EXPLORING RESILIENCE OF SOCIO-ECOLOGICAL PRODUCTIVE LANDSCAPE THROUGH UNDERSTANDING CHANGE, IMPACT AND RESPONSE AMONG FARMERS: THE CASE OF NORTHWESTERN ANKARA

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES OF MIDDLE EAST TECHNICAL UNIVERSITY

BY
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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY IN
CITY AND REGIONAL PLANNING

SEPTEMBER 2023
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ABSTRACT

EXPLORING RESILIENCE OF SOCIO-ECOLOGICAL PRODUCTIVE LANDSCAPE THROUGH UNDERSTANDING CHANGE, IMPACT AND RESPONSE AMONG FARMERS: THE CASE OF NORTHWESTERN ANKARA

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Doctor of Philosophy, City and Regional Planning
Supervisor: Prof. Dr. Anlı Ataöv Demirkan

September 2023, 480 pages

Rural areas are landscape areas that are constantly evolving in the historical process, where the human-ecology relationship evolved with culture. The transformation in agricultural production landscape, in which socio-ecological systems intersect, is important for the sustainability of rural and urban areas. In the evolving socio-ecological landscapes, Northwestern Ankara stands as a vibrant case study showcasing the dynamic interplay of human activities, agricultural practices, and natural forces. Encompassing the districts of Güdül, Beypazarı, and Ayaş, this region represents diverse agricultural activities, accounting for nearly 90% of Ankara's vegetable production. With unique climatic and topographical features facilitating agricultural biodiversity, it embodies the complexities of rural landscapes in Northern Ankara context. This research, rooted in the interpretivist paradigm, aims to explore the dynamics of Northwestern Ankara's socio-ecological productive
landscape, emphasizing its interaction with spatial, environmental, productive, and administrative systems amidst changing conditions. A mixed-methodological approach is employed, integrating qualitative interviews, geospatial data, secondary statistics, and on-site observations to provide a holistic view of the changing landscape dynamics. Three main dimensions are explored: Productive Landscape Components, Man-Made and Climatic Conditions, and Agricultural Production Steps. Through this lens, the study seeks to understand the adaptive responses of farmers, through focusing on the driving factors behind landscape changes, and the implications on farmers. The results aim to bridge the gaps between social and natural sciences, underscoring the need for integrated rural landscape management strategies in the face of change.

**Keywords:** Socio-Ecological Systems, Rural Planning, Socio-Ecological Productive Landscapes (SEPLs), Landscape Change, Adaptive Response
ÖZ

DEĞİŞİM VE ETKİLERİNE ÇİFTÇİLERİN VERDİKLERİ CEVAPLARI ANLAMAK YOLUYLA SOSYO-EKOLOJİK ÜRETİM PEYZAJINI DİRENÇLİLİĞİNİN ARAŞTIRILMASI: KUZEYBATI ANKARA ÖRNEĞİ

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Eylül 2023, 480 sayfa


**Anahtar Kelimeler:** Sosyo-Ekolojik Sistemler, Kırsal Planlama, Sosyo-Ekolojik Üretken Peyzajlar (SEPLs), Peyzaj Değişimi, Uyumluluq Yanıt
To my family
ACKNOWLEDGMENTS

This study has grown very organically from the start. My path crossed with my advisor, Prof. Dr. Anlı Ataöv, who has now become more than an advisor but a lifelong teacher and a part of my extended family throughout this journey. Our encounter was miraculous, and I believe that what we share is much larger than this study. Nevertheless, this study would not be as it is without her incomparable and invaluable support.

I am deeply grateful to the Thesis Monitoring Committee Members, Prof. Dr. Melih Pınarcıoğlu and Prof. Dr. Nilgül Karadeniz, for their intriguing questions and mind-opening discussions. Furthermore, I sincerely thank the Thesis Jury Members, Dr. Dicle Kortantamer and Prof. Dr. Menelaous Gkartzios, for their valuable contributions.

It was a long research journey marking a very important period of my life. As the length of the journey increased, many paths crossed with many people who have contributed to the study in various ways. I cannot thank them enough for every single support they provided.

I have become a part of various work environments and had the chance to work in diverse fields with diverse professionals. Among all, I thank my colleagues from Izmir Institute of Technology. It was a very self-exploratory experience to be on the teaching side of the profession. I specifically thank Prof. Dr. Koray Velibeyoğlu for supporting me since the beginning of my IZTECH journey.

I would like to express my gratitude to my last workplace, the Parabol Software, which I believe my path crossed for a purpose as a result of different encounters, and I became a part of them while completing this work. I sincerely thank them for providing me with the experience of working with wonderful people on a very difficult road, even if it is tiring, and for supporting me in finalizing this research.
Ceyhan Temürcü is one of the most inspiring people whom I have met during my research journey. His contribution to this study is immense, both in the initial conceptualization and the fieldwork which I conducted in Güdül. He encouraged me to become a part of the Dört Mevsim Ekolojik Yaşam Derneği (Four-Season Ecological Life Association) and the emerging agroecological studies in the region. I also would like to express my gratitude to the producers in this association and the Tahtacörencik Doğal Yaşam Kolektifi (Tahtacörencik Natural Life Collective) for their invaluable efforts in agricultural production.

I gratefully thank to my dear friends, Gülçin Dalkış Melek, Can Gölgelioglu, Burçak Dell’Uomo Safrı Çubukçuoğlu and Zeynep Özcan for their support during different stages and important milestones of this research.

My dear love, Tufan, suffered in this process but never gave up supporting me and listening to me. I thank him for not leaving me alone in every step of this work, from the conceptualization to the conduct of the field research. His invaluable support and mental effort are evident in every brick of this research.

Finally, I cannot express the depth of my gratitude to my family: my dear beloved mother Meltem, my father Faruk, and my brother Burhan, for their never-ending support. I cannot thank them enough for every single effort that has made me who I am.

The fieldwork of this study has been supported by the Middle East Technical University Scientific Research Projects Coordination Unit under grant number BAP-TEZ-D-202-2022-10838.
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LIST OF ABBREVIATIONS

MoAF  Ministry Of Agriculture and Forestry  
MoEUCC Ministry of Environment, Urbanization and Climate Change  
OECD Organization for Economic Co-operation and Development  
RDA Regional Development Agency  
TURKSTAT Turkish Statistical Institute  
WB World Bank  
WTO World Trade Organization  
GDoM General Directorate of Meteorology  
GDoPP General Directorate of Plant Production  
GDoAR General Directorate of Agricultural Reform  
PDoAF Provincial Directorate of Agriculture and Forestry  
DDoAF District Directorate of Agriculture and Forestry  
MoAVA Ministry of Agriculture and Village Affairs  
FRS Farmers’ Registry System  
ARIP Agricultural Reform Implementation Project  
ÇATAK Environmentally Purpose Agricultural Land Protection  
SES Socio-Ecological System  
CAS Complex Adaptive Systems  
SEPLs Socio-Ecological Productive Landscapes  
ABMs Agent-Based Models  
FRS Farmers’ Registry System (ÇKS)  
DEM Digital Elevation Model  
LULC Land Use Land Cover  
NDVI Normalized Difference Vegetation Index  
DSI State Hydraulic Works  
EU European Union  
FAO Food and Agriculture Organization of the United Nations  
WTO World Trade Organization  
TurkStat Turkish Statistical Institute  
CoA Chamber of Agriculture  
COMDEKS The Community Development and Knowledge Management for the Satoyama Initiative  
ELC European Landscape Convention  
SESF SES Framework
CHAPTER 1

INTRODUCTION

1.1 Conceptual Background

Rural areas are constantly changing landscapes that evolve as a result of the interplay of human activities and natural forces. This dynamic interrelation creates different landscape practices concerning agricultural methods, field systems, and the use of natural resources in different traditional rural landscapes. Although the change is an inherent characteristic of every space, the accelerated rates of change in rural areas resulted in increased concerns over the sustainability of agriculture in rural landscapes. These concerns stem from the impacts of major external and internal driving forces that are acting on different spatial, temporal, and institutional levels that lead to change in the condition of agriculture. Sustainability of agriculture and landscapes has the utmost importance concerning livelihood generation, food security, biodiversity conservation, ecosystem functioning, and water and climate regulation for wider regions (Dale et al., 2013). Understanding the patterns of change and responses to change in agricultural systems can lead to better strategies for planning and management of rural landscapes.

Rural landscapes, which are predominantly influenced by human activities, encompass two-thirds of the land cover globally (Farina, 2000). Within the European context, the influence of rural landscapes is even more profound, accounting for 95% of EU territory and housing 66% of its population (Agnoletti, 2014). Furthermore, these landscapes produce the majority of the world's food, water, energy, and industrial minerals (Woods, 2010).
There is a growing adoption of the rural landscape concept by global organizations such as ICOMOS and the FAO for sustainable development (Agnoletti, 2014). ICOMOS’ perspective views rural landscapes as a cultural heritage, encompassing not only agricultural practices but also various aspects of social and ecological systems, including traditional livelihood strategies, settlements, cultures, biodiversity, and ecosystem components (ICOMOS, 2017).

There is a dynamic relationship between farming practices and landscape functioning, asserting that rural landscapes' value can extend beyond the interests of the local communities that shape them (Włodarczyk-Marciniak et al., 2020). Furthermore, agricultural activities have larger impacts on broader ecosystem functions, such as carbon sequestration, biodiversity conservation, and water preservation (Dale et al., 2013).

A multifaceted understanding of rural landscapes as productive areas not only based on agricultural output and economies, but the source of essential ecosystem functions and significant cultural and historical assets. When managed sustainably, these landscapes play a pivotal role in biodiversity conservation and climate resilience (Agnoletti, 2014). Thus, the concept of rural landscapes when combined with a socio-ecological systems approach can be utilized for intertwining social, economic, and environmental aspects.

The concept of socio-ecological productive landscapes (SEPLs) refers to landscapes that harmonize human activities with natural processes and biodiversity, providing crucial goods and services sustainably. The International Partnership for the Satoyama Initiative (IPSI) originally introduced the SEPLs concept, leading to community-based initiatives like COMDEKS for the adaptive management of these landscapes (Gu & Subramanian, 2014b; IPSI Secretariat, 2015). SEPLs comprise a mosaic of land uses and habitats, including forests, agricultural areas, grazing lands, human settlements, and cultural sites. These landscapes are influenced by a multitude of interrelated factors such as land use, socio-cultural traditions, climate, topography, biodiversity, and resource availability (Kizos et al., 2010; ICOMOS, 2017; Dunbar et
The literature on SEPLs embody the key dimensions of rural productive landscapes, including food security, agricultural sustainability, rural livelihoods, biodiversity preservation, and climate change adaptation (Baldini et al., 2021; Dale et al., 2013; Estrada-Carmona et al., 2014; Plieninger et al., 2006; Reyes et al., 2020; Tress et al., 2005). Local communities in SEPLs play a pivotal role in preserving biodiversity and healthy ecosystems through sustainable agricultural and livelihood practices, often influenced by traditional knowledge and cultural norms (Olupot, 2015; Ichikawa & Dunbar, 2015).

Socio-ecological systems (SES), originally coined by Berkes and Folke (1998), which are described as integrated human and ecological subsystems is an important concept that calls for an explanation under the present study. Central to this discussion is the perspective of SES as complex adaptive systems (CAS), characterized by features such as adaptation, competition and cooperation dynamics, self-organization, and emergence (Nel, 2009).

The SES approach addresses the gap between social and natural sciences by recognizing the interdependent and co-evolving nature of human and ecological systems (Cote & Nightingale, 2012; Gallopín, 2006). Such systems can range from localized community-environment relationships to a global level, incorporating humanity and the entire ecosystem. The SES approach also embraces nonlinear dynamics and heterogeneity, considering their impact on policy formulation (Levin et. al., 2013). Considering heterogeneity in SES provides an understanding of the diverse agents and their interactions within these systems.

In summary, the SES approach provides an integrated perspective on human and ecological systems, viewing them as co-evolving complex adaptive systems. It offers valuable insights into the interconnectedness of social and ecological processes, emphasizing the need for bridging the gap between social and natural sciences, and illuminates the way forward for sustainable management strategies.

Research into landscape changes has recently embraced an integrated approach, utilizing diverse spatio-temporal-actor scales to unpack the interplay between
different drivers of change (Xie et al., 2022). Despite an increase in interdisciplinary studies, some researchers argue that there is a deficit in research that concurrently examines ecological and social processes (Beilin et al., 2013). Various studies have explored landscape change using historical rates of change, key actors and driving forces, and tools such as GIS and remote sensing (Schneeberger et al., 2007; Poças et al., 2011; Campos et al., 2012).

Social-Ecological Systems (SES) research, which investigates the complex interactions between social and ecological systems, has gained importance and popularity (Berkes & Folke, 1998). Several SES frameworks have been proposed, with varied focus on the social, ecological, or interactional aspects (Anderies et al., 2004; Ostrom, 2009). However, a study by Barthel et al. (2019) reveals that despite the proliferation of SES studies, many do not provide clear definitions of the term. However, frameworks for understanding SES vary in their strengths, limitations, and focus areas. They offer unique perspectives on the complex dynamics of SES, but there remains a need for a comprehensive theoretical framework that can unify these diverse approaches and better capture the intricacies of social and ecological systems in landscape research (Binder et al., 2013; Cumming, 2014).

The literature discusses current limitations and emerging critiques within this body of research, particularly with an emphasis on its inadequate representation of the social subsystem. Key criticisms, posited by Cote and Nightingale (2012), Fabinyi et al. (2014), and Stonajevic et al. (2016), argue that the SES theory often simplifies the complexity of social life and processes, including the critical role of power, social diversity, and morality. Fabinyi et al. (2014) claim that while the SES model provides a holistic view of human-environment relations, it often neglects the societal heterogeneity, moral dimensions, and power dynamics, focusing excessively on human adaptation to their settings.

This comprehensive review of literature shows primarily critiques about the conventional use of indicator-based assessments in examining the resilience of SES. The present study asserts that such approaches, while providing quantifiable insights,
fail to encapsulate the complex and multi-dimensional nature of SES resilience. More precisely, these assessments often overlook the intricate social dynamics inherent within SES, such as the nuances of human decision-making, power relations, cultural contexts, and diversity of social actors (Spiegel et al., 2021; Sahle et al., 2023; Ciftcioglu, 2017; Dunbar et al., 2020; Natori and Hino, 2021).

In addition, existing literature on SES resilience exposes several biases in research, including an excessive emphasis on the structural and functional aspects of institutional systems, an over-simplification of human adaptation to environmental changes, and a neglect of social complexity (Cote & Nightingale, 2012; Fabinyi et al., 2014). Additionally, the critique echoes the need for a more inclusive understanding of SES resilience, one that appreciates human agency and the role of communities' self-organization (Davidson, 2010; Fischer et al., 2012).

