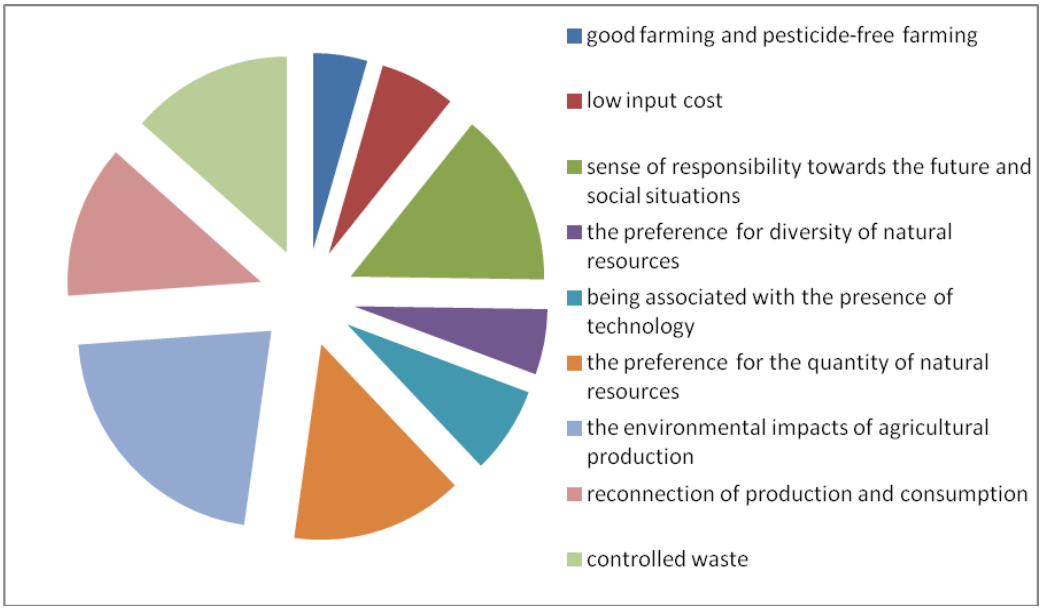

Figure 4
Distribution of sustainability code

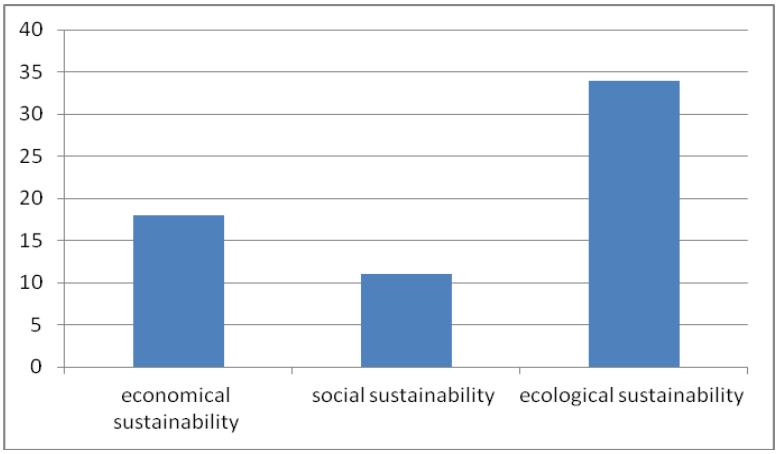

Figure 5
Distribution of sub-codes of sustainability code

The code "efficiency" was used 63 times among the fourteen field notes. Within these coded areas, eight instances defined efficiency as “reduced energy consumption,” eleven instances as “time-saving”, fifteen instances as “cost-saving”, thirty-two instances as “increase in production quantity”, nine instances as “production without being dependent on seasonality”, sixteen instances as “reduced resource consumption”, and eleven instances as “human controlled production”. (Figure 6)

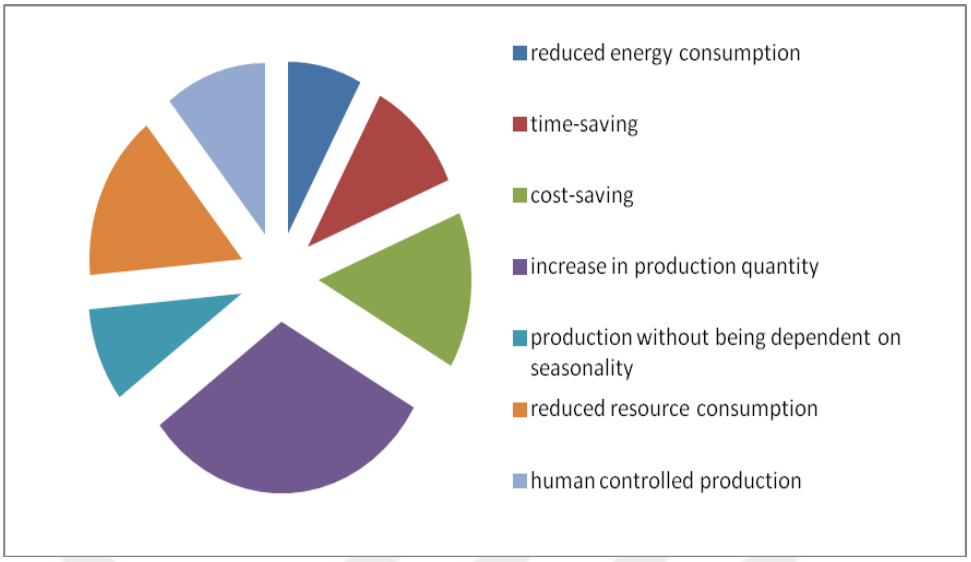

Figure 6
Distribution of efficiency code

The code “gender” was used 25 times among the fourteen field notes. Within these coded areas, there was one instance that defined gender as “a value-based definition of a gender”, five instances that mentioned “prioritizing the employment of one gender over another”, fourteen instances that “referred to gender in the producer domain”, one instance that mentioned “gender in the consumer domain”, seven instances that mentioned “gender in the business domain”, and one instance that “referred to women based on aesthetic perception”. (Figure 7)

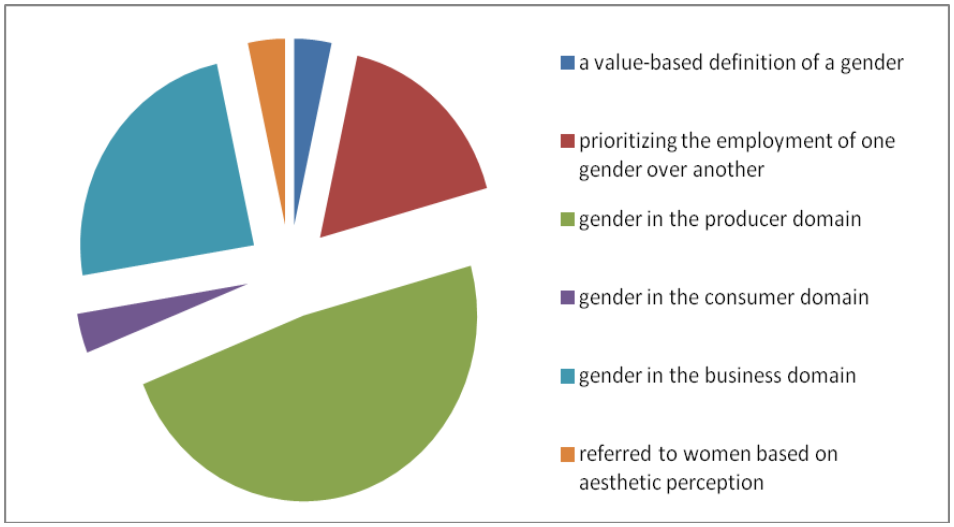

Figure 7
Distribution of gender code

Under the code "aim," there are 12 coded areas among the fourteen field notes. Out of these twelve areas, six of them fall under “the aim of providing accessible and healthy food”, three under “the aim of reducing the environmental impacts of agricultural production processes”, one under “the aim of creating differentiation in the production market”, two under “the aim of providing easy, good, and efficient production methods”, four under “the aim of supporting social and environmental development”, and finally, one under “the aim of providing good investment services”. (Figure 8)

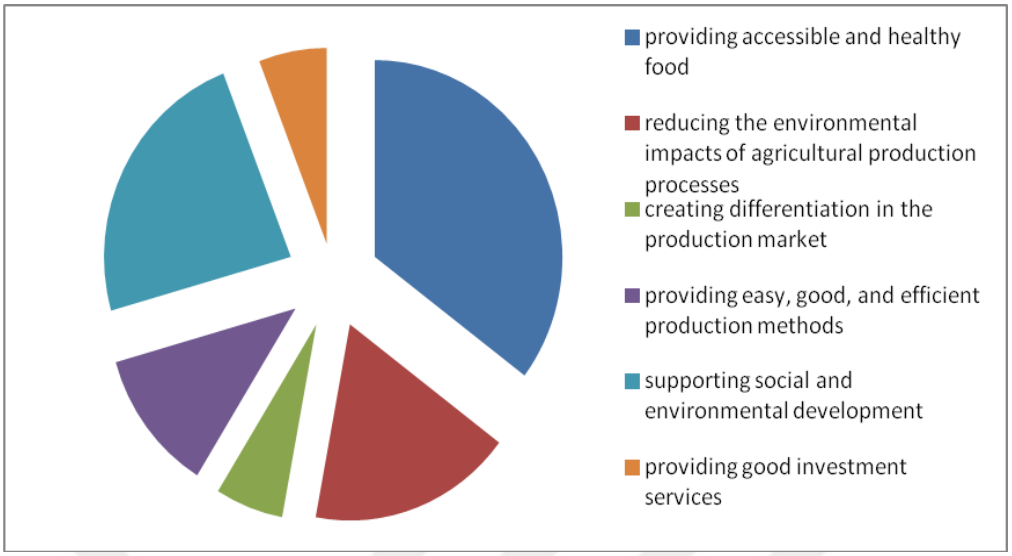

Figure 8
Distribution of aim code

Among the fourteen field notes, “soilless agriculture” was coded 18 times. Within these 18 codes, seven of them described soilless agriculture in terms of “efficiency”, seven used it to “highlight the advantages of soilless agriculture”, three explained it “based on its sustainability”, four discussed soilless agriculture on “its relationship with technology and the future”, and three presented it as “an investment tool”. (Figure 9)

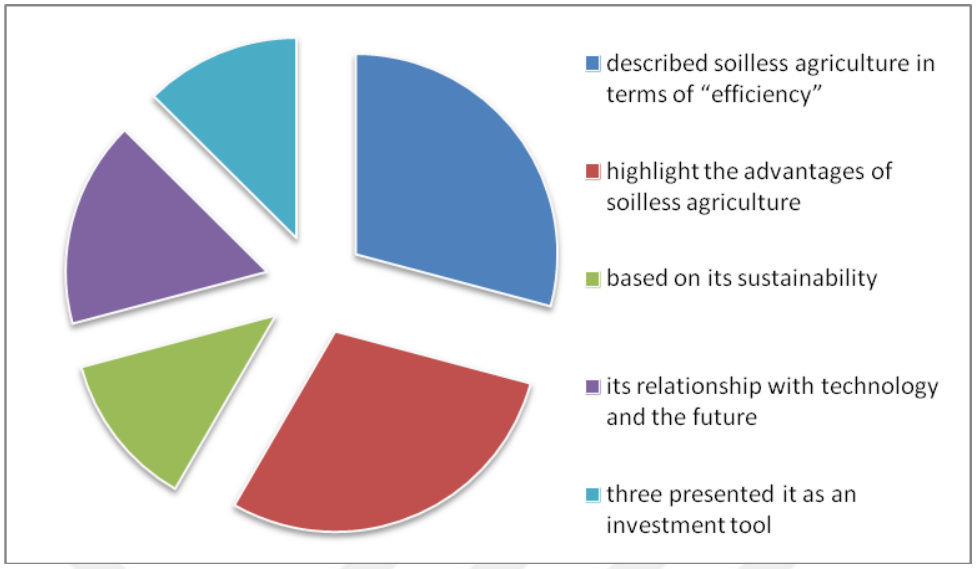

Figure 9
Distribution of soilless agriculture code

Within the fourteen field notes, the code "values" was used 7 times. There was one coded area that aligned "values with business", three coded areas that emphasized "the value of environmental concern", three coded areas that highlighted "the importance of technology", and two coded areas that emphasized "the value of sustainability". (Figure 10)

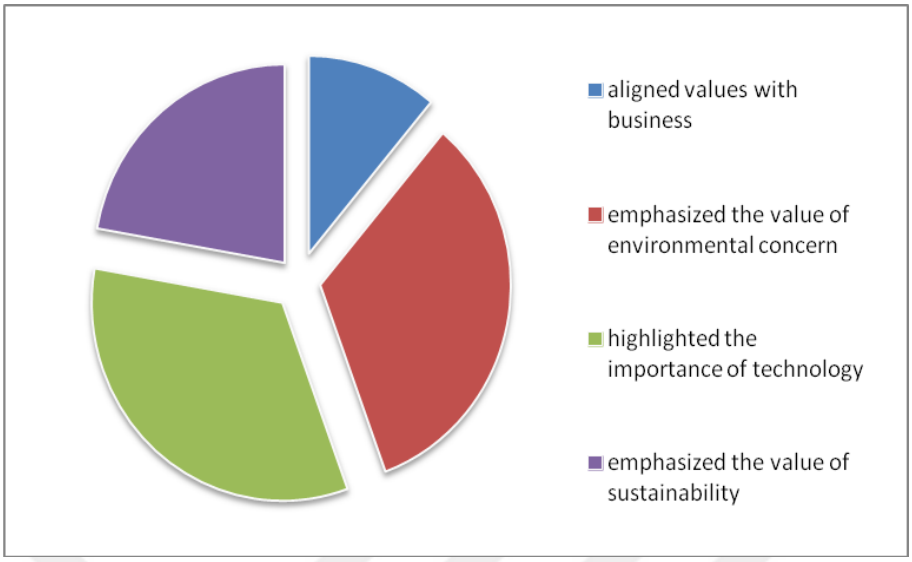

Figure 10
Distribution of values code

The code “clean food” was used 21 times among the fourteen field notes. Within these 21 codes, there were three instances that “supported the concept of sustainable food” and eighteen instances that “aimed to create and provide the perception of healthy and clean food”. (Figure 11)

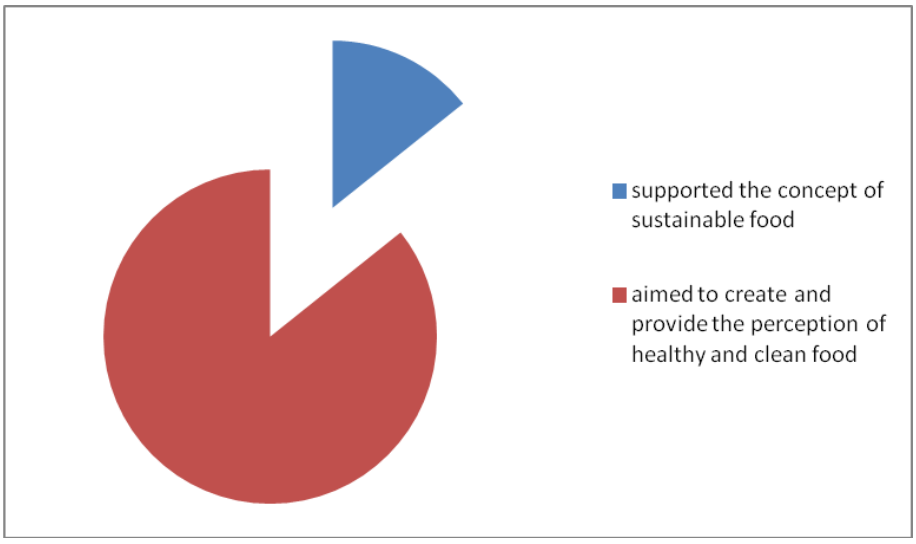

Figure 11
Distribution of clean food code

The code “agricultural transformation” was used 16 times among the fourtenn field notes. Out of these agricultural transformations, four were described as “changes based on efficiency”, six were related to changes “created by technology”, five were associated with changes based on “taste and flavour”, and five were discussed “in the context of spatial changes”. (Figure 12)

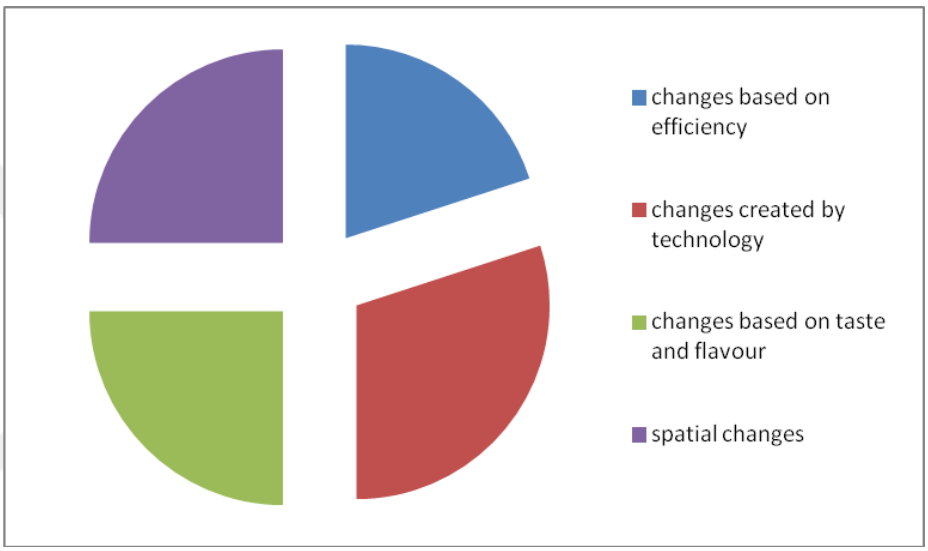

Figure 12
Distribution of agricultural transformation code

The code “logo” was used 11 times among the fourteen field notes. Within these eleven instances, there were eight coded areas that featured “elements related to nature and made references to nature”. Additionally, there were four coded areas that “made references to nature through the use of green colour”. One coded area preferred “elements independent of nature”, and one coded area established “a relationship with efficiency”. (Figure 13)