This study argues for a shift in SES resilience studies from solely indicator-based assessments to methodologies that incorporate a broader understanding of social dimensions, including human agency, power dynamics, culture, and diversity of social actors. This shift is argued to facilitate a more holistic and nuanced understanding of the resilience of socio-ecological systems.

This study asserts the necessity to integrate a comprehensive understanding of the social dimension, particularly including local knowledge, human decision-making, and actor responses, into socio-ecological systems (SES) resilience research. Berkes and Folke (1998) emphasize the value of local knowledge, also known as traditional ecological knowledge or indigenous knowledge, in influencing interactions and management of local resources. This knowledge, deeply rooted in cultural practices and belief systems, conveys the potential to impact SES in profound ways. Furthermore, Berkes (2009) discusses the adaptive nature of indigenous knowledge systems and their complementarity with scientific knowledge systems.

However, Bürgi et al. (2005) and Levin et al. (2013) emphasize the challenges in synthesizing diverse datasets and the need for diverse methodologies to understand and model complex SES, including the use of qualitative methods like surveys and
interviews. Case studies, like that of Rescia et al. (2008), support the need for incorporating local knowledge and human decision-making in SES resilience research. Similarly, Yager et al. (2019) highlight the importance of combining scientific data with local knowledge in understanding the change of land cover. In a similar manner, Tengö et al. (2014) introduce a research approach for integrating indigenous, local, and scientific knowledge systems in biodiversity and ecosystem governance. Thus, more comprehensive integration of the social dimension, particularly acknowledging the role of local knowledge and human decision-making, is crucial to enrich our understanding of SES dynamics and resilience, which, in turn, informs and enhances management and conservation efforts.

The notion of adaptive capacity is understood as the ability of systems, institutions, humans, and other organisms in an effort of adjusting to potential damage, taking advantage of opportunities, and responding to consequences (IPCC 2014; Armitage and Plummer, 2010; and Young, 2016). Importantly, this capacity varies across different contexts, nations, communities, social groups, and timelines, highlighting the nuanced complexity inherent in SES. Understanding adaptive capacity requires an emphasis on the crucial role of diversity, heterogeneity, and response diversity in maintaining system resilience (Levin et al., 2013; Leslie & McCabe, 2013). Additionally, an understanding of the adaptive capacity requires an examination of broader socio-economic and political forces, and the appreciation of cultural traditions, historical context, and ethical perspectives (Young, 2016; Smit & Wandel, 2006; Cote & Nightingale, 2012).

Despite its importance, there are certain challenges associated with assessing adaptive capacity, particularly in rural areas. A variety of approaches have been employed, ranging from the capitals approach, which focuses on social, human, physical, natural, and financial capacities (Walker et al., 2006; Metcalf et al., 2015), to more integrated methodologies such as the DPSIR model (Castonguay et al., 2016). However, the limitations of these approaches, such as the impacts and responses cannot be simultaneous, and this situation suggests alternative methods,
such as examining the impacts of stress events on similar systems or studying a system's adaptation over time (Eagle, 2011).

In line with this, this study asserts that a comprehensive and integrated approach to understanding and assessing adaptive capacity is highly important to understand SES resilience and actors’ responses towards change. Farmers play a significant role in socio-ecological systems (SES) as both drivers and respondents to change in productive landscape. The interplay between social, environmental, and economic factors inherent in agricultural systems underscores the importance of farmers' actions and decisions in shaping these landscapes (van der Sluis et al., 2019).

In the face of environmental, economic, social, and political disturbances, the resilience of SES is often linked to farmers' capacity for adapting and responding. Therefore, the multiple roles that farmers take on as landowners, farmers, and estate managers influence the landscape differently (Busck, 2002; Primdahl, 1999). Crucially, these roles must be considered separately, as decisions made in each capacity can lead to divergent landscape outcomes (Primdahl, 1999).

Adaptation strategies employed by farmers in response to changes vary significantly, with their decisions influenced by factors such as market prices, access to resources, technological advances, labor market conditions, and the political environment (Knickel, 1990; Kristensen et al., 2004; Kristensen et al., 2009; Valbuena et al., 2010). This highlights the complexity of farmers' roles, motivations, and responses in the face of changes (Müller and Munroe, 2008; Holland et al., 2017; Conway et al. 2016; Inwood and Clark, 2012; Smith et al, 2019).

Recognizing farmers' roles beyond production to encompass landownership is essential, as public policies often neglect these aspects, resulting in narrow, less effective approaches to landscape management (Primdahl et al., 2013). Moreover, the farmers' responses to changes are highly individual, dictated by their beliefs, objectives, and unique circumstances (Busck, 2002; Kristensen et al., 2004, 2009). However, as discussed above, there are criticisms of resilience thinking for its lack of acknowledgment of human agency and diversity of perspectives (Sinclair et al.,
In this regard, it is important to develop tools to explore farmers' motivations, attitudes, and decision-making strategies (Vliet et al., 2015), acknowledging the heterogeneity of actors and responses (Darnhofer et al., 2010).

The districts of Güdül, Beypazarı, and Ayaş that compose the Northwestern region of Ankara offer a vivid socio-ecological landscape shaped by its geomorphology, topography, climate, and diverse flora and fauna. They possess climatic characteristics influenced by their geographical and topographical features formed by hills, valleys, and terraces. These districts are in the Kirmir Creek basin, which is renowned for its diverse agricultural activities ranging from farming and husbandry to viticulture and orcharding, contributing about 90% of Ankara's vegetable production (TurkStat, 2021). Their diverse microclimates also allow for the growth of Mediterranean crops, showcasing the area's capability of agricultural biodiversity.

This region has been home to agricultural production initiatives and production cooperatives. It has significant ecological and historical assets, housing critical biodiversity zones, protected natural landscapes, and areas of agricultural production. Land use changes have been minimal over the past three decades, aiding the preservation of both natural and historical heritage. In fact, Beypazarı is on UNESCO's tentative World Heritage List due to its well-preserved Ottoman urbanization examples, and similar cultural values are found in Güdül and Ayaş.

Despite all this, the region lacks an overarching environmental or development plan. Issues such as rural-to-urban migration, securing rural income, sustainable agricultural practices, and establishing rural-urban food networks are not addressed. There are limited studies that stress the necessity for integration these concepts into the planning at the intersection of rural and urban areas.

In short, Güdül, Beypazarı, and Ayaş were chosen for their distinctive combination of factors like diverse landscape components and agricultural characteristics, that form the socio-ecological productive landscape of Northwestern Ankara. Figure 1.1 presents the conceptual background of the research that is discussed above.
Figure 1.1. Conceptual background of the research
1.2 Research Aim, Questions and Methodological Approach

Based on this background, the ultimate goal of this research is to enhance adaptive planning and policymaking of socio-ecological rural productive landscape through informing the resilience and adaptive responses of actors of socio-ecological productive landscape, farmers, in the face of changing conditions. To achieve that, this study sets its main aim to explore and understand the dynamics of the socio-ecological landscape of Northwestern Ankara by examining its interplay with spatial, environmental, productive, and administrative systems, particularly in the context of changing conditions. Interrelatedly, the first sub-aim is to delineate the current state and changed state of the socio-ecological productive landscape and to assess the impacts of changing conditions on two dimensions: natural resources and agricultural outputs, and steps of agricultural production. Moreover, understanding the changes enables deciphering the adaptive responses of the farmers against the impacts of change in aforementioned two dimensions. This constitutes the second sub-aim of this study.

In reference to these aims which ultimately intends to provide a comprehensive understanding of the interrelations and dynamics that shape the socio-ecological landscape of Northwestern Ankara in the face of changing conditions, the present study sets three objectives to reach.

The first objective is to characterize the socio-ecological productive landscape of Northwestern Ankara in terms of its spatial, environmental, productive, and administrative systems.

The second objective is to define the impacts of man-made and changing conditions on the natural resources and agricultural products within the socio-ecological landscape of Northwestern Ankara and explore the responses of farmers in these dimensions.

The third objective is to analyze the steps of agricultural production within the socio-ecological landscape of Northwestern Ankara through understanding current
and changed state and experienced impacts and responses of farmers to these changes in the steps of agricultural production, namely land preparation, seed selection and obtainment, irrigation, plant protection, fertilizing, harvesting, processing, and packing, and marketing.

Based on these aims and objectives, the research asks the following research questions:

**Main RQ.** How does the socio-ecological landscape of Northwestern Ankara operate through the interrelations between spatial, environmental, agricultural productive, and administrative systems in response to the changing conditions?

**Sub-RQ1.** What is the socio-ecological productive landscape of Northwestern Ankara, operated by spatial, environmental, productive, and administrative systems?

**Sub-RQ2.** How have changing conditions impacted natural resources and agricultural products within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?

**Sub-RQ3.** How has the production practice changed within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?

This research employed a mixed-methodological approach, seamlessly blending qualitative and quantitative data collection and analysis centered on a single case study in the Northwestern part of Ankara. Utilizing an embedded mixed-method design, the study took on a primarily qualitative disposition, strongly rooted in the interpretivist paradigm, seeking to understand the changing dynamics of the socio-ecological productive landscape. At its core, the research was driven by the hermeneutics approach, emphasizing the interpretation of texts derived from in-depth interviews and various documents. Geospatial data and secondary statistical data enriched the qualitative findings, providing a robust perspective on the changing landscape dynamics. The integration of various data types – qualitative verbal data, secondary quantitative and qualitative data, spatial data, and visual materials –
enabled a comprehensive understanding of the topic at hand. Data collection methodologies varied from in-depth interviews, data extraction from pertinent institutions, exploration of open data sources, to on-site observations. Analytical strategies, such as content analysis, spatial analysis, and simple statistical analysis, were harnessed to extract meaningful insights. Through these diverse methodologies, the research intends to explore the socio-ecological productive landscape of Northwestern Ankara, emphasizing the interplay between multiple variables amidst changing conditions.

The research systematically organizes its variables into three primary dimensions: (i) **Productive Landscape Components**, which investigate the interplay between socioecological aspects and the specifics of agricultural practices and producer characteristics; (ii) **Man-Made and Climatic Conditions**, which examine the influences of human-induced and climatic changes on key elements like soil, water, and plants, and the resultant farmer adaptation strategies; and (iii) **Agricultural Production Steps**, which delve into the comprehensive stages of farming from land preparation to marketing, spotlighting existing methods, evolving practices, and farmers’ adaptive responses. These dimensions collectively offer an in-depth insight into the socio-ecological dynamics of Northwestern Ankara's productive landscape.

### 1.3 Significance of the Research

This part explores the significant contributions of the study, encompassing theoretical, practical, and methodological significances. Through an in-depth investigation of socio-ecological systems and the crucial roles played by farmers within them, this study delves into theoretical aspects while also considering practical implications for agricultural policy and landscape management. Furthermore, it introduces an innovative methodological approach for integrated research. Each of these facets underscores the significance of comprehending rural landscapes as dynamic entities influenced by both human activities and natural processes.
As for the **theoretical significance**, this study deepens the understanding of rural landscapes as socio-ecological systems (SES) by integrating the nuances of human activities, natural forces, and their resultant landscape practices by farmers. By exploring the dynamics of Northwestern Ankara's socio-ecological landscape, the research fills existing gaps in SES theory, especially concerning the multifaceted roles that farmers play in these systems through not adapting indicator-based assessment of adaptive capacity and resilience but through exploring the processes emerging from changing states and impacts in several dimensions of agricultural production. It offers a richer perspective on the co-evolution and interplay between human and ecological systems, countering criticisms of literature of the SES, Resilience and Adaptive Capacity that highlights the oversimplification of social processes.

Regarding the **practical significance**, as focused on Northwestern Ankara, an area characterized by its rich agricultural biodiversity and prominent role in Ankara's vegetable production, this research offers invaluable insights for planners, policymakers, and agricultural practitioners in relevant public institutions. The detailed examination of farmers' adaptation strategies amidst changing conditions provides evidence-based recommendations to enhance agricultural sustainability, food security, and resilience against future disturbances. Furthermore, by spotlighting the diverse roles farmers undertake, the study underscores the need for public policies that view farmers not just as producers but also as citizens, landowners, and land managers, thereby promoting more holistic and effective landscape management strategies.

**Methodologically**, by employing an embedded mixed-method design, this study pioneers an approach that integrates qualitative and quantitative data, centered around the case study of Northwestern Ankara. The research showcases how a primary qualitative approach can be enriched by geospatial data, secondary statistical data, and other quantitative methods, offering a robust perspective on changing landscape dynamics. The holistic integration of diverse data types and analytical strategies, from content analysis to spatial analysis, sets a useful collection for future
SES studies, promoting a comprehensive methodological approach that captures the complexities of socio-ecological landscapes.

1.4 Organization of the Chapters

Chapter 2 presents the theoretical framework under two sections:

- Section 2.1 delves into socio-ecological systems (SES) viewed as complex adaptive systems (CAS), with a focus on characteristics like self-organization and emergence. The emphasis is on rural productive landscapes. The subchapter has four parts:
  i. Detailed examination of rural productive landscapes in socio-ecological contexts.
  ii. Introduction of the concept of Socio-Ecological Systems (SES)
  iii. Introduction of the concept of Socio-Ecological Productive Landscapes (SEPLs)
  iv. An exploration of recent methods used to research and analyze productive landscapes as SES.

The aim is to better comprehend the intricate interplay between rural productive landscapes and socio-ecological systems.

- Section 2.2 focuses on change, resilience, and adaptability in rural productive landscapes through the socio-ecological systems (SES) perspective. It views agriculture and rural landscapes as SES, aiming to grasp the interplay of social, economic, and environmental factors. Farmers, as central figures, influence and adjust to these landscapes, responding to challenges as both initiators and recipients of change. The chapter is structured as:
  i. Understanding the causes and effects of rural change, emphasizing farmers' roles.
  ii. Analysis of SES resilience, focusing on disturbances, adaptability, and transformation.
iii. Exploration of adaptability in socio-ecological landscapes.
iv. Detailed study of farmers’ significant roles in SES, and their contributions to managing and guiding change.

Chapter 3 presents the research methodology under nine sections:

- Section 3.1 and 3.2 presents the methodological approach and the process of constructing the methodological framework of the research. These chapters focus on the central underpinning of the research design and rationale that research aim and questions is based on.
- Section 3.3 presents the rationale behind case study selection.
- Section 3.4 introduces the sampling strategy, sample size and characteristics of the samples.
- Section 3.5 introduces the variables used for exploring the socio-ecological productive landscape.
- Section 3.6. and 3.7. presents data gathering techniques and data analysis methods employed for qualitative, spatial, and secondary data collected for the research.
- Section 3.8. and 3.9. presents ethical considerations and limitations of the methodology adopted.

Chapter 4 submits the contextual background of the research through introducing the context of rural areas and agricultural production in Turkey and the socio-spatial, environmental, and agricultural characteristics of the Ankara and case study region.

Chapter 5 presents the analysis and findings of the research under three sections:

- Section 5.1 explores through analyzing the components of the socio-ecological productive landscape through setting the interrelations among its the components and introducing the agricultural production context in the region covering three districts under study.
• Section 5.2 presents the results of the analysis on current and changed state of man-made and climatic conditions, their impacts over water, soil and plant dimensions of production and the responses of farmers against these changes.

• Section 5.3 delves into the agricultural production steps through exploring the current and changed states, experienced impacts, and responses of farmers in land preparation, seed sourcing, irrigation, plant protection, fertilization, harvest, processing, packaging, and marketing steps.

Chapter 6 presents the conclusion for the main research questions, the limitations, contributions of the research and final considerations for further research.
CHAPTER 2

LITERATURE REVIEW

As the world continues to undergo profound socio-environmental transformations, the dynamic relationships between rural productive landscapes and socio-ecological systems (SES) have gained prominence in academic discourse. This literature review embarks on an exploration of these complex relationships, illuminating the profound interplay between rural productive landscapes, SES, and the farmers who navigate this complex terrain. The review is organized into two core sections.

The opening section of this chapter, Section 2.1, takes an in-depth exploration of the concept of rural productive landscapes within socio-ecological contexts. It begins by introducing the fundamental concepts of Socio-Ecological Systems (SES), delving into their components, interactions, and adaptive features. As the stage is set, we also introduce the concept of Socio-Ecological Productive Landscapes (SEPLs), where human activities in productive rural settings influence and are influenced by ecological dynamics. Additionally, this section examines the recent methods employed in the research and analysis of these productive landscapes as SES. This section seeks to offer a comprehensive understanding of the intricate interplay between rural productive landscapes and socio-ecological systems.

Transitioning into Section 2.2, the focus leads on the dynamics of change, resilience, and adaptability within rural productive landscapes from a socio-ecological systems perspective. This conceptual approach regards agriculture and rural landscapes as inherently complex adaptive systems and considers the complex interactions among social, economic, and environmental factors. At the heart of these landscapes are the farmers, central figures whose actions and decisions significantly shape the SES. They navigate and respond to challenges, acting as both initiators and recipients of change. In this section, we seek to achieve a nuanced understanding of the causes
and effects of rural change while emphasizing the pivotal roles played by farmers. This section further explores SES resilience, emphasizing the capacity of farmers to withstand disturbances, adapt, and potentially transform. Furthermore, this section delves into the concept of adaptability within socio-ecological landscapes. Finally, a detailed examination is conducted to elucidate the indispensable roles of farmers within SES, highlighting their contributions to managing and guiding change.

Figure 2.1. Conceptualization of the literature followed throughout the research.

The journey through this literature review aims to unravel the complexities of SES in rural productive landscapes, drawing upon a body of research that illuminates the dynamics of these systems. Figure 2.1. draws upon the conceptualization of the literature review and main components of the approach adopted. By examining these two following sections, this chapter aims to provide a comprehensive foundation for the subsequent approach, contributing to the deeper understanding and effective management of rural productive landscapes.
2.1 Rural Productive Landscapes in Socio-Ecological Systems Research

The present subchapter aims to expand on the fundamental understanding of socio-ecological systems (SES) as complex adaptive systems (CAS), emphasizing their significant characteristics, such as self-organization and emergence. The present study will concentrate on exploring these concepts in the context of productive rural landscapes. This subchapter is organized into four subsections, each of which offers an in-depth discussion of the rural productive landscape and its socio-ecological dimensions. It also explores deeper into the conceptual framework of socio-ecological systems and the most recent methodologies used in researching and analyzing rural productive landscapes as SES. The objective of this study is to gain an expanded understanding of the complex relationships between rural productive landscapes and socio-ecological systems.

The socio-ecological systems (SES) framework is a conceptual framework that recognizes the interdependent relationships and coevolutionary dynamics between human (societal) and ecological (biophysical) subsystems, rather than considering one as a subset of the other. SES can be comprehended as complex adaptive systems, commonly referred to as CAS, which are distinguished by their complex structures, self-organizing properties, and the emergence of order throughout the entire system. This framework operates across various levels of analysis, ranging from small-scale local communities to the broader global ecosystem. The fundamental characteristics of these systems include adaptation, cooperation and competition dynamics, self-organization, and emergence. The comprehension of SES depends on fundamental attributes of complex adaptive systems, such as emergence and self-organization.

Self-organization pertains to the inherent ability of a system to autonomously and flexibly evolve or modify its internal configuration in reaction to alterations in its surroundings, while emergence is a phenomenon that arises when the collective behavior of a system exceeds the combined behavior of its individual components, leading to unforeseen properties or behaviors. This understanding can enhance the
development of management strategies that are more efficient and sustainable for socio-ecological systems.

Overall, the socio-ecological systems (SES) approach, when analyzed from the perspective of complex adaptive systems, offers significant insights into the interdependent nature of social and ecological processes. This understanding can enhance the development of management strategies that are more efficient and sustainable for socio-ecological systems. Despite the expansion of SES research and the development of numerous analytic frameworks, these approaches must continue to evolve to account for the inherent complexity and diversity of socio-ecological systems. Such comprehensive and adaptable methodologies will continue to be essential for comprehending and managing the complex interaction between social and ecological processes. The criticisms indicate the need for a more nuanced and comprehensive strategy for incorporating the social dimension into SES research. They emphasize the necessity of taking into consideration the complexity of social life and social processes, the role of power, and the interests, rights, and responsibilities of various social actors. In addition, there is an appeal to avoid overly simplistic reductionism and embrace the inherent complexity and diversity of socioecological systems.

2.1.1 The Concept of Rural Productive Landscapes

There is neither a single definition of landscape nor a single assumption regarding the origin of the word. As one of the contested definitions in spatial studies, the term has been chiefly annotated with its scenic value and natural components. The word “landscape” is assumed to be originated from the Dutch word “landschap” and transferred into the English language as “landscape” around 16th century (Wylie, 2009). According to Antrop and Van Eetvelde (2019), the word derives from “lantscap” (landscep or landscip), which means land or region, and the suffix –“scep” denotes reclaiming or creating. However, land and landscape have fundamentally distinct meanings. Land refers to soil, topography, and territory or a specific, well-
defined area usually organized and maintained by its owner (Antrop, 2000a). Landscape is a shared cultural commodity that relates to our perceptible surroundings and means ‘organized land’ unique to people who create and maintain it and the place of action and activities born as a result. In Turkish language, ‘peyzaj’ is the word for landscape. The world is derived from French word ‘paysage’. In French, while ‘pays’ annotates to country, territory, or rural, ‘paysan’ means peasant, as the rural person with low rank or status, usually engaged in agricultural labor (Harper, n.d.). The existence of different linguistic interpretations and translations creates difficulties due to multiplicity in meaning, which give rise to alternative research themes and actions (Antrop, 2018). However, while the word landscape/paysage had been used for visual appearance, condition of the land, and a way of seeing, the concept of landscape has been transformed and formalized from being a set of forms that correspond to aesthetic value to the representation of processes underlying these forms and values (Balestrieri, 2015).

Landscapes are composed of different characteristics, structures, systems, and elements. According to Crumley & Marquadart (1990), socio-historical and physical structures determine the landscape. While socio-cultural structures comprise political, legal, and economic dimensions such as class, inheritance, political interest groups, trade, laws, and administrative units, physical structures are free from human control, including climate, topography, and geology. Authors assert that landscape is determined and mutually decisive by sociohistorical and physical structures, as well as their interpretations (aesthetic, symbolic, religious, ideological). According to Hart (1998), landscapes are composed of three essential elements: landform/land surface, vegetation, and human structures, including systems of land division, the structures associated with economy, house types, and agglomerations of settlements such as villages, towns, and cities. Hart’s explanation of components focuses on natural and human-made elements in a landscape with specific attention to physical, tangible elements. However, these components lack the binding, intangible elements which are the products of human interrelation with nature, expressed through culture. The interrelation of human and natural processing forming landscapes makes culture
an indispensable part of landscapes. As Sauer (1925) puts it, “culture is the agent, the natural area is the medium and cultural landscape as the result” (p. 310). According to Antrop (2018), history, economics, and ecology are key factors in the structuring and understanding of landscapes. Overall, there is a tendency in literature to discuss ecological and environmental dimensions without considering its social and cultural elements (Höchtl et. al., 2006; Agnoletti, 2014).

Balestrieri (2015) summarizes broader elements used for landscape classification. These elements include the patterns of spatial organization; the natural environment; cultural traditions, circulation networks; boundary demarcations; vegetation related to land use; building, structures, objects, clusters, archeological sites, surface ecology, climate, geomorphology, soil, and landcover. A holistic understanding of the landscape considers that each element gets its value and significance depending on the context and surrounding elements’ composition. To explain the interrelation between the parts and the whole, Antrop (2000) uses Gestalt Psychology and its principles that says the whole is more than the sum of its parts. In such an understanding altering one part always alters the entire in some manner. As a result, the evaluation of all reciprocal interactions among the components in a complex setting is hard and this situation undermines the determination of the extent or magnitude of impact (Antrop, 2000).

Understanding that holism, dynamism, and relativism are the inherent characteristics of landscapes opens the discussion of space and time relationships in the history and evolution of landscapes (Sauer, 1925; Wood& Handley, 2001; Taylor & Lennon, 2011). Sauer (1925) asserts that landscape cannot be grasped without its time and space relations. The landscape is ever-changing. The nature of the composing parts, as well as their interconnections, evolves. As a result, the structure and function of a landscape are inextricably linked (Antrop, 2000). Human’s ability to modify territory manifests itself in various ways, varying depending on environmental conditions and production processes, resulting in various landscapes across time (Balestrieri, 2015). Traditional landscapes emerged because of man’s interaction with the environment, and their characteristics are deeply tied to many aspects of local topography, climate,
water supply, soils, and historical occupation (Pôças et al., 2011). The rich and multi-layered legacy of past civilizations determines the complexity of the historical character of the landscapes as settlement and livelihood activity result in new plant species, cultivation techniques, fields, and land demarcation methods, water collection and use, and historic buildings and land structures (Agnoletti, 2014). An understanding of the spatial and temporal context that which landscapes are embedded is important in researching and planning landscapes (Marcucci, 2000).

Antrop & van Eetvelde (2017) summarizes the major aspects used in explaining landscapes. According to the authors,

“Landscape is seen as a spatial entity, having a variable extent and scale, and has territorial properties; it is perceived and experienced by humans; it is composed of many very different elements and components that interact and are hierarchically structured, it has a spatial organization and management that is largely influenced by humans, it is dynamic, and changes are an inherent property of it.” (p. 57).

The rise of globalization and the environmental problems facing landscapes resulted in increasing international attention towards the concept and this required a formal definition. Two formal definitions are relevant: The definition of cultural landscapes from the UNESCO World Heritage Convention (1996) and the European Landscape Convention (ELC) (2000). While the adoption of the term 'cultural landscapes' rather than only ‘landscape' in the convention was intentional to guide policy measures to go beyond environmentally determinist approaches of nature conservation persisting in the management practices and to integrate both tangible and intangible heritage values (Antrop & van Eetvelde, 2017).

UNESCO defines cultural landscapes as:

“Cultural landscapes represent the "combined works of nature and of man" [which] are illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or
opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal. The term "cultural landscape" embraces a diversity of manifestations of the interaction between humankind and its natural environment" (UNESCO, 1996, p.11).

The second definition is from the European Landscape Convention (ELC). The convention defines landscape as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (European Landscape Convention, 2000, p.2). This definition highlights three important characteristics of the landscape: the place specificity, the importance of perception, and the co-evolution of natural processes and human activities. The convention was established with the goal of defining protection measures for all valuable landscapes, whether natural or heavily affected by human activities (Balestrieri, 2015).

As Balestrieri (2015) discusses, the classification of landscapes is another dimension posing problems. As explained above, the earlier roots and meanings of landscape in different language families point to non-urban, rural characteristics of the concept. However, the adoption of landscape-based strategies leads to the diversification of the landscape concept. Different adjectives were added to the word to clarify the meaning of landscape (Antrop, 2018). Some examples are cultural, natural, rural, urban, traditional, modern, historic, and archeological landscapes. For example, the European landscape tradition strictly divides cultural and natural landscapes (Antrop & van Eetvelde, 2017). Environmentally deterministic approaches that explain cultural landscapes as natural landscapes transformed by human activity were challenged during the 20th century. For example, Sauer (1925) considers cultural and natural landscapes as two complementary essential aspects to understanding the whole landscape. The dichotomist explanations lose their power in the 21st century parallel with the understanding of the extent of human activity on the planet and the globalization of environmental problems. The landscape is now a continuum in the gradual scale of the intensity of human influence (Antrop & van Eetvelde, 2017). The division of landscapes into cultural and natural typologies undermines the
interconnection and co-evolution of natural and social processes continuously forming the landscape.

This problem intensifies when classifying landscapes as rural landscapes. The term ‘rural’ has become an ambiguous concept without a single overarching definition that can be applied everywhere. Blurring the rural-urban dichotomy, decreasing the importance of the agricultural sector in rural areas and in return, increasing multifunctionality in rural areas resulted in the change of past explanations of rural and urban depending on binary conceptualizations. Traditionally, the classification of a region as a rural area depended on the location as being outside the urban center, agriculture single sector, and population size and characteristics. Currently, traditional 'rural' regions experience changes throughout the developing and developed world because of drivers of change from political, socio-cultural, technological, economic, spatial, and natural dimensions that act on multiple scales. The magnitude of change necessitates both reconceptualization of rural and urban interrelation and the development of approaches for understanding and managing change in rural landscapes.

Kizos et. al. (2010) emphasizes the importance of focusing on the concept of landscape in rural areas for four reasons. The first one emphasizes that the concept of landscape is an interface between human activities and the natural environment and that it is a "mirror" of all actions in a particular spatial context. The authors assert that landscape is the most appropriate concept for defining and analyzing spatial problems in different contexts and therefore the landscape approach has gained importance in rural development policies and practices. Considering that two-thirds of the land cover on the planet corresponds to agricultural lands, livestock grazing areas, and managed forests, it can be said that rural landscapes are one of the most dominant forms of the landscape which are highly influenced by human activity (Farina, 2000). Rural regions generate the majority of the world's food and capture the majority of its water. They are the dominant source of the world's energy, as well as the majority of the industrial minerals (Woods, 2010). In the European context,
95% of the European Union (EU) territory is covered by landscapes classified as rural, and 66% of the EU population lives in rural areas (Agnoletti, 2014).