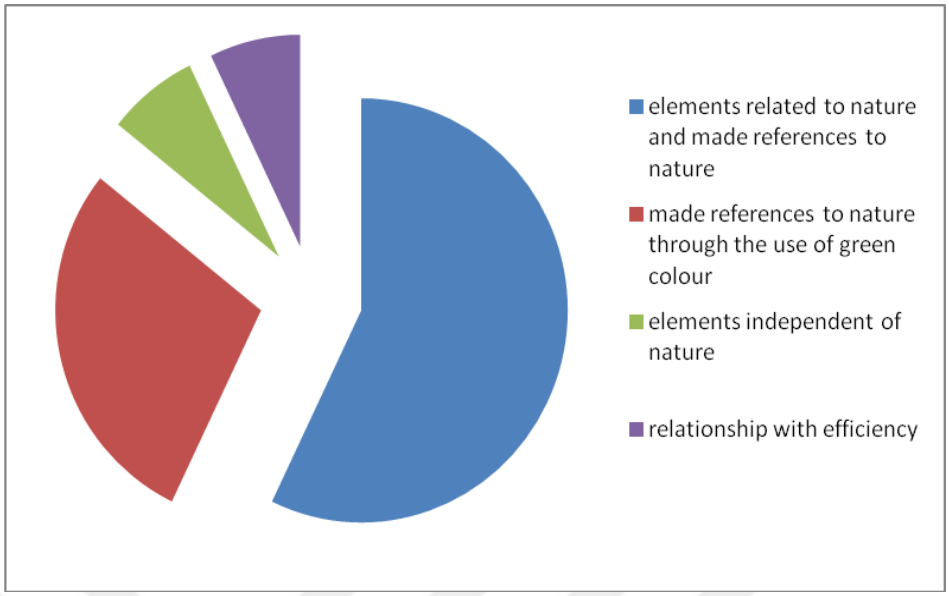

Figure 13
Distribution of logo code

The code “slogan” was used to code 31 areas among the fourteen field notes. These include four slogans that “advocate for improved agricultural production through advanced technology and soilless agriculture”, three slogans that “view soilless agriculture as a profitable business area”, three slogans that assert “the healthier products produced through soilless agriculture”, three slogans that emphasize “year-round production capabilities”, three slogans that argue for “the ease of soilless agriculture production”, five slogans that claim “the higher quality of products from soilless agriculture”, two slogans that “encourage consumers to engage in soilless agriculture”, three slogans that highlight “the social and economic sustainability aspects of soilless agriculture”, and six slogans that argue for “soilless agriculture serving larger purposes”. (Figure 14)

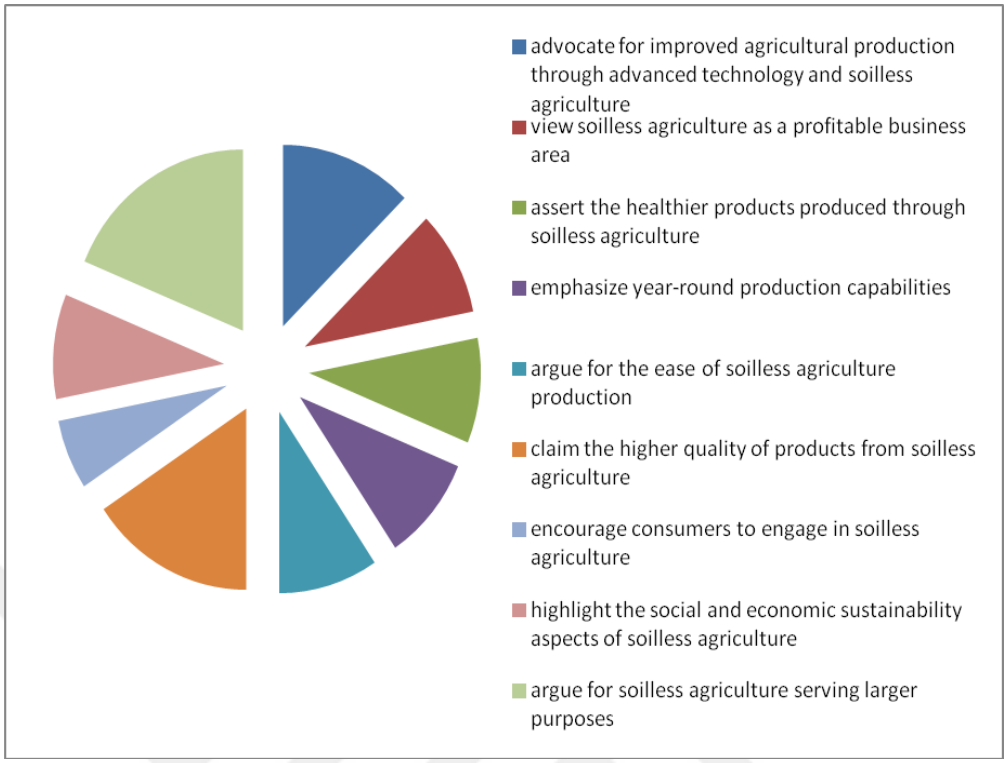

Figure 14
Distribution of slogan code

The code “the problem” was used for 19 areas among the four field notes. Out of these 19 codes, six of them defined the problem as “global population growth”, eleven highlighted issues such as “the excessive use of limited agricultural land, climate change, waste, and food insecurity”. Additionally, five coded areas identified the problem with “production systems”, while two described “the quality and freshness of products” as problematic. Lastly, one coded area identified the problem as “social insecurity”. (Figure 15)

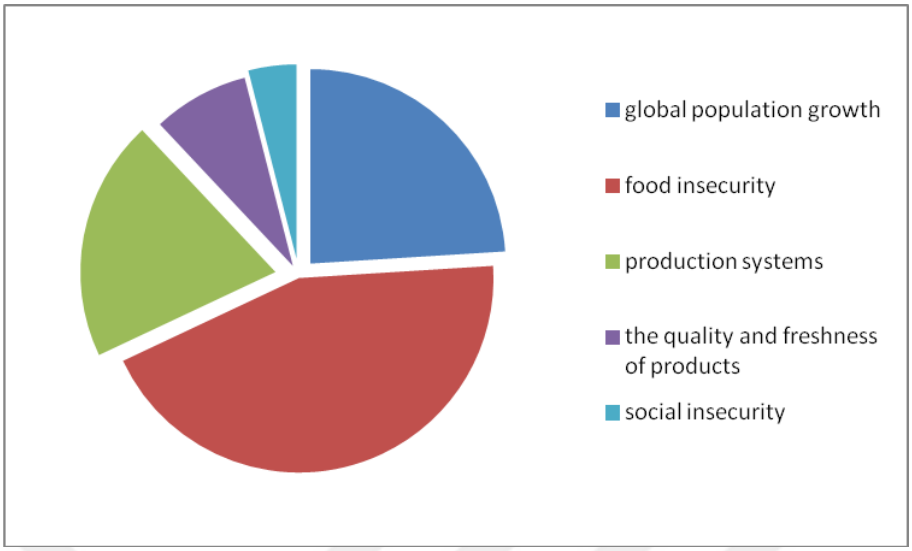

Figure 15
Distribution of the problem code

The code “ecology” was used 24 times among the fourteen field notes. Out of these coded areas, three highlighted “the use of ecology as a marketing tool”, three emphasized “ecology as plant-focused and aimed at taking good care of plants”, five emphasized “ecology as valuing the living Earth”, six focused on “the financial aspects of ecology”, and five focused on “ecological discourse that prioritizes consumer health”. (Figure 16)

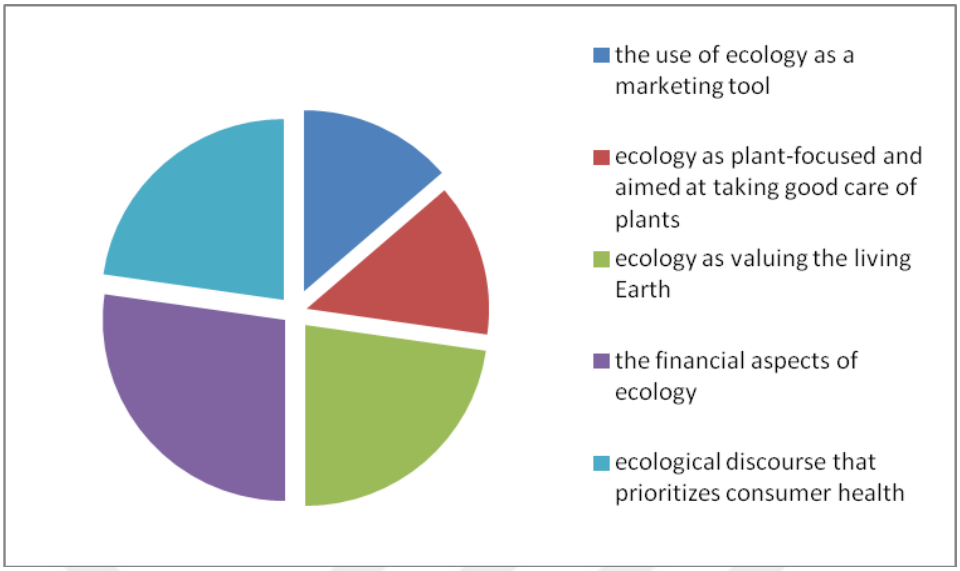

Figure 16
Distribution of ecology code

The code “technology” was used 47 times among the fourteen field notes. Out of these coded areas, three highlighted that “technology offers a more sustainable future”, fourteen emphasized that “technology enables more efficient production”, seventeen stated that “technology provides controlled production”, two mentioned that “technology provides higher quality products”, eleven highlighted that “technology enables ecologically sustainable production”, and five expressed that “technology positively influences agriculture”. (Figure 17)

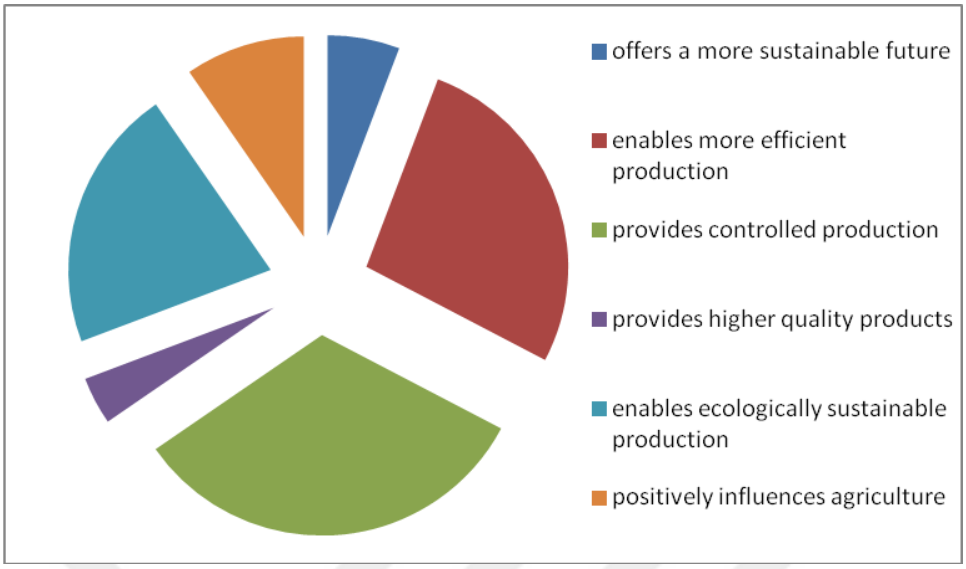

Figure 17
Distribution of technology code

The code “farmer profile” was used 26 times among the fourteen field notes. Out of these coded areas, two of them referred to “the scientist/farmer profile”, three mentioned “the corporate/engineer/farmer profile”, three described “the shirted farmer profile”, one referred to “the uncertain and experienced farmer profile”, one mentioned “the physically and mentally disabled farmer profile”, one referred to “the traditional farmer profile”, and five discussed “the non-human technological farmer profile”. (Figure 18)

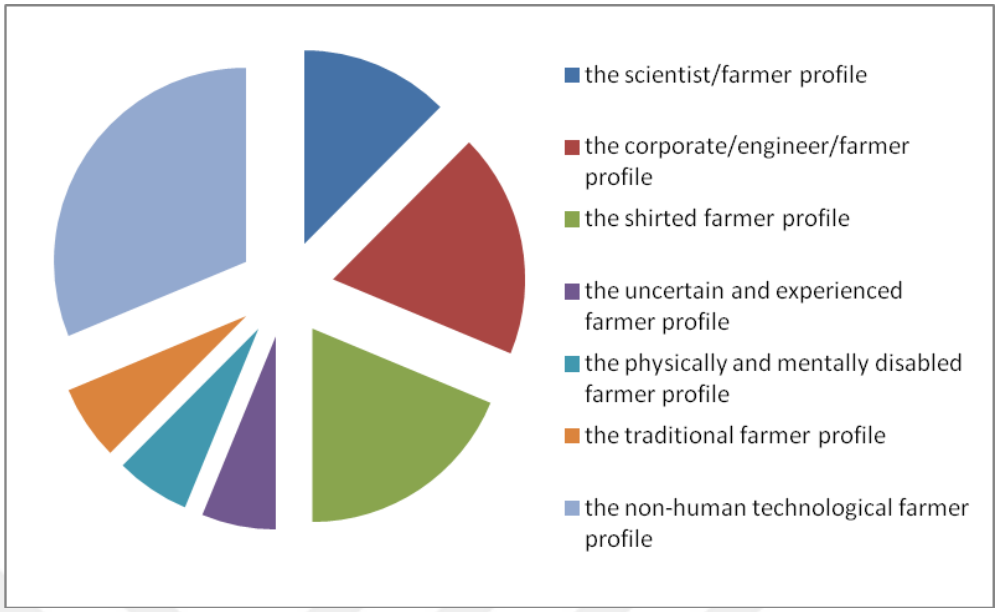

Figure 18
Distribution of farmer profile code

The code “future” was used 21 times among the fourteen field notes. Within these coded areas, there are four instances where “the future, where technology and agriculture are all constructed together, in progress and as a necessity”, four instances where “the future is designed with food as “clean food” produced through vertical farming rather than traditional agriculture”, five instances where “the future is designed with producers as different from traditional farmers”, seven instances where “future production areas are conceptualized as locations other than traditional fields”, one instance where “the future emphasizes more efficient production”, and four instances where “the future supports the perception of change as a must”. (Figure 19)

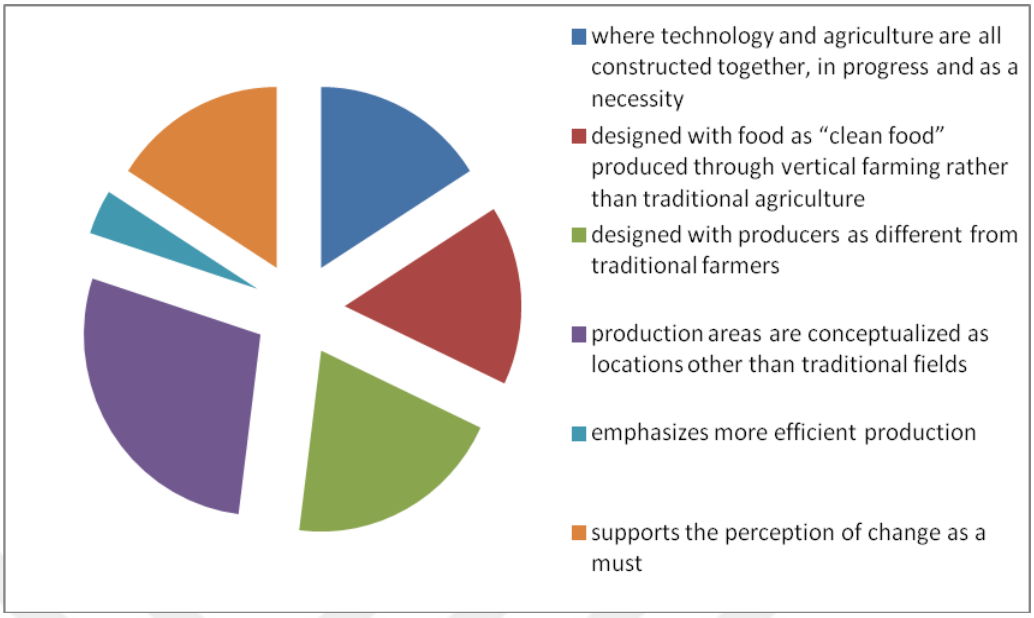

Figure 19
Distribution of future code

4.2 Analysis of the Data

In this section, I will examine the numerical data derived from the coded sections of fourteen web pages, focusing on the complex interaction of sustainability, efficiency, and the conceptual framework introduced by Donna Haraway.

4.2.1 Sustainability or Business

According to the websites of the fourteen different hydroponic farming producers, the company providing support for hydroponic farming installations, and the companies supplying hydroponic farming products, they see the concept of sustainability dominantly as "the environmental impacts of agricultural production" and then “reduction of environmental impacts”, and “advantages of soilless agriculture”. It means that sustainability is seen as ecological sustainability and also the positive consequence of soilless agricultural production method.

For example, Ironox describes sustainability as follows:

> *They mention building a sustainable food system that has a positive impact and consequences on the world and also they emphasize that people from different professional backgrounds and experiences have come together to seek solutions to food-related problems.* (Ironox, What we do?)

Here, it is stated that soilless agriculture, seen as a sustainable food system, has positive effects on the world. They made a connection between sustainability and nature.

Similarly, Vertical Harvest presents sustainable methods, as solutions to the negative impact of cities on nature. In “About us” page, they stated that “One of the reasons is to reduce the negative impact of cities on nature considering cities as the largest food importers. The aim is to create more sustainable and self-sufficient cities.”

Indeed, in this context, sustainability is mentioned as reducing the harm to nature that comes with soilless agriculture.

Furthermore, the concept of sustainability is mentioned as “the responsibility towards the future and societal conditions” equally emphasized with its perception of “preference for the amount of natural resources”. Moreover, the perceptions of “controlled waste”, and "reconnection of production and consumption" closely follow with nuanced differentiations.

Haifa mentioned about the responsibility towards the future and societal conditions as, “Human rights and equality between the genders, empowering women and girls, eradicating poverty in all its forms and preserving the environment”, in their “Sustainable Development Goals” page.

On Ironox, the preference for the amount of natural resources showed as, “The world's population increases, the harmful impact of agriculture on the environment

also increases. Ironox imagined the system to grow fresh produce using less space and fewer resources.”

At the same web page, they showed controlled waste as:

> *Three headings with small logos and brief descriptions are provided. The first heading is "accurate yield prediction." It states that Ironox can predict crop yields and plan the harvest accordingly, ensuring that they deliver exactly what is ordered. This approach results in less waste since the delivery is based on the specific needs of each location.* (Ironox)

On Gotham Greens, they mentioned the reconnection of production and consumption as:

> *For example, it is mentioned that a commercially operated greenhouse can also function as a supermarket. They also mention their collaboration with Whole Foods, informing the society about local food production, sustainable energy, water conservation, and the reuse of urban areas.* (Gotham Greens, Story)

In this case, when considering the overall presence of these sustainability perceptions, it is evident that the concept of "the environmental impacts of agricultural production," which was initially mentioned and has the highest occurrence, significantly surpasses the others. When the concept is considered on its own, the ecological context for soilless agriculture stands out. Although these perceptions of sustainability include the relationship with the environment, the form and quantity of consumption of natural resources, and the reconnection of agricultural production and consumption involving situations such as transportation and carbon footprint, they do not explicitly support an orientation towards the preference for soilless agriculture as a production method. These perceptions highlight and reflect the outcomes and advantages associated with soilless agriculture. In summary, it can be stated that sustainability appears to be more of a

consequence of engaging in soilless agriculture rather than a prominent factor driving the preference for soilless agriculture.

Among the slogans associated with sustainability, sustainability is positioned as “highlighting the features of soilless agriculture that support the social and economic sustainability.” Slogans are messages we want to convey to consumers. They are intended to be the first thing that catches their attention and summarize the situation. It is important to consider the message they convey.