In literature, the concept of rural landscape and agricultural landscape is used as interchangeable concepts (Xie et al., 2022). However, these two concepts annotate to different meanings. The concept of rural landscape describes complex interactions between humans and nature in rural areas better than the concept of agricultural landscapes or simply landscapes (Kizos et al., 2018). While the agricultural landscape, which centers dominantly on farming activities, forms a subcategory of rural landscapes, the latter represents the complex relationship between nature and humans which is not limited to agriculture but also concerns spatial organization, sociocultural processes, and interaction of the ecosystem components. In addition, the concept of rural landscapes provides a broader knowledge-action arena where a diverse group of social actors (including scientists) comes together to study production, conservation, and recreation goals, as well as for developing scientific understanding and management decisions (Laterra et al., 2012).

The rural landscape concept is increasingly adopted by global level organizations such as ICOMOS and Food and Agricultural Organization (FAO) with specific attention towards sustainable development. This is due to the promotion of landscapes as a viable new paradigm for a developmental model that would harmoniously combine social, economic, and environmental aspects in space and time in a landscape-based strategy, especially in the European context (Agnoletti, 2014). ICOMOS (2017) approaches rural landscapes from a heritage perspective and considers all rural areas as landscapes and cultural heritage sites. According to ICOMOS-IFLA principles concerning rural landscapes as heritage, rural landscapes are “terrestrial and aquatic areas co-produced by human-nature interaction used for the production of food and other renewable natural resources, via agriculture, animal husbandry, and pastoralism, fishing and aquaculture, forestry, wild food gathering, hunting, and extraction of other resources” (p.2). ICOMOS identifies rural landscapes as living systems that cover rural elements and diverse relationships that
these elements form in functional, productive, spatial, visual, symbolic, and environmental dimensions.

On the other hand, ICOMOS principles accept that all rural areas have cultural meanings attributed to them by people and communities which leads to an understanding of rural landscapes as cultural landscapes. The important aspect of the ICOMOS definition is that concept of the rural landscape is not restricted to agricultural landscape and agricultural practices; they are multifunctional spaces that combine components of the social and ecological systems such as livelihood strategies, settlements, cultures, traditions of human communities, biodiversity, ecosystem components and all above, their interrelated functioning. From this perspective, rural landscapes can be considered as sites that hold diverse types of heritages such as cultural and biological diversity as well as land and landscape management techniques, which have evolved through the interaction of humans with the surrounding environment (i.e., building types, techniques of resource use and conservation, cultivation techniques, cuisine). These heritages represent the interwoven relationship between society and nature and represent how local communities perceive and establish relationships with their natural environment (Rossler, 2006).

Agriculture is one of the most dominant practices in rural landscapes. Agriculture is the oldest form of human interaction with natural systems, involving the modification of land for crop and livestock production, as well as the redirection of energy, nutrients, water, and biomass flows for human use (Dale et al., 2013). The result of this interrelation has been the transformation of the land to generate food, fiber, and energy through continuous human action by adaptation and development. This continuous process shapes settlement patterns, land-management methods, crop choices, animal production, and landscape heterogeneity and their interrelated functioning throughout time. In addition, agriculture accounts for around 38% of the Earth's terrestrial surface, making it the most extensive use of land on the planet (FAO, 2020). This makes the rural productive landscapes an important area of
investigation considering the dynamics of change stemming from multiple dimensions.

The extent of agricultural production in rural areas makes the farmers the main managers of useable lands and this fact highlights the reciprocal relationship dependence between farming practices and landscape functioning (Włodarczyk-Marciniak et al., 2020). Yet, landscapes can have values that transcend beyond the interests of the immediate social group that shaped them, due to their greater value as public goods at regional, national, and global levels, especially in certain contexts (Agnoletti, 2014). According to Dale et al. (2013), ecosystem functioning and related processes such as water preservation, pollination, nutrient and soil retention, carbon sequestration, flood control, and biodiversity conservation occur at scales wider than farms. In addition, providing food to wider regions, visual and recreational values for urban communities and rural income opportunities to rural communities are other roles of agriculture in rural landscapes.

In addition, Fischer et al. (2012) discusses the importance of traditional farming landscapes for biodiversity conversation. Authors state that traditional farming landscapes are common in locations where farming traditions have altered little over generations such Japan's Satoyama landscapes, India's Western Ghats, Mexico's Milpa cultivation systems, southwestern China's terrace landscapes, sub-Saharan Africa's agroforestry systems, and Eastern Europe's traditional village systems. According to Fischer et. al. (2012) traditional farming areas have specific biophysical properties that can conserve natural or semi-natural vegetation through enhancing biodiversity.

In short, productive landscapes in rural areas are essential for multiple factors. They are the backbone of agricultural output, supporting economies at different levels and supplying commodities like food, fiber, and fuel. In addition, they provide essential ecosystem functions such as maintenance of water quality, enhancement of soil productivity, regulation of climatic conditions, and promotion of biodiversity. These landscapes possess significant cultural and historical significance, serving as
a representation of both regional and national identities while also protecting traditional practices. When managed in a sustainable manner, these resources assume a crucial function in the conservation of biodiversity and the reinforcement of climate resilience by means of carbon sequestration and adaptive measures. Ultimately, these entities facilitate human health and welfare. From this perspective, landscapes are presented as a viable new paradigm for a developmental model that would harmoniously combine social, economic, and environmental aspects in space and time in a landscape-based strategy (Agnoletti, 2014).

2.1.2 Socio-Ecological Systems Approach

Since the late 20th century, there is a growing body of literature that treats human and ecological system as integrated complex system that is conceptualized as socio-ecological systems (SES) (Berkes & Folke, 1998; Holling 2001; Colding et al. 2003; Anderies et al. 2004; Forbes et al. 2004; Adger et al. 2005; Young et al. 2006; Smith & Stirling, 2008; Walker & Lawson, 2009). Socio-ecological research originates from the contribution of several scientific traditions. The common concern behind this body of research is the gap between social and natural sciences that results in specialization and individualization of these scientific fields. Socio-ecological research aims to bridge this gap and to heal the ability of communities to react to changes occurring in both natural and social systems in an intertwined manner.

The term “socio-ecological systems (SES)” first coined by Berkes and Folke (1998), combines societal (human) and ecological (biophysical) subsystems that depend on mutual interactions and coevolution. They define socio-ecological systems as nested and multilevel systems that serve society in terms of important resources such as food, fiber, and water. Socio-ecological systems’ approach neither assumes the human system as a part of the ecosystem nor the ecological system as a part of human systems but assumes a mutual interdependence and coevolution of both systems. Cote & Nightingale (2012) considers human-environment relations as connected systems with similar objectives and trajectories that depend on feedback dynamics
between both social and ecological systems. According to Gallopín (2006) the SES can be delineated for a range of scales, spanning from the regional community and its environment to the planetary system encompassing the whole humanity (known as the "anthroposphere") and the ecosystem.

The SES is a complex adaptive system in which an ecological system is closely interconnected with and impacted by one or more social systems (Anderies et al., 2004). Ecological systems are complex networks of interdependent biological units or organisms, whereas social systems encompass organisms that establish cooperative and mutually dependent relationships. The term SES refers to social systems where certain human interactions are mediated through interactions with biophysical and non-human biological entities. According to (Gari et al., 2015a), the concept of SES arises from the dynamic interplay between human activities and the natural environment, whereby both entities exert mutual influence on each other. SES can be observed in various settings such as river catchments and coastal zones, where individuals and other living beings interact with the natural surroundings and one another. For instance, Anderies et. al. (2004) gives the example of a fisherman can who influence another's activities through their mutual engagement with the fish population, a complex and dynamic living asset.

Complex adaptive systems (CAS) are foundational to the understanding of socio-ecological systems (SES). Several authors conceptualize socio-ecological systems, where social and natural components interact with each other, as complex adaptive systems (Levin et al., 2013; Martín-López et al., 2017; Tian, 2017). These systems have been described as complex and intertwined constructs where human beings form an integral part of nature (Berkes and Folke, 1998). Early theories focused on a dichotomy between people and the environment, but more inclusive approaches have gained currency in the past century (Cundill et. al., 2005). This has led to principles and ideas such as complex system dynamics, linked social-ecological systems, nonlinear feedback, and resilience to change in social and ecological systems (Berkes & Folke, 1998). The concept of CAS, defined as open systems that interact with their environment (Nel, 2009), is central to the SES approach.
Complex adaptive systems are characterized by their intricate structure, comprising numerous independent agents whose interactions result in self-organization and the emergence of a system-wide order (Waldrop, 1992). Examples of such systems pervade nature and society. From the organization of genes in a developing embryo for creating different tissues and organs to the organization of a flock of birds and the evolution of organisms, atoms organizing themselves into molecules also demonstrate the characteristics of CAS (Waldrop, 1992).

The scale-related considerations of SES as complex adaptive systems are another critical aspect. These systems operate on multiple scales, each comprising various interacting components (Waldrop, 1992). For example, the global economy consists of multiple country-level economies, each of which can be considered a complex system in its own right and contains even smaller systems (Tian, 2017). This means, the CAS framework extends beyond biological and ecological systems to also encompass social and economic ones, such as how "marketplaces respond to changing tastes and lifestyles, immigration, technological developments, and shifts in the price of raw materials" (Waldrop, 1992, p. 11). In summary, economies, ecosystems, and social and cultural systems that operate on multiple scales all exemplify complex adaptive systems.

Nel (2009) outlines four fundamental characteristics of complex adaptive systems: adaptation, dynamics of cooperation and competition, self-organization, and emergence. Adaptation is an integral component of complex adaptive systems. The ability of a system and its components to learn and change based on their experiences is vital for its sustainability (Nel, 2009). The adaptability of a system is shaped by the actions of human agents and can involve altering the stable state of the system or changing processes generated by dynamics at other scales (Walker et al., 2004). The authors view adaptation as the social component of the system, defining it as the effect of individuals and groups on the system. From their perspective, the criteria of adaptability involve controlling the direction of the system, changing the stable state of the system (resistance, tolerance, etc.), or altering the processes created by the
dynamics reflected at other scales. The actions and interactions of individual elements within the system can give rise to coherent or chaotic behavior (Tian, 2017). In the past, system dynamics was the predominant method for researching complexity, relying on a range of system-level variables to explain and understand a complex system's behavior and dynamics. However, the paradigm of CAS provides a more comprehensive understanding of complex systems by focusing on how the behaviors and interactions of individual agents influence the system's overall dynamics (Tian, 2017). In these systems, a large number of human agents make decisions and interact with other agents and the natural system, with their actions influenced by their social, economic, and institutional settings. Agents within the system learn from their interactions and consequently evolve, thereby increasing the adaptability of the system. As such, understanding the adaptive interactions of agents is foundational for understanding CAS dynamics and processes (Tian, 2017).

**Self-organization** is another critical characteristic of complex adaptive systems. According to Cilliers (1998), the capacity for self-organization is "a property of complex systems that enables them to develop or change their internal structure spontaneously and adaptively in order to cope with, or manipulate, their environment." (p.90). This feature allows systems to spontaneously and adaptively develop or change their internal structure to respond to environmental changes. Rauws and de Roo (2011) add that self-organization is a process where system interactions lead to the spontaneous emergence of a coherent spatial or organizational structure without external coordination. Complex adaptive systems tend to self-organize, often without any centralized regulation, and exhibit a hierarchical structure where components at lower levels form the foundation for components at higher levels. For instance, the global economy comprises numerous country-level economies, which themselves are complex systems composed of even smaller systems (Tian, 2017). However, there are factors that impact self-organization, such as political instability, poverty, a culture characterized by distrust, significant social disparities, and ethnic conflicts among communities (Fischer et. al., 2012).
In addition to self-organization, another key feature of complex adaptive systems is the **emergence**. Here, the behavior of the system as a whole supersedes the sum of the behaviors of its constituent parts. Interactions between elements can result in emergent properties or behaviors that cannot be predicted based on the properties or behaviors of the individual elements. Additionally, these systems exhibit nonlinearity in their relationships between system elements, leading to disproportionate changes in the system as a whole in response to small alterations to one element.

In addition, Levin et. al. (2013) considers nonlinear dynamics and heterogeneity as components of CAS and explore their impact on policy formulation. According to them, the presence of nonlinear dynamics within social-ecological systems (SES) can yield unanticipated outcomes if overlooked. Traditional linear models often fail to explain sudden transformations in ecosystems, such as the shift of coral reefs to alternate states or the conversion of forests into grasslands. Consequently, effective management practices need to consider the system's history and anticipate potential nonlinear responses to policy interventions. In addition to nonlinearity and scale considerations, heterogeneity is a significant attribute of complex adaptive systems (Levin et al., 2013). Diverse agents with different capabilities, resources, and objectives interact within these systems, contributing to their overall complexity. The system's behavior cannot be predicted merely by understanding the individual agents; but requires an appreciation of their interactions and how these interactions give rise to emergent phenomena.

Understanding human-environment systems through the CAS theoretical framework leads to an understanding of sustainability as a system-level quality. This emergent quality results from human agents' actions and interactions, natural systems' biophysical processes, and interactions between social and natural elements (Tian, 2017). Consequently, the study of SES from the perspective of complex adaptive systems can provide valuable insights into the interconnectedness of social and ecological processes and how human actions can influence the dynamics and direction of these systems. This understanding can inform the development of more
effective and sustainable management strategies for socio-ecological systems (Berkes & Folke, 1998). In similar line, according to Folke et al. (2010), the root of many current issues with the use and management of natural resources is the failure to realize the interconnectedness between ecosystems and the social processes. This is due to the interconnected feedback loops within socio-ecological systems that influence their overall systems dynamics.

Anderies et al. (2004) highlights the significance of SESs that rely on collaborative efforts within social structures, particularly in cases where individuals have intentionally allocated resources towards establishing infrastructure to effectively manage diverse disturbances. In circumstances where there is a close interdependence between social and ecological systems, the SES is comprised of numerous subsystems and is also integrated within multiple larger systems.

In conclusion, the socio-ecological systems (SES) approach is an integrated perspective on human and ecological subsystems, recognizing their mutual interaction and coevolution. It is rooted in an understanding of SES as complex adaptive systems (CAS), which are characterized by adaptation, dynamics of cooperation and competition, self-organization, and emergence. This approach provides a comprehensive framework for comprehending the complexity of our world, emphasizing the spontaneous, adaptive, and often unpredictable nature of these systems. It also offers valuable insights for bridging the divide between social and natural sciences, facilitating a more integrated understanding of the intricate dance between human societies and the ecosystems they inhabit.

2.1.3 Socio-Ecological Productive Landscapes (SEPLs)

As noted by Kizos et al.(2010) and ICOMOS (2017), rural productive landscapes are composed of various interrelated components that encompass agricultural fields, areas designated for livestock grazing, forests that are managed, bodies of water, human settlements, infrastructure, and sites of cultural significance,). The literature emphasizes several dimensions of rural productive landscapes including food
security, agricultural sustainability, rural livelihoods, biodiversity preservation, climate change adaptation, as well as landscape management and planning (Baldini et al., 2021; Dale et al., 2013; Estrada-Carmona et al., 2014; Plieninger et al., 2006; Reyes et al., 2020; Tress et al., 2005). The complex and dynamic processes that make up rural productive landscapes have a substantial impact on ecological services, agricultural production, and the preservation of livelihoods.

The concept of socio-ecological productive landscapes (SEPLs) has gained prominence in conservation discourse due to the acknowledgement of the necessity to extend conservation efforts beyond protected areas to encompass the management of landscapes and ecosystems that have been influenced by human activities (Gu & Subramanian, 2014a). International Partnership for the Satoyama Initiative (IPSI) defines Socio-ecological production landscapes and seascapes (SEPLS) as “dynamic mosaics of habitats and land uses where the harmonious interaction between people and nature maintains biodiversity while providing humans with the goods and services needed for their livelihoods, survival and well-being in a sustainable manner” (IPSI Secretariat, 2015, p. 19). Despite being a relatively new concept, SEPLs shares a fundamental premise with the literature on social-ecological systems and resilience thinking, which supports the interconnectedness of social and ecological systems, and claims the need for adaptive management to respond ecosystem change (Folke et al., 2010; Walker et al., 2006).

The concept of SEPLS originated from International Partnership for the Satoyama Initiative (IPSI). The initiative has launched The Community Development and Knowledge Management for the Satoyama Initiative (COMDEKS) by the Ministry of the Environment in Japan, the Secretariat of the Convention of Biological Diversity, the United Nations University, and was carried out by the UNDP from 2011 to 2016. The project's goal was to disseminate best practices and important lessons learned from grassroots initiatives in order to build capacity, to replicate them in other regions, and to scale them up to subnational and national levels (Gu & Subramanian, 2014a). Over 280 case studies applied the COMDEKS methodology around the world, including the Dağça district in the province of Muğla in
southwestern Türkiye. The COMDEKS methodology focuses on community participation in the process of landscape design, and highlights that the indicators of resilience developed by COMDEKS are essential to the community consultation process. In the framework of this indicator-based approach, members of the community and other relevant parties convene to perform an initial evaluation utilizing the defined indicators, subsequently employed to establish a comprehensive "landscape strategy." (Dunbar et al., 2020)

The identification of SEPLs entails several interrelated factors including land use, socio-cultural traditions, climate, topography, biodiversity and availability of resources. A broad range of different habitat types, including secondary forests, wood plantations, cropland, irrigation ponds, wetlands, grasslands, beaches, and coastal zones, as well as human settlements, characterize the socio-ecological production landscapes and seascapes (Dunbar et al., 2020). Olupot (2015) uses four criteria to characterize these landscapes. These characteristics are;

“i) land use type (e.g. crop lands, livestock grazing areas, built-up areas, and protected areas); ii) terrain and elevation characteristics (mountainous, high altitude, low altitude, hilly, and plateau); iii) amount of annual rainfall (humid areas and drylands); and iv) hydrological characteristics (wetlands and uplands)” (p. 80)

These SEPLS has close linkages the local culture and knowledge (IPSI Secretariat, 2015). Additionally, a SEPL has a significant reliance on indigenous biological resources as the primary productive activities in the landscape are centered around the agricultural areas and livestock areas, with additional elements serving as supporting functions to ensure the overall functioning of the ecosystem. According to Olupot, (2015) such reliance is largely responsible for the persistence of those resources. According to Ichikawa & Dunbar (2015), local communities have played crucial roles in preserving healthy land and seascapes in regions where people engage in direct interactions with environment through farming, fishing, and the collection of materials from forests and other ecosystems. They have developed
methods of producing food and other materials in an efficient and sustainable manner by adaptation to, and occasionally change of, the surrounding environment because of their close interactions with nature.

The study of Gu & Subramanian (2014) reveals that socio-ecological productive landscapes (SEPLs) have a significant impact on the economic growth of local, national, and global communities. The production and extraction processes occurring within these landscapes are susceptible to external pressures stemming from a range of change drivers, including socio-political, legislative, economic, and socio-cultural dimensions. However, SEPLS around the world have changed into urban landscapes or homogenous production systems that require excessive inputs of, for example, agrochemicals that have significant impacts on the associated biodiversity and ecosystems as a result of the growing human population as well as changes in socio-economic systems brought on by industrialization, urbanization, and globalization (Gu & Subramanian, 2014; Ichikawa & Dunbar, 2015). (See subchapter on drivers of change socio-ecological productive landscapes)

Socio-ecological production landscapes (SEPLs) have been identified as central in the conservation of biodiversity beyond designated protected areas (Natori & Hino, 2021). This role is visible considering that the significant cause of biodiversity loss is land use, specifically agriculture. As a considerable amount of biodiversity exists beyond the current protected areas, the conservation of productive landscapes is crucial for effective management. However, according to Natori & Hino (2021) approximately 80% of the SEPLs globally detected by Satoyama Initiative, are situated beyond officially recognized conservation priority sites, such as protected areas and Key Biodiversity Areas. These are regions utilized predominantly for production purposes while preserving biodiversity. According to Saito et al. (2020), the SEPLs approach is inherently a comprehensive strategy that transcends sectoral boundaries and diverse policy objectives, including not only conservation but also rural development, water resource management, public health, and food security. It adopts a holistic perspective that encompasses both the ecological and social aspects of the land/seascape system.
In summary, the study of socio-ecological productive landscapes (SEPLs) is crucial due to their multifaceted significance. They offer critical habitats for many species, are a rich source of biodiversity, and provide crucial ecosystem services like nutrient cycling, water purification, and climate regulation. SEPLs facilitate the provision of livelihood resources to local communities. Furthermore, these geographical features have a pivotal function in ameliorating the effects of climate change by means of carbon sequestration. The investigation conducted in these domains amplifies our understanding of the resilience of systems and informs approaches to manage changes in the environment. Socio-ecological production landscapes (SEPLs) serve as significant locations of cultural heritage and traditional ecological knowledge, thereby emphasizing the critical need for their conservation. SEPLs approach offers more sustainable and integrated management strategies.

2.1.4 Researching and Analyzing Socio-Ecological Productive Landscapes in Rural Areas

The study of landscapes has evolved as a complex field of research, encompassing diverse disciplines including geography, planning, landscape architecture, resource economics, archaeology, sociology, psychology, and ecology (Antrop, 2000b; Antrop & van Eetvelde, 2017; Tress et al., 2005). Over time, this development has undergone several phases (Antrop, 2018), including the early protoscientific phase, the emergence of geography as a scientific discipline focusing on landscape, the rise of aerial photography and historical geography, the humanistic approach, and a shift towards applied and transdisciplinary landscape studies in response to 'landscape crises' which results from accelerating change and growing uncertainty, and the transition toward applied and transdisciplinary landscape studies since 1990s.

According to Antrop (2019), throughout the transformation of landscape research, on the one hand, it has become more applied, and society oriented but on the other, it has become less theoretical and academic. However, becoming less theoretical and academic does not necessarily yield to negative understanding of the situation,
several civic initiations has been working in the field of landscape ecology and conservation and at some point, experiences stemming from practice might lead to development of an overarching and interdisciplinary theory.

Recently, the study of landscape changes has adopted a more integrated approach. These multidisciplinary and multi-methodological studies include various spatial-temporal-actor scales to unravel the complex interplay between various drivers of change (Xie et al., 2022). Such research has significant implications for multiple areas like land use and land cover change, landscape conservation and planning, biodiversity, ecosystems, cultural and agricultural landscapes, and urban and peri-urban landscapes.

The increasing complexity of landscape research necessitates a holistic approach that transcends the traditional divisions between natural and social sciences. Landscape is a complex concept that different disciplinary fields such as geography, planning, landscape architecture, resource economics, archeology, sociology, psychology, and ecology has developed diverse explanations, research approaches and methodologies regarding landscapes (Antrop, 2000b; Antrop & van Eetvelde, 2017; Tress et al., 2005b). Although there are numerous studies focusing on landscapes, particularly rural landscape is a topic that has yet to be sufficiently researched (Balestrieri, 2015).

Despite this multi-faceted approach, some researchers argue that there is a deficiency in studies that concentrate on both ecological and social processes to understand the effects of social drivers on land use and biodiversity (Beilin et al., 2013). Others have investigated landscape change by examining historical rates of change, identifying the key actors and driving forces behind these changes, and using tools like GIS and remote sensing for detailed analyses (Schneeberger et al., 2007; Poças et al., 2011; Campos et al., 2012). These studies provide critical insights but often lack a comprehensive understanding of the impact of drivers of change and responses of actors to drivers and change.

The realm of landscape research thus lies at the intersection of various disciplines, requiring an understanding of ecological, social, cultural, and economic factors. It
calls for the integration of diverse methodologies and data types – from GIS and remote sensing to interviews and surveys. Despite the inherent challenges, the field continues to evolve towards more integrative and interdisciplinary approaches, reflecting the complex and dynamic nature of landscapes as socio-ecological systems. Socio-ecological systems (SESs) research is of utmost importance in understanding the complex nature of rural landscapes and agricultural production, providing significant perspectives for the promotion of sustainability of rural areas and agricultural production.

The concept of Social-Ecological Systems (SES) has gained significant attention in recent years, reflecting growing interest in understanding the complex interactions between social and ecological systems (Berkes & Folke, 1998). An array of frameworks has emerged to analyze these systems, with varying degrees of emphasis on the social, ecological, or interactional aspects. Several scholars have proposed various SES frameworks to understand and address the complexities inherent in such systems (Berkes & Folke, 1998; Anderies et al., 2004; Ostrom, 2009). These frameworks, evolving over time, aim to analyze and understand the dynamics and resilience of SES.

Barthel et al. (2019) aims to assess the evolution of SES concept after 20 years of its first use in analyzing resilience of resource management systems by Berkes and Folkes (1998). The researchers aim to understand how different authors use the concept in relation to research that deals with social and ecological linkages. For this aim, Barthel et al (2019) analyze randomly selected 50 journal articles that are retrieved from Scopus database. The analysis shows that there is a constant increase in the number of SES publications since 2019. However, the results show that only 61% of the publications do not provide a definition of the term. Additionally, they highlight that there are three main SES frameworks that commonly influence other researchers the most which are discussed below.

Berkes & Folke (1998) are among the first to assess the resilience of resource management systems using the SES concept, defining five key elements: ecology,
people and technology, local knowledge, property rights, and institutions. Their framework provides a descriptive basis to study the interconnectedness within SES, and thereby, lead the foundation for management strategies and principles fostering resilience (Raufflet, 2000).

According to Barthel (2009), while the framework of Berkes and Folke can be regarded as a descriptive framework that focuses on "the linkages between institutions, management practices, and different environmental knowledge systems" (p.8), the frameworks developed by Anderies et. al. (2004) and Ostrom (2009) can be considered as diagnostic frameworks. However, this model, despite its age, has remained influential (Barthel et al., 2019), alongside other diagnostic models such as those by Anderies et al. (2004) and Ostrom (2007, 2009) with its power to understand complexity and interrelations between local knowledge and ecosystem functioning.

The diagnostic framework of Anderies et. al, (2004) proposes an identification of potential vulnerabilities of social-ecological systems (SESs) to disturbances. It highlights the link between resource users and public infrastructure providers as a key variable and describes design principles for more general SESs (Anderies et. al, 2004).

Ostrom (2009) conceptualizes SESs as complex systems comprising diverse subsystems at various levels. By this model, SESs consisted of resource systems, resource units, users, and governance systems that interact with each other to generate outcomes. These outcomes subsequently provide feedback to the subsystems and components. According to Ostrom (2009) the complex nature of SESs has posed a difficulty in determining the reasons behind the sustainability of certain systems and the collapse of others. The proposed SES framework by Ostrom holds significant utility in the identification of relevant variables that are to be employed in the formulation of data collection, fieldwork execution, and analysis of findings pertaining to the sustainability of complex socio-ecological systems.
Ostrom employs the SES framework to investigate the rationale behind the users' investment of time and effort in averting a "tragedy of the commons."

Among the frameworks available, Ostrom’s SES Framework (SESF) has been widely adopted due to its comprehensive approach to complex systems comprising diverse subsystems (Ostrom, 2009). While SESF is praised for its potential in organizing key SES variables and simplifying case study variable selection (Binder et al., 2013), it has also been critiqued for its predominant focus on social processes and relative neglect of ecological considerations (Vogt et al., 2015). This is due to the lack of interdisciplinary dialogue and a shared vocabulary. Vogt et al. (2015) criticizes Ostrom’s approach, which suggests all outcomes in SESs can be understood purely in terms of social processes and aggregations of human decisions. The critics called for a comprehensive representation of ecological variables and dynamic processes and advocated for a multidisciplinary approach to capture the complexity of SESs better. Despite its origins in social sciences, SESF is unique in offering the option to treat both social and ecological systems with almost equal depth, unlike most frameworks with an eco-centric perspective such as Ecosystem Services framework or an anthropocentric perspective such as DPSIR, HES or SLA frameworks (Binder et al., 2013).

The Driver-Pressure-State-Impact-Response (DPSIR) framework has been devised as one of the means for understanding and managing SESs, and developing environmental policy (Gari et al., 2015; Agramont et al., 2022). The framework was developed by the Organization of Economic Cooperation and Development (OECD) and the European Environment Agency (EEA) (EEA, 2003). The Environmental Agency (EEA) has established the following categories for the DPSIR framework. Driving forces are societal, demographic, and economic advancements that lead to changes in lifestyle, consumption, and production patterns. Pressure indicators are alterations in emissions, physical and biological agents, resource utilization, and land use caused by human activities. State indicators are quantifiable parameters that describe the physical, biological, and chemical characteristics of a specific geographical location. Impacts are consequences of alterations in the environment,
such as effects on human and ecosystem health, availability of resources, depletion of manufactured capital, and biodiversity. Responses are measures taken to mitigate, adapt to, compensate for, or prevent alterations in the environment. The impact on society and the environment depends on the state's carrying capacity and thresholds, and the societal response depends on society's perception of the problem and might vary (EEA, 2003; Gari et al., 2015).

Despite its comprehensive approach, this framework has also faced criticisms. Svarstad et. al. (2008) critically evaluates the theoretical foundations of the DPSIR framework and argue that the framework is not neutral in generating knowledge, as it reflects the discursive positions that users apply to it. Authors contend that despite claims of the framework's effectiveness in facilitating communication between researchers and stakeholders, it falls short due to its inability to adequately handle the diverse attitudes and definitions of issues by various stakeholders and the public. One major criticism is that the framework lacks a theoretical base, which might limit its ability to generate insights beyond descriptive analysis (Cumming, 2014). In addition, Neimejer et. al. (2008) asserts that these frameworks have limitations due to their reliance on simple, uni-directional chains, which do not capture the complexity of indicators for environmental assessment. According to Agramont et. al. (2022), DPSIR oversimplifies socio-ecological systems and neglects local dynamics. Authors assert that there is a regional mismatch between driving forces/pressures and policy responses which have crucial impacts on vulnerable communities. Authors suggest integrating geographical and social factors in the DPSIR to enhance river basin management practices.