On the Vertical Harvest website:

> *They mention their goals with the heading "Grow food vertically & create jobs locally." In the description below, they write "Help us change the world." They state that their company produces fresh, local produce year-round through hydroponic farming and also provides employment opportunities for underserved populations.* (Vertical Harvest, Home page)

On Gotham Greens' web page, they used the heading "Cultivating cities, and growing veggies too". (Gotham Greens, Farms)

Here, they emphasized this blurring about cities and agricultural production areas. In this regard, it appears that the focus is on highlighting the economic and social sustainability aspects of soilless farming. Although social sustainability is the least coded among these websites, it is still an important topic that they want to draw attention to. This may be because it has the potential to impact consumers. On the other hand, highlighting the economic sustainability aspect is also a key focus. From this, we can infer that there is an intention to influence consumers with regards to this aspect.

In some websites, sustainability is discussed as a problem, with references to “food insecurity” and “social insecurity”. However, despite “food insecurity” being prioritized among the other concepts mentioned as problems, such as “global

population growth", "production systems," and "product quality and freshness," the number of issues unrelated to sustainability seems slightly higher than those associated with sustainability. If the problem is seen as separate from sustainability, it can be argued that the products produced in this field could potentially provide a solution to another problem. In that case, can we say that the focus is on a different aspect unrelated to sustainability?

From another perspective, when examining the areas where companies discuss their own values and their purpose of existence in relation to the preference for soilless agriculture, I can observe sustainability as follows. It is important to explain their values and aims through sustainability. However, the crucial point is to assess how much of the value and aim coding examined on these websites is related to sustainability. In terms of the values code, we can say that the sum of values that highlight business and technology is roughly equivalent to the number of values associated with environmental issues and sustainability.

On Gotham Greens' website:

> *Under the heading "Our Values," the company lists its values as vision, sustainability, technology, community, locality, and quality. In the vision section, they describe themselves as farmers in apartment buildings. They highlight that they see what others perceive as grey as green, that they create flourishing communities out of what others see as urban decay, and that they produce the freshest food in the world. They mention that local, fresh, and sustainable food is actually a response to the beautiful things in the world.*
> *In connection with this, they also mention that they are committed to taste, quality, and sustainability. We can say that their concept of sustainability is based on ecological reasons rather than just efficiency.* (Gotham Greens, Story)

In terms of company values, the sum of "environmentally conscious" and "sustainability-oriented" values is slightly higher than the sum of values that align with "business interests" and "technology oriented", although the difference is not

significant. The values associated with sustainability and the environment, are as follows:

On Ironox's website, they defined their values as "one team, challenging the status quo, and doing good for people and the planet."

On the other hand, in the areas where companies discuss their purpose of existence, aims such as “reducing the environmental impacts of agricultural production processes” and “supporting social and environmental development” constitute 18% and 24% of the total aims mentioned.

Urban Cultivator's website addresses the reduction of environmental impacts of agricultural production as follows:

> *To make healthy and organic herbs, vegetables, and microgreens accessible to every family while reducing carbon footprint.* (Urban Cultivator, Our Mission)
> *A 2-minute and 37-second video is added. In the video, rotating images of the cabinets are shown, and Tarren Wolfe, the founder, begins by expressing their desire to make a change in the market and create something different. They emphasize the importance of reducing carbon footprint and promoting healthy food.* (Urban Cultivator, About Us)

On the Vertical Harvest website, they mention their commitment to supporting social and environmental development:

> *In the continuation of the statement, it is mentioned that by growing crops on these small-scale areas and employing the forgotten workforce, the perspective on food and job insecurity in the country can be changed. Finally, in capital letters, it states “be a changemaker”* (Vertical Harvest, Home Page)

I found that it encourages and invites consumers to be part of the change, and it also implies another meaning: being consumer of Vertical Harvest.

> *They also see food and food production system as a tool for change. Among their goals are providing local services, supporting the regional development, bringing food production closer to home as a more localized model, and establishing a network of farmers.* (Vetical Harvest, The Story, About Us)

It is important to understand these companies and their reasons for existence. It is also important to understand their relation with sustainability. Why it is important? It is important to understand their reasons for existence, what they value, and what they prioritize in order to determine their focus. In this regard, the most coded aim appears to be “providing accessible and healthy food”, which is not unreasonable considering that the most significant problems are “food insecurity” and “global population growth.”

Sustainability is often showed in the field of ecology as companies focusing on plant-centric approaches and aiming to take good care of plants. It is associated with production methods that value the Earth's ecosystem. On the other hand, the relationship between sustainability and technology is discussed in terms of technology offering a more sustainable future.

On Ironox’s webpage:

> *I am moving to the "Technology" page. The page starts with a video featuring a girl looking through a telescope, and the headline reads, "Plant Science, Robotics, and Data: A Pathway to Net-Zero Farming." Here, science and robotics seem to serve the same purpose or address the same issue: net-zero farming, which refers to agriculture with reduced negative environmental impact.* (Ironox, Technology)

I can say that soilless agriculture connects to sustainability and efficiency through technology. Soilless agriculture cannot be considered efficient and sustainable without the input of technology; these are intertwined elements that come together.

When examining the concept of sustainability across the fourteen websites I have analysed, the overlapping concepts highlight the environmental benefits of soilless agriculture rather than being the first reason for its preference. The ecological

consequences have been emphasized, but they have not been seen as the motivation for starting soilless agriculture.

When examining the sections related to the preference for or promotion of soilless agriculture, it is evident that it is primarily associated with “business.” Among the areas where soilless agriculture is mentioned across these fourteen websites, 13% focus on showing soilless agriculture as an investment instrument, while 29% emphasize soilless agriculture on efficiency. Another 29% highlight the superiority of soilless agriculture over other production methods. When considering the elevation of soilless agriculture in contrast to other production methods, which can be seen as marginalizing them, it can be interpreted as a promotion of soilless agriculture. In the remaining sections, 13% associate soilless agriculture with sustainability, and 17% link it to technology and the future.

On the website of Resif Sera, soilless agriculture is mentioned in relation to efficiency as “Soilless agriculture is preferred for strawberry production due to its ability to provide controlled climate conditions, protection against diseases, early harvesting, and high yields.” (Resif Sera, Hydroponic Strawberry Greenhouse)

On the website of Ttfarm, the question "Why soilless agriculture?" is answered as “...is about the early harvesting, increased yield, independence from soil, and improvements in productivity and quality.” (Ttfarm, Frequently Asked Questions)

On the website of Artechno Grow Systems, the areas associated with business are presented as follows:

> *On the page, there is a background photo of vegetables in a greenhouse. The page primarily emphasizes “being your partner in personalizing/customizing technology, and there is a “Contact Us” button right below it to get more information about this system.* (Artechno Grow Systems, Hydroponics)

Through this interaction with the consumer, I clearly perceive the company as business or enterprise.

In Vertical Harvest's webpage, areas related to sustainability, technology, and the future are presented as the section titled “Radio & Podcasts,” where they have included various broadcasts, also has shows like “Vertical Farming Podcast” and “Future of Food.”

This section adds an additional dimension to their website, providing users with access to relevant audio content related to vertical farming and the future of food. It indicates that Vertical Harvest is actively engaged in promoting knowledge sharing and staying up-to-date with industry trends and also it shows that they see vertical farming as a solution for the future of food.

On Seed Leaves’ website:

> *On the third photo, vertical farming being done inside a home, where two girls of different ages are looking at and picking produce from the vertical setup, appearing happy. The headline used for this photo is “Tower garden home”. The description mentions that they provide indoor production systems, enabling us to have access to food in our homes 365 days a year.* (Seed Leaves, Tower Garden at Home)

The choice of featuring young children in the photo is interesting, as it reflects themes of the future, innovation, and the belief that young people are the future. It also conveys the idea that they see themselves as part of that future.

On Gotham Greens’ webpage the relation between soilless agriculture and sustainability is clearly evident on their website:

> *At the very end of the page, there is a question, “Why grow in a greenhouse?” and their answer to it. The response emphasizes that with advanced technology in greenhouses, we can have year-round fresh production, resulting in reduced resource consumption and waste. It is also mentioned that greenhouses in cities are at the centre of the quality and the sustainability.* (Gotham Greens, FAQ)

When examining the domain of "business," which is one of the most frequently mentioned code after sustainability; I observe that soilless agriculture is mentioned as an industry. In this domain, soilless agriculture is described "as a sector with growth potential", and it is emphasized that "soilless agriculture is profitable". These areas constitute a significant portion, accounting for 13% and 16%, respectively.

The areas where Artechno Grow Systems creates the perception of being a sector with growth potential on their website are as follows:

> *The person in charge explained how they started as a small company in the field of water technology and added that have now expanded to offer comprehensive services in various areas. They also mentioned their partners and presented the latest news.* (Artechno Grow Systems, How it all began)

On Vertical Harvest's The Story webpage it is mentioned "How startups that began in unfavorable locations have risen to become high-rise plant factories."

On Netled's webpage:

> *It is mentioned that if we want to get into the vertical farming business or expand our existing operations, we are in the right place and it is suggested to grow together. Two things that caught my attention here are the mention of "vertical farming business" as an industry or sector and the dual meaning in "Let's get growing!", referring both to business and plants.* (Netled, Home Page)

The areas that mention the profitability of soilless farming are as follows on the Resif Sera website:

> *On their webpage, it has been ranked first on the list of profitable business ideas for investors, and therefore, the entry of large capital holding companies into the sector has been effective in the widespread adoption of soilless agriculture production system.* (Resif Sera, Bilgi Bankası, Topraksız Tarım Nedir?)