Comparative studies by Binder et al. (2013) and Cumming (2014) added depth to understanding of SES frameworks. These researchers categorized frameworks into analysis-oriented and action-oriented. According to Binder et al. (2013), the former, like SESF, organized and evaluated SES data, whereas the latter aimed to improve a situation. According to Binder et. al. (2013), analytical frameworks like the SESF are based on organizing and evaluating SES data. They provide a functional way for system understanding. Whereas action-oriented frameworks provide information to
improve a situation, such as improving the livelihood of communities in developing countries. On the other hand, Cumming (2014) classified SES frameworks into hypothesis-oriented, assessment-oriented, action-oriented, problem-oriented, and theory-oriented frameworks. Cumming (2014) discusses the absence of a comprehensive theoretical framework in the growing field of social-ecological systems (SESs) research, a field that addresses critical contemporary questions. The author argues that the development of such a comprehensive framework is desirable as it would enhance our ability to generalize from individual case studies, distinguish critical findings from less important ones, predict the impact of management and policy interventions, and build greater resilience in SES.

An emerging critique within the realm of SES research is the notion that the social subsystem's representation is inadequate as mentioned by Cote and Nightingale, (2012), Fabinyi et al. (2014) and Stonajevic et al. (2016). According to these authors, SES theory often neglects the complexity of social life and processes, including the role of power, social diversity, and morality. According to Fabinyi et. al. (2014), the SES model provides a holistic view of human-environment relations, but has limits such as ignoring social variety, morals, and power, and overemphasizing how humans adapt to their settings. This conceptual oversimplification is evidenced by a common tendency to reduce the social dimension to governance and management approaches, effectively overlooking the full scope of human activity (Ollson and Jerneck, 2018).

The review of literature on SES shows a notable gap in addressing power imbalances. According to Fabinyi et al. (2014), the research on SES tends to excessively highlight the correlation between people's preferences and the environment, while simultaneously disregarding the significance of social diversity and power dynamics. It is noteworthy that power dynamics are inherently intertwined with human adaptation to their environments, a variable that is frequently overlooked in studies of socioeconomic status.
Hodbod and colleagues (2019) respond to these critiques by employing a political ecology paradigm that accounts for the disparate allocation of ecological consequences across various demographic groups. The study conducted in the Omo-Turkana Basin in Ethiopia demonstrates the significant impact of conflicts related to resources and the unequal distribution of power on social subsystems. This highlights the necessity of a more intricate portrayal of the social component in the SES framework.

The call for increased depth and complexity in the social aspect of SES is echoed in the study conducted by Guerrero et al. (2018). Notwithstanding the recent increase in social-ecological research, the authors discover that achieving a comprehensive integration of social and ecological aspects still poses a challenge. Social factors, including culture, politics, and power, are often disregarded despite their significant impact. The authors contend that successful integration can be attained by means of interdisciplinary cooperation, deliberate involvement of stakeholders, diverse methodologies, and explicit articulation of policy implications and recommendations.

Fischer et al. (2012) provide a case study of the implications of the previously mentioned theoretical complexities. The authors examine the impact of globalization and rural development initiatives on the Saxon region of Romania through a case study. They observe that these factors cause a disruption in the social subsystem, resulting in a disconnection between the social and ecological subsystems. This situation undermines the complex relationship between social and ecological factors, emphasizing the need for SES research to adopt more sophisticated, power-sensitive, and situation-specific methodologies.

Recent research interest in socio-ecological systems (SES) has led to approaches stemming from the need for comprehensive and participatory ways to understand the complex interactions of social and ecological subsystems.

Alessa et al. (2009) argue that the need for transition from the idealized notion of "neat" Social-Ecological Systems (SESs) to a more realistic understanding of
"messy" SESs, which take into account the multiple resources used by various users, as well as the technologies they utilize. As Alessa et al. (2009) noted, however, many of these models and approaches portray SES as "neat" systems in which human and ecological components interact in a predetermined and predictable manner. This viewpoint disregards SES' inherent complexity and unpredictability. To address this issue, Alessa et al. propose a framework for analyzing "messy" SES, with a concentration on human settlements differentiated by size (city, town, village) as a reflection of ecosystem productivity, social organization, and resilience. Recognizing the complexity of social-ecological interactions, the framework includes diverse indicators such as the diversification of social capital, the expansion of resource use zones, and the spread of knowledge. According to the authors, it is important to incorporate people's preferences and priorities into a socio-ecological model that also recognizes the uniqueness of human decision-making processes. They argue that this helps truly understand human impacts on landscapes and ecosystem services. Furthermore, they claim that this model should also represent the responses of plants and animals to human actions, offering dynamic feedback on the consequences of specific actions.

Martín-López et al. (2017) operationalize SES for landscape planning. Their scientific approach spatially defines the boundaries of SES and describes social-ecological units. The methodology of Martín-López et al. for three Mediterranean cultural landscapes includes ecological regionalization, socio-economic regionalization, SES border identification, and SES unit characterization. To confirm these SES borders, the methodology uses key informant participatory mapping. This approach expands beyond municipal statistics and emphasizes the significance of local cultural and institutional aspects in defining the socio-economic unit.

Holzer et al. (2018) view socio-ecological research as part of a larger trend toward transdisciplinarity in science. To address concerns, the authors combine academic, practical, and social expertise to tackle shared public issues. After a thorough literature study, the authors categorize the evaluation methods into five groups: questionnaire models; mixed methods; staged environmental policymaking process
review: the Research Embedment and Performance Profile approach; and case studies. The study emphasizes the need for effective evaluation frameworks in socio-ecological research and presents a novel six-stage framework as a potential solution. This approach combines qualitative and quantitative investigation, data synthesis and visualization, focus groups for reflection, and a final data synthesis tailored to the evaluation audience(s).

Giannecchini et al., (2007) uses the cultural landscape and socio-ecological systems framework as a theoretical foundation for discussing the interrelation of environmental change with socio-economic factors in Bantustan Region of South Africa. Although this is an example from an indigenous community formed of ethnic clans, this example represents a historical analysis of 23 years of change in socio-economic factors, household livelihood strategies, and landcover change in the village level. The authors assert that the SES approach is useful for assessing interrelations with landcover change and socio-economic change in their study area. They perceive this landscape as a unique and complex one that is framed by the interactions of nature-society rather than perceiving it as a landscape that is changed by human impact. The applied methodology is composed of multiple approaches that depend on an assessment of aerial photos, participatory rural appraisal, focus groups, participatory mapping and timeline, household survey, semi-structured interviews which were triangulated by secondary data from institutions. (Giannecchini et. al., 2007). The authors find that local socioeconomic and biophysical factors interact in complex ways at diverse scales that shape the landscape.

These studies emphasize the need for holistic, integrative, and participatory SES research. They demonstrate SES complexity and the need for tools to better understand and manage these systems. However, the existing multidisciplinary and interdisciplinary research practice have certain drawbacks that clusters around quantitative research and lack of social dimension among SES researchers. This situation also leads to another critical drawback which requires linking data with different qualitative, quantitative and spatial qualities and gathered through different
techniques. Upcoming section on researching and analyzing SES resilience discusses this problem in details.

2.2 Change, Resilience, and Response in Socio-Ecological Productive Landscapes

This chapter explores change, resilience, and response in the rural productive landscape using socio-ecological systems (SES) as a lens. By classifying agricultural practice and rural landscape as SES, it aims to present how social, economic, and environmental factors interact and affect the dynamics of the rural productive landscape. Farmers are the key actors in these dynamics as they actively shape and adapt to the landscape in response to various difficulties, acting as both change agents and change respondents. The first subsection examines the specific causes of change in the rural environment and its effects, highlighting the crucial position of farmers. The following explores SES resilience, providing an analytical viewpoint on how these systems experience disturbances, adaptation, and change. The third subchapter explores the adaptability and adaptive capacity in a socio-ecologically productive landscape. The final section delves deeper into a more detailed examination of the farmers' roles in SES, identifying how their actions contribute to and navigate the change.

A brief introduction to underlying drivers of change clusters in seven categories including demographic, political, agricultural and food system, technological, economical, natural, and spatial drivers of change. As mentioned, these drivers of change operate in multiple scales and the conceptual boundaries of these drivers are not rigid, touching multiple drivers at the same time. This situation represents the complexity of the agricultural systems operating in rural landscapes.

The resilience of socio-ecological systems (SES) is a multifaceted concept encompassing the robustness of a system, its adaptability, and its capacity for transformation. The way these systems react and adapt to disturbances is pivotal to understanding their stability, longevity, and resilience. This comprehension of
resilience extends beyond the realm of mere survival, but also to the ability of the SES to persist, learn, adapt, and even transform amidst change. Recognizing and effectively managing this resilience is increasingly important in the face of rapid globalization and escalating environmental transformation characterizing productive landscapes in both developed and developing regions. Future research needs to continue to evolve in response to these changing dynamics, ensuring that it encompasses a truly integrative approach that recognizes the complexity of the social and ecological interdependencies inherent within these systems. The capacity for self-organization, learning, and adaptation are critical elements in promoting resilience in SES, as is the acknowledgment and understanding of the political, historical, and cultural contexts of these systems.

While the prevailing reliance on indicator-based assessments in SES resilience research provides some useful insights, it fails to encapsulate the complex nature of these systems adequately. The critique underscores the need to broaden the scope of SES resilience studies by incorporating a more comprehensive and nuanced understanding of the social dynamics within these systems. These social dimensions, such as human agency, power dynamics, cultural context, and social actor diversity encapsulated in local knowledge, significantly influence the resilience of SES and their understanding is vital for the holistic representation of SES resilience. The shift toward recognizing and integrating these elements will likely contribute to a more complete and insightful understanding of how socio-ecological systems operate, adapt, and transform.

2.2.1 Drivers and Impacts of Change in Rural Productive Landscape

The study of understanding and analyzing landscape change has been one of the central inquiries of geography and landscape research (Wood & Handley, 2001). However, the accelerated rate of change resulted in growing attention to the dynamics of change in the rural landscape. The efforts to understand the change in the rural landscape have two distinct branches: studies focusing on the drivers and
studies focusing on the impact and result of the change. However, there is a growing recognition that drivers and impacts do not link with a simple cause-and-effect relationship. The change in landscape occurs through drivers that can act at multiple scales and can impact diverse domains including sociocultural, economic, political, spatial, and natural contexts that are also molded with the local contextual factors. According to Marsden (1998) change in rural space follows different paths in certain times and spaces depending on the locally specific combinations of local and external interrelations. This leads to multiple manifestations of change at different localities even under similar drivers. As a result, understanding driving forces, actors, and resulting impacts is essential for unraveling the processes of change, projecting future change, and for directing and managing change through developing policies for landscapes (Hersperger & Bürgi, 2010; Schneeberger et al., 2007). The diversity of approaches to understanding the drivers of change and specifically to landscape change shows that landscapes are under the direct or indirect influence of certain factors operating on multiple scales (both hierarchical and nested). This means that the drivers of change cannot be studied isolated from each other as they represent a complex system composed of dependencies, interaction, and feedback loops that operate on several temporal and spatial levels (Bürgi et al., 2005). This complexity creates challenges to studying drivers of landscape change (Kizos et al., 2018) and creates difficulties in establishing direct linkages between drivers and change (Kristensen et al., 2009). The complexity exacerbates considering that certain driving factors have an immediate influence on the landscape (e.g., fire, hurricane) while others affect the landscape indirectly and with a time lag (e.g., laws and regulations or cultural revolutions) (Schneeberger et al., 2007). In addition, the increased connectivity of production ecosystems that stems from human-induced drivers, such as advancements in trade, transportation, technology, and consumption results in long-distance interrelations in biophysical and socio-economic spheres (Nystrom et al., 2019). For example, land transformation in a certain location might have drastic impacts on productive ecosystems at distant locations such as deforestation for agriculture might impact global evapotranspiration and CO₂.
emissions, thus impacting rainfall patterns, drought, and aqua biodiversity in other locations. Such connectivity represents the complex interactions underlying differences between parts of the ecosystems. Although there are still remote production ecosystems such as subsistence fishing and farming areas or variegated agricultural landscapes that have not been impacted by human action or integrated into international trade, they will be progressively shaped by global-level drivers such as policies, economic adjustments, and technological developments (Nystrom et al., 2019).

To study drivers of change, Bürgi et al. (2005) suggested a basic classification for drivers including cultural, socio-economic, political, technological, and natural/structural dimensions. Several authors have adopted or modified this classification in order to expand knowledge on the drivers of landscape change in a certain spatial-temporal context (Gu & Subramanian, 2014b; Hersperger & Bürgi, 2009; Plieninger et al., 2016; Schneeberger et al., 2007; van Vliet et al., 2015). Young (2016) identified four key factors that drive rural change, namely economic globalization, advancements in technology, environmental shifts, and changes in governance methods.

The difficulties in establishing relationships between drivers and change have led to the conceptualization of drivers as underlying and proximate drivers of change (Geist & Lambin, 2002; Campos et al., 2012; Van Vliet et al., 2015). Geist & Lambin (2002) define proximate causes as the human activities or immediate actions that occur at the local scale. Agricultural land expansion is an example of proximate causes that arise from intended land use change which impacts other types of land cover in that specific location. Whereas social processes such as population dynamics or agricultural policies are considered underlying drivers that create a foundation for proximate drivers to operate and that act either act at the local level or have an indirect influence from national and global levels.

Valbuena et al. (2010) divides processes that lead to change in rural regions into two categories: exogenous and endogenous processes in the region. While endogenous
processes include socio-economic and biophysical conditions of a specific region (e.g. population, farming, social institutions, local and regional governments, topography and water availability), exogenous processes act on global and national scales including changes in global market, climate change, global agreements (e.g. WTO) and policy frameworks such as the Common Agricultural Policy of the European Union.

Van Vliet et. al. (2015) focus on proximate and underlying drivers of change and consider demographic, economic, technological, institutional, and sociocultural drivers as underlying drivers of change like the previous studies such as Burgi et. al. (2005). To unveil the local processes of the agricultural land change, the authors assert that land managers' decisions are influenced by underlying drivers and as a result, farm and farmers characteristics are considered as separate categories that influence processes of change. This understanding is compatible with the approach of Primdahl (2010) who asserts that the way a place is shaped is influenced by a combination of local people's autonomous decisions and actions, local adaptations and responses to outside decisions and events, and outside decisions influence the evolutionary trajectory of a place. In this sense, several studies center on the role of farm and landscape-level actors and processes to better understand change in specific landscape contexts.

Darnhofe et. al. (2010) examined social, economic, and ecological drivers of ongoing change and sources of disturbances for farms, operating at different spatial and temporal scales emphasizing the complexity of managing a farm amidst these various influencing factors. The approach of the authors focuses on short-, mid- and long-term drivers and their impacts on farm/local level, regional/national level and international/global level.

According to Darnhofe et. al. (2010), short-term drivers are sudden changes and occurrences that can have a substantial impact on farming operations. On a local or farm level, these factors include the selection of feed sources, the impact of meteorological conditions on crop and animal feed growth, and the management of
social conflicts, such as those resulting from pesticide drift or GMO crops. Significant regional or national effects of drought, drought relief programs, and local, regional, or national market opportunities emerge. Short-term fluctuations in commodity prices as a result of international political crises, food safety crises, or an increase in fuel costs that could impact transportation costs for inputs are crucial factors to consider on a global scale. These short-term factors necessitate prompt responses and adjustments in order to preserve farm operations.

According to Darnhofe et. al., mid-term drivers reflect changes that could take months or years to materialize. At the farm or local level, these drivers may include changes in production methods (such as the transition to organic farming), changes in farm ownership, or changes in the farm family life cycle that influence labor availability. It also encompasses the farm's involvement in the local community and farmer organizations. Changes in relationships with traders and retailers, values (such as the adoption of organic farming by the farming community), agricultural policies, ecosystems, and landscapes are significant on a regional or national scale. Changes in commodity prices, changes in diets (such as the transition from rice to wheat in many Asian countries), and the global degradation of essential ecosystem services, such as the provision of potable water, are important mid-term drivers on an international or global scale (Darnhofe et. al., 2010). To ensure sustainability, these factors demand proactive planning and strategic adaptation.

Long-term drivers refer to alterations and tendencies that develop over extended intervals, potentially several years or decades. At the local or farm level, these can include changes in soil quality and biodiversity, as well as a decrease in adaptability due to large investments or specialization. On a regional or national scale, demographic shifts such as an aging population and rural depopulation, shifts in consumer preferences and values (such as demands for animal welfare and rejection of GMOs), and the emergence of a land ethic among new settler agricultural societies can be significant drivers. Factors such as climate change, international agreements (such as those established by the World Trade Organization), global demographic growth and migration, and global degradation of essential ecosystem services can
have a significant international or global impact. These long-term factors necessitate future-oriented, deliberative decision-making and can profoundly shape the farm's trajectory (Darnhofer et al., 2010).

Based on the discussions in the literature, this section discusses the driving forces and patterns of change in agriculture at both farm and rural landscape levels in an interrelated manner under seven dimensions. These dimensions are namely demographic, political, food and agricultural system, technological, economic, natural, and environmental, and spatial drivers.

It is important to note that the drivers of change cannot be discussed when they are divided into categories for the drivers act and operate on multiple scales and impact each other simultaneously. Additionally, it is hard to establish linkages between short, mid, and long terms drivers and their impacts on different scales. To overcome this difficulty, this subchapter narrates the underlying drivers and respective changes in farm level and the rural landscape level together. Although the present study focuses more directly on the impact and response patterns in agricultural productive landscapes and argue that the landscape components interact with each other in an intertwined manner, it is useful here to provide a brief introduction to the drivers of change in rural landscapes impacting agricultural production. Thus, the overall aim of this subsection is to set a background about the underlying drivers that lead to a change in agricultural production and rural landscapes.

2.2.1.1 Demographic Dimension

The growing human population, which increased from nearly 1 billion to 6 billion, has become one of the intrinsic challenges of the last two centuries in many dimensions. The increase in human population has raised pessimistic concerns originating from Malthusian explanations of the availability of resources to meet the growing food demand. Classical Malthusian theory asserts that population growth leads to an expansion of crop production even in marginal areas, which in turn decreases labor productivity and per capita output. This process continues until
population growth is unsustainable as per capita output declines to subsistence levels (Hazell & Wood, 2008)

Increasing the food supply requires the expansion of agricultural lands and food production locations. The food security discourses and free trade policies that originated in the mid-19th century paved the path for the globalization of food and agricultural systems (Wilkinson, 2015). During the 20th century, technological advancements to increase yields followed the colonization of other continents for agricultural expansion. The "Green Revolution", the industrialization of agriculture, and developments in biotechnology and genetics (GMOs, certificated seeds, etc.) were developed to ensure food availability for increasing human populations (Lang, 2010). These attempts triggered the development of modern plant breeding technologies, inorganic fertilizers, and pesticides to increase agricultural yield (Hazell & Wood, 2008). However, they had adverse impacts on the ecosystem.

The Malthusian explanation, in which agricultural methods limit the supply of food to feed an increasing population, undermines technological advancements in agriculture and human adaptation to changing conditions. In contrast with Malthus, the Danish economist Ester Boserup (1965) underlines that an increase in population triggers agricultural intensification to increase food supply by means of innovations such as machinery and fertilizers, developed as a part of human adaptive strategies. Until now, the growing need for food to feed the increasing urban population has historically been met by increasing the area of cultivation and technological advancements to increase yield (Hazell & Wood, 2008). However, the need for cultivation has stagnated because of intensified agriculture. According to Rudel et al. (2009), feeding the growing human population, which increased by 74.3 percent between 1970 and 2005, became possible by switching to intensified agriculture using agricultural inputs to increase yield. In this period, per capita income increased by 87.2% and total food production increased by 123% on a global level. Whereas the globally cultivated area allocated for all crops increased moderately by 21.3%. Rudel et al. (2009) show that globally, more than 20% of 161 countries around the world (including Turkey and some Southeastern European counties such as Croatia,
Serbia, Italy, Hungary, Greece, Switzerland, and Austria) increased yields while decreasing cultivated land between 1970 and 2005. This situation requires the elaboration of the agricultural system, not only with land coverage but also with technology implemented during agricultural production.

Despite efforts to increase the size of agricultural production, the hunger problem persists today even if global agricultural production has grown faster than population growth since the 1970s. Between 2010 and 2050, the human population is expected to increase by 34%, reaching 9.1 billion (FAO, 2009), while the global food demand is expected to increase within the range of 35% to 56% (van Dijk et al., 2021). Yet approximately 12% of the world population experienced food insecurity in 2020, and the COVID-19 pandemic has exacerbated the food insecurity and malnutrition problem around the globe (FAO et al., 2021). According to Hazell & Wood (2008), hunger-related problems originate not from food supply shortages but from an uneven distribution of income. These situations also raised concerns about food security. FAO (2006) defines food security as "a situation when citizens have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life." (p.1). Although its goals and definitions have varied over time, food security has increasingly become a debate in the international and national arenas since the 1990s as sustainability discussions gained momentum globally due to the rise of practical and ethical concerns about the environment, climate, and life on earth. As a result, achieving food security as a part of the sustainability agenda is still defined as a global goal under the UN Sustainable Development Goals (SDGs). As it seems, continuous increases in the global system of agricultural production cannot end the hunger problem and can trigger serious health and environmental problems. This requires not only the sustainability of agricultural production but also an equal distribution of benefits and earnings from production, including to the small-scale producers who are at the beginning of the food chain.

Additionally, the use of agricultural products for non-food purposes such as energy and feed crops is another dimension in this discussion which is highly linked with
the food and agricultural system drivers. Increased allocation of crops for non-food purposes such as animal feed, bioenergy, and other industrial uses affects food availability for the feeding of human populations (Foley et. al., 2011). While 62% of crop production is associated with human food, 35% is used for animal feed and 3% is used for other purposes. Crop production for industrial uses is relevant to intensified agriculture and land cover change. Some industrial products such as corn (maize), wheat, soybeans, potatoes, bananas, cacao, coffee, sugarcane, and cotton compromise 57% of the Earth's overall cropland (Rudel et. al., 2009). Therefore, increasing the allocation of crops for non-food purposes such as animal feed, biofuel and other industrial uses also hinders food availability for the feeding human population and ending hunger (Westhoek et al., 2014).

2.2.1.2 Food and Agricultural System Dimension

Agricultural systems have significantly changed all around the world during the last century. According to Nystrom et. al. (2019), production ecosystems has increasingly become globally connected on a scale and extent that has never been experienced before due to three interrelated tendencies: "(1) the continued conversion of the Earth’s biosphere into simplified production ecosystems, (2) the increased intensification and dependence of these production ecosystems on human inputs, and (3) their expanding connectivity through global markets" (p.98). To put simply, agricultural systems transformed from relatively closed agroecosystems that depend on local inputs in terms of human and natural resources to globally open agroecosystems that rely on imported inputs and energy to sustain food production levels (Kristensen et al., 2009). Global agricultural system does not homogenously impact the agricultural systems everywhere. Development of agriculture shows spatial variability among locations concerning the differences in farming systems, productive capacity, population density and dynamics, food demands, available infrastructure, market access and public policies of countries that choose to import food or invest in agricultural and environmental improvement (Hazell & Wood,
mechanization of farming activities, (ii) intensification of use of external inputs, and (iii) separation of livestock and crop production (Knickel, 1990).

Agricultural intensification, which encompasses coupled social, environmental, and economic dimensions, has been a dominating type of global land-use change throughout the last century. Intensification through land use and agroecosystem change is driven by policy impacts and market integration on farm production, food security concerns, and the response to global environmental changes (Zimmerer, 2010). Agricultural intensification aims to increase yields per cultivated area. For this aim, global food production has increased by 123% that corresponds to increase of cultivated areas only by %25,7 between 1990 and 2005. Although these attempts originated with the concerns over ending hunger, hunger persists showing that there is distribution problem rather than food shortages at the current state as discussed in the previous subchapter. However, global cultivated land continues to increase at the expense of forests, wetlands, and pasture habitats (FAO, 2011). In addition, agricultural intensification is associated with water degradation, pollution, and growing energy use. Global irrigated cropland doubled, and total use of fertilizers used per area of cropland has increased by almost 420% between 1961 and 2019 on the global level (Foley et. al., 2011; FAOSTAT, 2021). In return, increased pesticide usage causes an increase in resistant insect populations, a reduction in beneficial species such as predators, pollinators, and earthworms, a shift in soil microbial diversity, and pollution of water and air ecosystems (Gill & Garg, 2014).

Agricultural intensification changed the labor requirements in agriculture through increased power necessary for land preparation. This resulted in the adoption of mechanical technologies to enhance agricultural productivity and lowering the unit cost of crop production (Pingali & Evenson, 2007). Agricultural mechanization occurred at different levels in the different regions across the world depending on the socio-economic and political environment in different local contexts. In addition, mechanization penetrated the production steps differently. While adoption of mechanization of land preparation, harvesting, and milling, steps in which more
power is needed, the mechanization was faster while for the jobs that require more human judgment, like as weeding, mechanization is still done by hand under low-wage conditions (Pingali & Evenson, 2007). For example, Sub-Saharan Africa shows lower levels of mechanization whereas middle income countries of Latin America show rapid adoption of labor saving technologies including mechanization and chemicalization. Adoption of mechanization and later technological advancement has resulted in the exodus of agricultural labor into other sectors. As a result, labor becomes more expensive in relation to land and capital as per capita income rises, and small farms are driven out by bigger, more financed farms that adopted more capital-intensive technology. Consequently, while many small farms disappear, others adapt to changing conditions by specializing in or becoming part-time farmers (Hazell & Wood, 2008). The polarization of agricultural sector between large, productive farms and small, extensive farms affects landscape patterns and habitat quality in rural areas (Kristensen, 1999).

According to Hazell & Wood (2008), increased productivity and market competitiveness have resulted in lowering food prices. According to McCalla (2009), increased yields and productive capacity during the 20th century resulted in decrease of grain prices since the 1870s. Especially, OECD agricultural support programs have enabled increased competitiveness among farmers in OECD countries, thus, contributing to low world prices. Yet, global food prices entered an increasing trend with the 21st century and doubled during the food crises of 2007-2008 and 2010 (Bellemare, 2015). The food price surges in 2007-2008 showed the vulnerabilities of this complex global food system in the form of volatile food prices, food shortages and food insecurity, especially in developing countries and low-income communities around the world.

Similarly, energy prices are highly relevant to changes in global agriculture and directly impact on food prices. Increasing energy prices have different impacts on changes in agriculture and land use. High energy prices can encourage lower use of mechanization that can result in decreased fertility on the one hand but can also decrease the negative environmental impacts through lowering tillage practices
which decreases soil erosion (Hazell & Wood, 2008). In poor regions, high energy prices might result in increased dependence on the use of wood, manure, and crop side products as a source of energy which can lead to deforestation and land degradation. Farmers respond differently to increasing input and output prices.

The structural change in agriculture has been conceptualized by the transition from productivism and post-productivism modes of agriculture since the 1990s, especially in Europe (Marsden, 1995). While intensification, specialization, and concentration are the central characteristics of productivism in agriculture, post-productivism in agriculture is characterized by extensification, diversification, and dispersal (Kristensen et. al., 2004). However, several authors challenge consideration of the linear development in agriculture through mechanization, industrialization, intensification and extensification or transition from productivism to post-productivism (Busck, 2002; Marsden, 1995). Similarly, Evans et al. (2002) criticized the explanation of agrarian change through the dualism of productivism and post-productivism results in uneven development in rural areas. In addition, post-productivism can no longer explain the complexity of the global agrarian system which has different repercussions on different spatial, temporal, and organizational scales.

Kristensen et. al. (2009) uses the concept of food regimes as an exploratory framework that aims to shed light on local changes in agricultural systems despite differences in national contexts. The corporate food regime gained dominance after the 1980s and flourished with the rise of neoliberal capitalism. Fossil fuel-dependent industrial agriculture, monopolized agribusinesses, market power, liberalized global food trade, long food supply chains, exploitation of natural resources, globalization of animal protein chains, and food-fuel economies are the main characteristics of the current food regime (Giménez & Shattuck, 2011; McMichael, 2009).

Led by the open trade policies, market liberalization in developing countries, and advancements in communication and transportation systems, international trade of food and agricultural products increased by 10 times since the 1960s, and currently,
exports from developing countries and emerging economies compromise one-third of global agri-food trade (Hazell & Wood, 2008; FAO, 2020). The entire supply chain has changed from seed to end-product under trade liberalization and globalization (Klijn, 2004). Market chains have been expanding on the global level and challenging developing country farmers in competing with globalized market chains that are consumer, type, quality, and safety oriented in agricultural products (Hazell & Wood, 2008).

Consumer preferences also determine changes in the landscape through influencing market demand. Consumers diversify their diets as per capita income rises, demanding more higher-value animal products, fruits and vegetables, and less staple food. They also want higher-quality, safer products, as well as more processed, pre-cooked foodstuffs. These trends are exacerbated by urbanization, which also places a high value on market access, particularly for perishable goods (Hazell & Wood, 2008). In addition, current patterns of food production and consumption create concerns over health-related problems such as increasing cancer and obesity rates. Globally, 44% of diabetes, 23% of ischemic heart disease and 7-41% of certain cancers are attributable to overweight and obesity (WHO, 2013). Moran (2006) argues that the change of consumption patterns after the industrial revolution has expanded the growing gap between humans and nature further. This rift between nature and humanity disables modern society in solving environmental problems.