In the field of sustainability, the concept of "low input cost" holds a value of 6%. It is indeed important to understand what sustainability is associated with and what it is not associated with in order to grasp the context. As I mentioned earlier, when sustainability is examined in alone, it is primarily focused on reducing

environmental impacts. However, when it is combined with the concept of efficiency, its perception changes.

The concept of low input costs is reflected on Story and Locality page, Gotham Greens' website as “Spending less time in transit means less wilting and waste. Additionally, the fuel consumption reduced because of the company's transportation network, and also reducing carbon emissions and air pollution.”

On Vertical Farming page Artechno Grow Systems', the benefits are presented as “labor savings, low maintenance requirements, and the ideal method of transporting plants in water for plant health.”

When examining “efficiency,” another highly mentioned code, it is observed that “business” and profitability oriented criteria such as “cost-effectiveness”, “increased production quantity”, and “year-round production without being limited by seasonality” constitute a significant portion of the efficiency, accounting for 15%, 31%, and 9%, respectively.

The cost-effectiveness of Artechno Grow Systems is presented on their website as follows:

> *Just below that, Artechno Grow Systems mentioned the advantages of hydroponics. There are three listed advantages. It is described as a comprehensive solution, controlled from a single location, and providing labor savings as the final advantage.* (Artechno Grow Systems, Vertical Farming & Hydroponics)

On Vegbed's Grow Guide page, it is shown as “For hydroponic producers, the highest cost is often associated with the changing layout of the growing area over time.”

Vertical Harvest's website shows as the following:

> *In a news article, it is mentioned that vertical farming yields more produce per square meter compared to traditional agriculture. It states that vertical farming*

> *consumes less water and additionally they also highlight that vertical farming is more efficient, faster-growing, and more productive.* (Vertical Harvest, Press&Media)

Regarding the ability to harvest products all year round, Gotham Greens' page states:

> *On the left side, there is a picture of lettuce, and on the right side, it is described that the lettuce can be harvested year-round. They also mention that their greenhouses rely on solar and wind energy while providing a climate-controlled environment that allows for year-round growth.* (Gotham Greens, Story)

Resif Sera describes the advantages of lettuce cultivation in soilless farming as follows:

> *It is mentioned that lettuce cultivation in soilless farming production method shortens the harvest period and allows for high-quality production throughout the entire year, thanks to the climate control technologies in the enclosed cultivation facilities.* (Resif Sera, Package Greenhouses)

In the context of company establishment purposes, the objectives of "creating a differentiation in the production market", "providing easy, efficient, and effective production methods," and "offering good investment service options" constitute a 24% portion. In this context, there are still business-oriented objectives presented.

In Urban Cultivator's website, they showed "making a difference in the production market" as follows:

> *On their webpage, there is a 2-minute and 37-second video. In this video, the visuals of their cabinets are rotating, and Tarren Wolfe, the founder, is introduced. He starts his speech by mentioning their desire to make a change in the market and create a difference.* (Urban Cultivator, About Us)

The purpose of being an easy, good, and efficient production tool is showed on Vegbed's website as:

> *It starts by introducing Albert Lin as the founder of Vegbed, stating that he established the company in 2017. He says that the aim of Vegbed is to create a better and easier production tool for hydroponic farming communities. A letter from Albert is included, where he explains why and how he started this journey.*

> *He shares that he was inspired by a friend's post on growing lettuce through hydroponics on Facebook. This sparked his interest in the field, and he began researching, realizing that hydroponics appeared to be much more efficient than traditional soil-based farming. As a result, he started experimenting with vertical farming, and during the process, he noticed the amount of dirt and cleaning required. This led him to seek a solution for easy and cost-effective cleaning, which resulted in the production of Vegbeds—clean, easy-to-use, and economically feasible hydroponic systems* (Vegbed, About Us)

Artechno Grow Systems has stated on their website that their aim is to provide excellent investment services. On Vertical Farming page, they emphasize their goal of offering comprehensive services to their customers in terms of planting and agriculture.

In the areas discussing soilless agriculture, sections that explain soilless agriculture in terms of efficiency constitute 29%, while sections referring to soilless agriculture as an investment instrument cover 13% of the content. From a broader perspective, soilless agriculture is perceived as an investment opportunity and a business, where the emphasis on efficiency is primarily associated with productivity.

On Package Greenhouses page, Resif Sera's website, the areas where soilless agriculture is explained in terms of efficiency are as "soilless agriculture is preferred for strawberry production due to controlled climate conditions, disease prevention, early yields, and high productivity."

On Ttfarm's website:

> *The relationship between soilless agriculture and efficiency is discussed in the answer to the question of why soilless agriculture. The emphasis is on early yields, higher crop production, independence from soil, and increased productivity and quality.* (Ttfarm, Projelerimiz)

In summary, it can be concluded that the preference for soilless agriculture is primarily driven by profitability and efficiency rather than its relationship with sustainability. Sustainability, in this context, is presented as a secondary factor or

advantage that comes with soilless agriculture, rather than a primary motivation to adopt this form of farming. Occasionally, sustainability is mentioned as a primary reason, focusing on reducing the environmental impacts of agricultural production and providing a sustainable future.

4.2.2 Interaction of Notions Sustainability and Efficiency

The common ground between sustainability and efficiency concepts is built upon economic sustainability in soilless agriculture. Both of these concepts are profit-oriented in the field of soilless agriculture. While environmental sustainability and reduced consumption of natural resources are mentioned in the sustainability aspect, their intersection with the efficiency concept lies in areas such as low input costs, preference for reduced resource consumption, cost-saving, and reduced energy consumption. These topics are also associated with economic sustainability.

The areas where both sustainability and efficiency are simultaneously encoded are as follows:

On the Seed Leaves website:

> *Next, a moving image is added, showing two young girls walking through a corridor in an area where vertical farming is being conducted, with their faces not visible. It is written in large fonts that it offers 950% more production, 30% higher yield, 95% less water usage, and 3 times faster growth.* (Seed Leaves, Home)

> *As I continue scrolling down the homepage, another heading appears, "Tower Garden Super Simple to Grow 365", and its description begins with the sentence: "We can take control of where our food comes from and grow it in our own homes." It is stated that with this system, production can be achieved throughout the year with less effort, mentioning the increasing food prices of today. It is also mentioned that by setting up a system, it is possible to achieve 95% less water usage, 3 times faster growth, and 30% more harvest. It is stated that a lettuce can be grown from seed within 5 weeks, and they want to emphasize the wide range of products by adding other vegetables such as cherry tomatoes, cucumbers, and zucchini alongside lettuce.* (Seed Leaves, Home)

On the Vertical Harvest webpage, it is shown as follows:

> *In the description on the left side, under the heading "Urban Hydroponic Farms", it is mentioned that the features of the farm include delivering from farm to plate within 24 hours, consuming less space and water, and providing working opportunities to over 40 underserved individuals.* (Vertical Harvest, Home Page)

On the Gotham Greens webpage, it is presented as follows:

> *In the description, it is written that convertible hydroponic systems are the most water-efficient farming method in the world. The company's irrigation system uses 10 times less water compared to conventional production.*
> *For less energy, footprint, and waste, they make the following statement: having greenhouses close to consumers reduces long journeys and the need for refrigerated transport. Less time spent on transportation means less wilting and waste. They also mention that the company's transportation network reduces fuel consumption, thus affecting carbon emissions and air pollution.* (Gotham Greens, Story)

Considering ecological sustainability, we can consider it as an efficient production technique. It is mentioned that we can obtain more products by using fewer resources in this production system. However, the definition of efficiency in soilless agriculture is related to how it is defined. The concept of efficiency is described as achieving profitability, increasing production, and reducing material resource consumption in this field. In this regard, the areas where these two concepts intersect align with economic sustainability.

4.3 Interaction of Soilless Agriculture and Donna Haraway

In this section of the analysis, I will utilize the data gathered from the fieldwork to examine the concepts proposed by Haraway in the context of sustainability and efficiency. First, I will apply the concept of situated knowledge to the field of soilless agriculture and explore its relationship with technology. Furthermore, I will explore the concepts of cyborg, forced life, and the Plantationocene, as developed by Haraway, in connection with soilless agricultural practices and their implications for sustainability and efficiency.

4.3.1 Situated Knowledge

According to Haraway's concept of situated knowledge, an individual's perception of the world, social and cultural background, and personal experiences influence the production and understanding of knowledge. Knowledge, by its nature, is not independent of identity, experiences, space, and time. This condition also affects the establishment or reconfiguration of power relations. (Haraway, 2013, p. 188). In this regard, technology and Haraway's concept of situated knowledge can be considered together. From Haraway's perspective, accepting the existence of situated knowledge allows us to challenge the production of scientific knowledge by certain classes or societies and opens up the opportunity to change it. Technology can be an instrument to change this and expand the domain of knowledge.

Considering using of technology, is it produced by a specific group, class, or family? After being produced, who has access to its use? Additionally, what are the benefits and consequences that arise from its use? In this way, we can consider soilless agriculture and the technologies used in it. For example, from one perspective, we can argue that soilless agriculture parallels Haraway's ideas because it differs from traditional farming, leading to a transformation of existing knowledge and offering distinct advantages compared to traditional agricultural methods. However, from another perspective, I believe it is worth asking the questions mentioned above. For instance, who produces soilless agriculture technologies? Is it the traditional farmers or investors? How does the utilization of these technologies in soilless agriculture alter the balance between production systems and farmers?

Let us examine soilless agricultural producers and the producers of soilless agricultural technologies, who distinguish themselves from traditional farmers.

Firstly, it is known that soilless agriculture entails higher initial costs compared to traditional farming. As a result, individuals, groups, or companies who venture into soilless agriculture possess the necessary economic resources to cover these expenses. Now, who benefits from this mode of production? We can once again refer to the groups involved in producing this form of agriculture. While it is true that in the long-term, if all forms of production transition towards sustainable practices, the resulting benefits will be enjoyed by everyone in a better world. However, at this stage, soilless agriculture occupies only a small fraction within the overall agricultural landscape, thus its ecological impact will primarily be experienced within its immediate surroundings, while the economic benefits will primarily benefit the investors.

Let us imagine a scenario where a specific group is responsible for producing soilless agricultural technologies, while on the other side, there are traditional farmers engaged in conventional production methods. Do soilless agricultural producers aim to share their knowledge and interact with other farmers to transform agriculture after recognizing the ecological and economic benefits of their approach? Or do they continue to prioritize their own economic profitability? Their possession of technological and agricultural knowledge, which serves to sustain and empower their own community, may limit its reach to a particular environment. From one perspective, the traditional agricultural knowledge has been altered by the introduction of soilless agricultural knowledge, resulting in a reduction of the power dynamics associated with traditional farming. On the other hand, soilless agricultural knowledge, being confined to a specific group, has only benefitted a limited portion of the population, giving rise to a new power dynamic. It is worth considering that

this space can be reshaped by the emergence of new knowledge and the involvement of different groups. However, it can be argued that the creation of a more equitable order, as envisioned by Haraway, has yet to be achieved and has possibly given rise to other forms of unequal relationships.

I think that technological and technical knowledge, while potentially posing a threat to ancient knowledge, might create a divide. While methods such as soilless agriculture won't solve the world's food crisis and eliminate ancient knowledge, I also consider that technological advancements in this context could further create division.

Through the use of technologies in soilless agriculture, we can argue that Haraway's perspective blurs the boundaries between plant and human relationships. For instance, by converting the water, humidity, light, and nutrient needs of plants into information that humans can understand, we can say that the relationship between humans and plants is reshaped. However, the primary motivation behind the desire to understand plants remains to fulfill human needs. I can say that as a result, the emphasis on the efficiency of soilless agriculture reinforces the dominant position of humans in the human-plant relationship, is highlighted in the analysis as global population growth.

If we consider how the acquired knowledge about plants has altered the plant-human relationship, the primary focus remains on benefiting humans. The knowledge gained about the needs of plants is not primarily designed to serve and improve living conditions of plants. Rather, it focuses on human needs, such as promoting healthier and higher quality nutrition, and ensuring food security for humans. In this context, the knowledge has not evolved into a more equitable

arrangement; instead, it has further strengthened the power dynamic that is human-centric.

4.3.2 Cyborg Manifesto

Haraway, in "Cyborg Manifesto," discusses the hybridity and fusion of machine and organism, referring to it as cyborg. According to Haraway, this hybridity strengthens the concept of freedom and removes dualistic structures. For instance, distinctions such as human, animal, plant, woman, and man disappear, and they converge under the singular form of being: becoming cyborg. Technology not only serves as a mediator in this situation but also as one of the actors. (Seidman, 1994, p. 83).

When examining soilless agriculture, these technologies enable the translation of plant needs into human language. Consequently, plants are no longer constrained to grow only in soil, as they exist in their natural state. Furthermore, through the utilisation of technology, plants can reach greater quantities and qualities beyond what is achievable under natural conditions.

From another perspective, does the expansion of freedom occur with this hybridization as Haraway suggests? Regarding soilless agriculture, from a human standpoint, it can be argued that the integration of plants with technology enables them to serve more for individuals, human desires and needs independently of seasons, weather conditions, and even the need to comprehend plants. Therefore, in terms of human being, I can talk about the experience a sense of liberation. However, is this liberation applicable to all actors involved? It can be said that it primarily benefits human needs. On the other hand, while there are some instances of blurring boundaries between humans, technology, plants, and animals in soilless agriculture

producers, it is not a prevailing consensus. For instance, on the website of a soilless agriculture producer, when introducing the staff members, robots with human names are presented alongside human employees. Conversely, in other examples, female figures were described in photographs associated with home-based production, aligning them with domestic settings.

When considering Haraway's concept of cyborgization, it may appear to progress in parallel with soilless agriculture. However, the distinguishing aspects should not be overlooked. As communication between plants and humans advances, the boundaries between them become blurred. Technology can intertwine the existence of humans and plants, leading to a blurring of distinctions. In this context, a significant question arises: the purpose all this blurring serves and what makes these areas more clear while blurring the others. While one can argue that the boundaries of the human-plant relationship are blurred, it can also be asserted that this blurring alters the power dynamics to strengthen human domination. With greater knowledge about plants, humans have increased their power to control them. On the other hand, the relationship between humans and technology is inherently unequal from the beginning, given that technology is created by humans.

Cyborgization also shares a similarity with situated knowledge. Although Haraway considers a more just and equitable order through this hybridization, the initial objective being human-centered results in the deepening of existing inequalities. In fact, the blurring of boundaries in the human-plant relationship and the extensive knowledge about plants held by humans have a negative impact on the plant's autonomy. This is because plants do not have the same knowledge and human

do not experience the same effects. While it can be argued that these boundaries become blurred for each actor, but this blurring lies within the human world.

4.3.3 Forced Life

Haraway explained forced life as: “forced life is not the organization of the forces of life and death for flourishing, but rather for extractive profit.” She mentioned about the exploitation of ecological resources to sustain and expand human existence, with the eradication of the natural environment, transforming the Earth into a resource for the survival and growth of human beings. (*Transcript*, 2019). In this context, Haraway criticizes the perspective that prioritizes human salvation and development over ecology. She argues that in nature, life and death already exist in a balance, and emphasizing human survival as a means to "balance" this balance appears to be profit-based. Profiting from or monopolizing the consumption of Earth's resources only for human benefit can disrupt the ecosystem, ultimately disturbing the inherent balance.

There is indeed a meaningful connection that can be established between the concept of forced life and soilless agriculture, along with the technologies employed in it. When examining the ecological consequences of soilless agriculture, we can observe that natural resources are utilized more efficiently, leading to a more sustainable production system. This results in the efficient utilization of resources such as water and energy, while reducing human dependency on soil. However, if we consider the underlying reasons and goals of soilless agriculture, we see that its primary purpose is to feed the increasing population. It is still a situation that serves the purpose of human survival, but the positive aspect lies in its harmless impact on nature.

Is the solution only to make production more efficient to meet the food needs of the growing global population, which is seen as a problem? Even if we increase production, will societies struggling with hunger and scarcity disappear? While it is critical to minimize the environmental impact as we increase production, it is also important to consider the fair and equitable distribution of food. We can solve the problem by ensuring that existing resources are accessible to everyone, without the need to further increase production and consume more natural resources. Therefore, I can say that the focus is on pointing out the lack of the produced food, while not addressing the human-induced inequality in distribution.

In conclusion, while soilless agriculture can offer an alternative to the concept of forced life by contributing to a more sustainable environment, it is important to consider its underlying motivations. It remains primarily focused on human interests and, as a result, has become an attractive business model and field of production.

Furthermore, the gains in production still primarily address to a certain group of people's food needs. For instance, can regions and individuals struggling with hunger benefit from the food produced through methods like soilless agriculture that are claimed to be more efficient? In reality, the methods proposed as alternatives to change this unequal order, like cyborgization, technological improvements, continue to feed the same populations. Despite the efforts for a more equitable world, the implementation of these methods seems to maintain the existing dynamics in terms of food distribution and access. While efforts may be made to transform the current system, the actual outcome still tends to favor the same privileged groups.

It is essential to recognize that a single phenomenon or practice can have multiple outcomes and interpretations. While it may align with Haraway's ideas in terms of its impact, it may not necessarily align with her principles and objectives.

4.3.4 Plantationocene

Haraway's concept of the Plantationocene does not explicitly refer to a specific time period but instead focuses on the long-term interaction between humans and the environment. It draws attention to the significant ecological and social changes caused by plantation agriculture, such as deforestation, soil degradation, displacement of local communities, and the complex connections between human and non-human lives. (*Transcript*, 2019). This concept gives critical reflection on the complex relationships among humans, plants, animals, and land, and the implications they have for the Earth and its diverse ecosystems.

From the perspective of the Plantationocene, it can be argued that soilless agriculture helps reduce the negative environmental and social impacts associated with traditional plantations. It appears to be a more sustainable production system that consumes fewer natural resources. In this sense, soilless agriculture can emerge as an alternative production method to traditional plantations, addressing the critiques raised by the Plantationocene concept. On the other hand, the emergence of a changing farmer profile with soilless agriculture also raises ideas about its potential social implications. It is important to reflect on how these changes may impact the social area.

Similar to its relationship with Haraway's other concepts, in the case of soilless agriculture; I observe a more ecologically compatible production system. However, from a social perspective, it supports an unequal order. It can be argued that soilless

agriculture consumes fewer natural resources and has a lower environmental impact compared to traditional agriculture, but it negatively affects the social structure of farmers, the producers. The profile of soilless agriculture producer's varies. Similar to the situated knowledge concept mentioned earlier, the economic and intellectual gains of production are exclusively obtained by this particular group of producers.

CHAPTER 5

CONCLUSION

Soilless agriculture initially caught my attention due to its potential to address seemingly unsolvable problems: growing world population, food crisis and hunger. However, I observed that it is not exclusively implemented in areas with non-arable land. This observation led me to question why soilless agriculture is preferred and its relationship to sustainability. Furthermore, I desire to explore the connection of sustainability and efficiency in soilless agriculture. I wonder if soilless agriculture provides the solution for the significant global issues of overpopulation, hunger and food crisis.

I also wish to delve into why the production process is pointed as the problem and solution when there is another crucial phase, distribution, in the agricultural process while we all know there is a huge lack of equal and fair distribution of existing resources, to which we do not insist on finding effective solutions.

With this goal in mind, in Chapter 2, in the literature review part, to understand the stage that agriculture has reached, I explored agricultural history from the discovery of farming to soilless agriculture. I notice that the emergence of agriculture, the introduction of technological advancements into the agricultural sector, and the stages of transformation it brought about have parallels with the development of soilless agriculture. As a result, today, none of these topics are independent of the economic base, and our ability to discuss sustainability and efficiency within the agricultural sector begins within this economical context.

Then also I examined literature of sustainability and efficiency studies in the agricultural field to understand their meanings and to contextualize these concepts in

my own research. It became evident that sustainability can have multiple interpretations, shaped by time, space, and the social and cultural contexts of these spaces. In general, sustainability was defined as the ability to sustain production with available resources over an extended period. The focus was on increasing production to feed a growing population while simultaneously preserving natural resources and making the environment more sustainable for a longer period of time. Regarding the concept of efficiency, I can say that it can be defined as the efficient use of natural resources in terms of productivity. From these definitions, I can say that the two concepts are clearly related.

In Chapter 2 also talked about the studies on soilless agriculture which were primarily economic studies in this field. These studies questioned the feasibility of practicing soilless agriculture from an economic perspective and investigated how productivity of the crops changed. However, there was a lack of research on the political and social impacts of soilless agriculture, particularly in the social sciences. I did not come across any studies that explored the social effects of soilless agriculture in terms of changes in production areas and producers. These existing studies were informative in understanding the concept of soilless agriculture and how efficiency was approached in these studies. The fact that I could not easily access a study in the field of social sciences related to soilless agriculture clearly indicates that this production method is viewed from an economic perspective and profit-oriented approach.

In the final part of this chapter, as I included Haraway's concepts of cyborgization, situated knowledge, forced life and plantationocene to understand the future she envisions, I thought that there was a harmonious relationship between

Haraway's concepts and the field of soilless agriculture and its technologies, as well as an opportunity to reconsider her concepts through this context. She imagines looking at gender from a higher perspective, not only breaking free from the binary of male/female but also envisioning a world where the technological and the human are not separated, and where all these technological advancements eradicate inequality. She thought that technology could even alter and expand the knowledge that is produced by a certain class. I approached this field from Haraway's perspective to examine whether the technologies in soilless agriculture can potentially overcome inequalities in both agriculture and the food system and determine whether it could be a more sustainable and efficient method for the world.

In Chapter 3, to answer the questions why soilless agriculture is preferred and what is the relationship with sustainability, I used “netnography” and selected soilless agriculture websites and questioning the concepts of sustainability and efficiency. I chose these websites of soilless agriculture producers and material suppliers without any specific criteria.After writing specific field notes from these websites, I identified and related codes that I thought were associated with the topic. As a result of the codes I have determined and the numerical results obtained from it, I understand these relations by emphasizing the sustainability, business and efficiency, which are the most used codes.

Chapter 4 presents the results obtained from the analysis of numerical data and thoroughly discusses their implications for my research. The study reveals a significant contrast: while there is a weak correlation between soilless agriculture and sustainability, a strong correlation exists between soilless agriculture and profitability. The results, rooted in the applied methodologies and analyses,

underscore that soilless agriculture places a greater emphasis on profitability rather than sustainability. This focus on profitability is also reflected in the design of efficient practices within soilless agriculture.

Another observation is that the pursuit of sustainability appears more as an outcome rather than a primary motivation. While the ecological consequences are emphasized, they are not viewed as the motivation behind the initiation of soilless agriculture. On the contrary, it is crucial to emphasize the central focus on economic sustainability. Therefore, I can assert that soilless agriculture establishes a connection between sustainability and efficiency driven by economic factors, facilitated through technology. Essentially, the presence of technology in soilless agriculture becomes a fundamental necessity; these various aspects are interwoven like puzzle pieces working in harmony. To perceive soilless agriculture as both efficient and sustainable, the integration of technology holds significant importance as it reinforces the relationship between efficiency and sustainability in soilless agriculture. When considering sustainability alone, the primary focus lies on reducing environmental impacts. However, in terms of efficiency, the perception shifts towards profitability.

From a broader perspective, soilless agriculture is seen as an investment opportunity and a business, where the emphasis on efficiency is closely tied to productivity. In summary, it can be concluded that the preference for soilless agriculture is managed by profitability and efficiency, rather than its correlation with sustainability. In this context, sustainability assumes a secondary role, presenting itself as an additional advantage that accompanies soilless agriculture, rather than being the primary motivation for embracing this farming method. Occasionally,

sustainability is cited as a primary reason, centering on reducing the environmental impacts of agricultural production and ensuring a sustainable future.

We can discuss production systems within the economic framework and the context of the capitalist system. Recognizing soilless agriculture and its technologies as profit-driven enterprises, it becomes evident that this production system is a direct outcome of the capitalist economic framework and societal structure. In this context, soilless agriculture, while emerging as a product of capitalism, simultaneously reinforces and deepen the characteristics of the capitalist economic order. The system always fosters more competitive environments and aims for more profit. At this point, it does not establish a relationship with those left behind and who struggle to adapt. Perhaps the absence of social sustainability, missing from websites and also in the study, could be precisely related to this reason. In this narrative, traditional farmers, their problems, and their production methods are not needed. A new production system has been established and is presented in the production market glamorized with claims of being more efficient and sustainable. However, the answer to the problems as world's food crisis, food insecurity, and increasing population is not in this new and one-sided nourishing production system and enterprises. The real solution lies in improving the existing methods, distributing fairly, and being able to reimagine the current system.Through this study, within the context of the relationship between technology, sustainability, and efficiency, I have reached the conclusion that soilless agriculture technologies, within this economic system, have not provided a solution to the inequalities in the food system. In fact, it has deepened these inequalities, and scientific and technological knowledge strengthened the class-based divide. As a result of this reinforcement, it can be said that a production system

dominated by the powerful ones. In this context, it's crucial to take into account the ownership of these technologies. Business owners who acquire this technological power also gain influence in agricultural production mechanisms and they reinforce their existing power. However, these companies aren't likely to be the saviors of the future, the agriculture and the food system. The production method, soilless agriculture and its technologies, they show as sustainable and efficient are not comprehensive and inclusive enough to effectively adress problems such as hunger, food crises, and the challenges of global population growth.The question of sustainability remains essential: sustainability for whom? It has been observed that the discussed investment opportunities and business prospects might still primarily benefit a specific group. Technological power has not presented an opportunity distinct from empowering the already powerful. Vulnerable communities continue to seek solutions to their ongoing scarcity issues. Traditional farmers may encounter the same challenges they have so far faced, and it's also crucial to consider whether or not existing technological knowledge is being shared. Knowing that small-scale farmers feed most of the world's population, it is evident that the solution is not in developing new production systems which is profitable for the company owners.

In this context, Donna Haraway's vision of a harmonious integration of technology and humanity stands in stark contrast to the reality of today's world. While her concept aimed at creating a more just and equitable future, we often witness technological advancements being harnessed primarily for profit-driven motives. Although, I would personally prefer Haraway's cyborg world, unfortunately it appears that in the current state of human existence, inequality and profit-oriented

motives continue to overshadow environmental concerns and natural resources, resulting in their utilization for advertising purposes in the market.

In this context, the evolving landscape of agriculture, particularly the changing profile of farmers due to technological advancements, becomes emblematic of this divergence. The questions about the future of traditional farmers in the face of these transformative changes and the role of robots in contemporary agriculture are indicative of the broader societal shifts. The potential displacement of traditional farmers by automation and technology forces us to rethink the fundamental social, economic, and knowledge structures underpinning agriculture.

The challenges and opportunities posed by these changes in agriculture are the larger societal dilemmas we face – questions of economic inequality, and the impact of technology on farmer profile. While Haraway's vision remains inspiring, the realities of today's world underscore the urgent need to navigate the intersection of technology and society in a way that truly aligns with her ideals and addresses the profound implications of these changes. I thought it would be interesting to analyze, but due to time constraints and the scope of my study, I was unable to explore it in depth: the changing profile of farmers. I found myself contemplating questions such as the future of traditional farmers in the midst of these technological changes, and whether robots might assume the role of farmers or even be considered farmers themselves. These questions led me to the idea that these changes have the potential to reshape the social, economic structures, and knowledge systems associated with agriculture. The exploration of this dynamic transformation in farmer profile, becomes a vital research area for understanding and potentially shaping the future

where technology and humanity can coexist in a more equitable and sustainable manner.

I can also say that, by realizing how the processes I encountered towards the end of my study are related to the structure of Turkish agriculture, because of the farmer profile and in terms of the distribution of social and economic welfare; the findings can also be applicable to developing communities. For example, soilless agriculture within the Dutch economy may have provided solutions to specific issues in that region; it means that these technologies did not deepen these inequalities that I mentioned before. However, considering the motivations they mention on a global scale and on their websites, there is lack of motivation to solve the problems-hunger, growing world population- they talk about this production method which serves for mostly the Dutch people. In the context of the Turkish example, one may articulate a focus on inequality that is predominantly localized. However, in the case of the Netherlands, which encompasses divergent economic structures, the discourse may shift towards a more global inequality.

Unfortunately, we are closer to the conflict between the technological and the natural, as seen in Black Mirror's "Beyond the Sea" episode. On the other hand, I still think that having a presence in space as a production area for soilless agriculture, supporting space exploration, and ensuring the sustainability of activities there are essential. However, on Earth, I think it's more valuable to improve existing production systems for everyone rather than enriching these profit-oriented soilless agriculture methods.

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