2.2.1.3 Political Dimension

The political drivers consist of diverse policies, plans, rules, and regulations that have implications on several dimensions concerning infrastructure, agriculture, forestry, nature conversation, spatial development, urbanization, sectoral development, and property rights (Hersperger & Bürgi, 2010; Plieninger et al., 2016). According to Hersperger & Bürgi (2010), political drivers originate and operate at different scales from local to international and cover non-formal dimensions includes property right regimes, decision-making mechanisms and social
networks concerned resource management, conflict resolution systems and institutions governing the distribution of resources.

Open trade policies and the policy orientations of supranational organizations such as OECD (Organization for Economic Co-Operation Development), WTO (World Trade Organization), IMF (International Monetary Fund) and World Bank are globally powerful drivers shaping agriculture in rural landscapes that originates from international level. Many developing countries have liberalized and opened their agricultural markets to international trade as a part of structural adjustment programs of IMF and World Bank since the second half of the 20th century. According to Hazell & Wood (2008), structural adjustments also shifted public sector strategies toward the agricultural sector in developing countries. As a result, state agencies removed providing direct marketing and service functions to farmers as part of the IMF/World Bank-led structural adjustment programs of the 1980’s and the early 1990s, which favored the private sector as a more effective supplier in many countries. As a result of the structural adjustment programs and agricultural policy transfers, farmers’ livelihood and well-being in developing countries has been compromised due to a lack of comparative advantage to access markets in developed economies and distortions in internal markets as a result of subsidized imports (Hazell & Wood, 2008). For example, transfer of global agricultural policies to national policy making resulted in unintended decrease in cultivated lands in NAFTA (The North American Free Trade Agreement) countries such as Mexico where the reduction of cultivated areas created a burden on small scale farmers in terms of competing with the import of lower price agricultural products and losing price support that led farmers to exit agriculture (Rudel et. al., 2009). In this sense, the socioeconomic and political driving factors are completely intertwined since socioeconomic needs are articulated in political plans, laws, and policies (Bürgi et al., 2005).

In European countries and in the countries under pre-accession process, The Common Agricultural Policy (CAP), which was initiated in 1957 with the purpose of food sufficiency in Europe and fair farmer income, has a leading role in
influencing rural landscapes through regional and local policy frameworks and market interventions (Kizos et al., 2010). According to Knickel (1990) capital intensive specialist farming replaced traditional mixed farming not because of economic advantages but because of policy implications in European countries (Knickel, 1990). The research of Kristensen (1999) that 20 years change of a village in Sweden shows similar results as specialization of full-time farmers to dairy farming originated from the introduction of new crops developed for modern dairy production and support by agricultural subsidies of EU. The study of Primdahl (2010) concerning six case studies in three different European countries shows that deregulation of agricultural policy and expansion of global food markets resulted in land use intensification in the favor of livestock production especially in the areas with good agricultural conditions. In the areas with marginal agricultural conditions, land use extensification occurs through leaving crop rotation and grassland management, and afforestation.

According to Schneeberger et. al. (2007), policy and economic mechanisms such as subsidies and payments are responsible from agricultural changes on the national level in the study focusing on Swiss example of agricultural landscape change. Interestingly, they find out that planning instruments have an ambiguous role in the major landscape changes as they have a significant role in growth of built-up area through becoming a political and economic apparatus.

Shift in governance methods is another force leading to transformation of rural areas. According to Young (2016), neoliberal approaches of the last twenty years has led regional competitiveness, local entrepreneurialism and devolution of responsibility for economic development in the form of rural development policy across developed countries. The financial crisis of 2007-2008 has been accelerated the dependence to neoliberal hegemony leaving rural areas in the condition of less institutional support and more economic and environmental problems (Young, 2016).

Primdahl (2010) states that 'market liberalization agenda' and 'sustainability agenda' are two worldwide policy agendas that are particularly relevant to agricultural
landscapes. The market liberalization agenda includes agricultural policies and is the source of gradually decreasing trend in agricultural subsidies. Highly centralized decision-making that has no concern for the local environment characterizes this agenda (Primdahl, 2010). As rural development grows more dependent on cities and villages losing their position of significance in the rising knowledge economy, rural collapse in many locations becomes inevitable. Many young people have moved to cities, leaving the previously self-sufficient villages, which were hollowed out and decaying (Li et al., 2019). This situation shows the interlinkages among political and demographic drivers and responses of the local communities.

Sustainability agenda promotes environmental, social, and economic sustainability through prioritizing conservation, ecosystem services, and resource equity in rural landscapes. While market liberalization has increased productivity and economic growth, it also degraded the environment and changed land use. Sustainability promotes environmentally, socially, and economically sustainable ways to mitigate these negative effects. To balance benefits for people and the environment, it becomes important to balance two agendas while considering the livelihoods and wellbeing of agricultural communities.

2.2.1.4 Technological Dimension

Technological developments act as underlying drivers of change initiated at the global level and impact change in agriculture differently. The improvement in technology is highly relevant to the changes in the food and agricultural system. Expansion of global communication and transportation opportunities increased the share of information, technology, and products relevant to agricultural development on the global level (Hazell & Wood, 2008). Meanwhile, technological improvements in plant and animal breeding, mechanization, transportation, supply chains and farm management techniques influenced agriculture and rural landscape substantially (Klijn, 2004).
On the national level, governments invested in agricultural science and education programs to support innovation processes and higher productivity (Klijn, 2004). In this situation, the take-up of innovation and technology becomes crucial. In line with this, the technological modernization of society becomes an underlying driver of change as Plieninger et. al., (2016) suggest. The design and management of new technologies significantly influence agriculture's environmental impact, especially when these technologies are poorly designed and implemented. According to Hazell & Wood (2008) new technologies are frequently created with a limited focus on short-term profitability for farmers rather than long-term sustainability. In addition, the misuse of technology or wrongly adopted technology can create environmental problems such as the wrong application of modern irrigation systems can result in salinization problems which results in soil degradation and a decrease in agricultural productivity.

There are contrasting approaches to the role of technological drivers in landscape change. While the study of Kristensen et. al. (2009) who explored long-term changes in an agricultural landscape in Denmark in the last 150 years shows that technology has limited influence on the change in the agricultural landscape, the results of Schneeberger et. al. (2007) that states the technological innovations as key driver contributing to the change in agricultural land use, built up area and road network. The advancement of transportation and communication technologies has facilitated the utilization of resources for production purposes in urban areas beyond their immediate surroundings. In contrast, rural areas have become progressively reliant on their metropolitan counterparts for various social, economic, and political goods and services. The contemporary era has witnessed a transformation in the dynamics of urban-rural interaction, whereby the once balanced exchange has given way to a unidirectional flow of labor and population towards urban centers, resulting in a growing reliance of rural areas on urban economies (Li et al., 2019). This situation shows the interrelation between political, technological, economic, and demographic drivers and their resulting change in the rural landscape and agricultural production.
2.2.1.5 Economical Dimension

Industrialization and rapid increase in the urban population in cities have significantly changed agriculture in rural areas. In earlier settlements, agricultural production was a central backbone of the settlement economy and food was physically positioned in the heart of settlements through the marketplace. In contemporary cities, agriculture as a sector moves away from being the defining economy of rural areas. This situation challenges the rural-urban divide based on a strict distinction of economic activities between the city and the countryside. A century and a half ago, almost 80% of the world's population was living not in urban centers but in the countryside, directly or indirectly dealing with agriculture (Grigg, 1974). The countryside was the place of agricultural-related activities whereas non-agricultural activities centered in cities and towns. Industrialization deeply shaped this relationship as urban centers become dominant economic nodes pulling the populations.

According to the data of the UN (2014), 54 percent of the world's population lives in urban areas, which is expected to increase to 66 percent by 2050. This situation creates inevitable results in rural areas with the aging population and the decreasing share of labor in the agricultural sector. Employment in agriculture has been in a trend of decrease globally as it has decreased from 44% in 1991 to 27% in 2019 (World Bank, 2021). In the same line, the number of farmers among 12 countries forming the European Union decreased from 15 million to 8 million between 1965 and 1985 (Klijn, 2004).

New rural work and living opportunities emerge in the rural areas with the increase of urban-related functions such as infrastructural, recreational, and residential uses. The rural, which was once defined as a space of production, gradually becomes a space for consumption (Öğdül, 2019), as rural areas can no longer be defined by a single economic sector, agriculture, but by multifunctionality (Frank & Hibbard, 2016). Multifunctionality leads to the diversification of economic activities in rural areas, triggering the emergence of new land uses and new economies mainly related
to urban activities and urban ways of living, in line with the post-productivism in agriculture as discussed in sections on food and agricultural system drivers. As a result, economic activities outside of agriculture such as tourism, industry, and infrastructural facilities started to take place in rural areas. The multifunctional agricultural regime is used to conceptualize post-productivism in agriculture. Multifunctional agriculture covers diversity, nonlinearity and spatial heterogeneity in agricultural practice which characterizes modern agriculture and rural society. This means that rural areas can no longer be defined by a single economic sector or homogenous spatial patterns but by multifunctionality. Conversely, partly because of advancements in transportation and communication technologies, cities have become more independent from the countryside in meeting their needs resulting in the increasing dependency of rural areas on metropolitan areas in addressing social, economic, and political goods and services (Li et al., 2019).

The expansion of international supply chains and networks across the world for the purpose of accessing raw materials and processing them has significant implications for agricultural regions in the context of economic globalization. The phenomenon has led to the marginalization of small-scale producers due to the prevalence of economies of scale in the global arena, favoring large corporations in the agricultural and commodity sectors (Young, 2016). However, despite the globalization of agricultural production, there is a tendency towards heterogeneity rather than homogenization in farming practices in different agricultural regions (Gil et al., 2019). As a result, there is growing attention toward farmers’ practices and approaches that center on family farms and individual farmers as central actors in agricultural development paths in different contexts (Busck, 2002). The heterogeneity in agriculture both at sectoral and individual farmer levels stems from response to the threats and opportunities and represents itself in different ways such as scale enlargement, land abandonment, extensification, intensification, and diversification (Klijn, 2004). While extensification refers to less input use including labor, capital, and fertilizers, intensification refers to the opposite. Diversification means income outside of agricultural production such as from recreation, or part-
time jobs in towns. Hazell & Wood (2008) considers non-farm income opportunities in the form of non-farm wage or self-employment earnings, as a local driver of change. Non-farm income has flourished as urbanization and spatial integration of the market form a significant part of rural people's livelihood strategies on the global level and in some instances, account for more than half of their income. However, opportunities for farmers and agricultural workers in many developing countries and underdeveloped regions are limited by human, financial, and physical capital, along with the economic conditions of the region or the country.

2.2.1.6 Natural and Environmental Dimension

Changes in the agricultural system and rural landscape not only result from the drivers of change from the dimensions of economy, policy, demography and technology, but also from the driver of the natural, environment and spatial dimensions. Due to their high cultural and economic reliance on landscapes and physical systems, rural regions are especially open to environmental changes (Young, 2016). Natural and environmental drivers cover natural and spatial configurations including climate, disturbances, soil characteristics, and topography (Plieninger et. al., 2016). These drivers represent a two-way interrelation of the impacts of global environmental processes on agriculture and the impact of agriculture on the environment. The operation of natural driving forces concerns the site factors, like climate, topography, and soil characteristics, and natural disturbances change the rural landscapes (Bürgi et al., 2005). While site factors generally show short-term stability but on the long-term variable-tangible characteristics, natural disturbances have slow-acting and fast-acting types such as hurricanes that can deeply alter the landscapes (Bürgi et al., 2005). Additionally, the vulnerability of rural areas to both slow-onset problems (such as drought) and rapid-onset problems (floods, fires, detrimental weather) is accelerated by climate change (Young, 2016). As a result of this multidimensionality, the environmental problems
relevant to agriculture show spatial variability depending on the context (Hazell & Wood, 2008).

The interrelation of natural drivers and the impacts of agriculture on the environment increases the complexity of agricultural systems. Environmental problems resulting from agricultural practice are ecological degradation of farming areas, the disappearance of species, the destruction of wildlife habitats, the reduction in crop rotations, the increasing pollution of ground and surface waters, soil erosion, overexploitation and abandonment of land, and the high inputs of non-renewable fossil energy and of other non-renewable resources (Knickel, 1990). The global food and agriculture system is responsible for 60% of global terrestrial biodiversity loss, approximately 24% of global greenhouse gas emissions, 33% of degraded soil, and the overuse of 20% of the world's aquifers (UNEP, 2016).

According to Foley et. al. (2011), the environmental impacts of agricultural production stem basically from two reasons: expansion of agricultural land and agricultural intensification. Agricultural intensification is responsible for water degradation, pollution and growing energy use as global irrigated cropland doubled and the total use of fertilizers used per area of cropland on the global level has increased by almost 420% between 1961 and 2019 (Foley et. al., 2011; FAOSTAT, 2021). Agricultural expansion and intensification are considered major contributors to climate change as they cause approximately 30-35% of greenhouse gas emissions (Foley et. al., 2011). In addition, extensive application of fertilizers and manure disrupted global nitrogen and phosphorus cycles which has an impact on terrestrial and aquatic life. Similarly, uncontrolled pesticide usage causes an increase in resistant insect populations, a reduction in beneficial species such as predators, pollinators, and earthworms, a shift in soil microbial diversity, and pollution of water and air ecosystems (Gill & Garg, 2014). Their persistent usage has been impacting the environment by penetrating numerous food chains and higher trophic levels, resulting in some acute and chronic human diseases due to consuming contaminated water, air, or food. Intensive agriculture depending on irrigation is also associated with the depletion of global freshwater resources. Moreover, the current agricultural
system is known for being one of the greatest contributors to water consumption and waste which in return leads to water shortages that will affect food production (Godfray et. al., 2010). Reducing food waste will directly impact the environmental impact of agriculture by reducing the allocation of resources such as water, land, energy, and inputs used in agricultural production.

Impacts of climate change varies among regions leading to change in agriculturally favorable and unfavorable areas in terms of temperature, precipitation and drought that results in change in cropping calendars, change in agricultural products and land abandonment. According to Hazell & Wood (2008) agricultural systems can adapt the impacts of climate change; yet more research is necessary to identify challenges ahead and better means to adapt.

According to Woods (2012), climate change and food security are the major factors in determining the future trajectories of rural spaces and rural societies into the 21st century. The issue of climate change is closely intertwined with that of food security, and both are significant factors that influence how rural futures are perceived. The rural environment is expected to experience direct impacts from climate change, which will consequently affect rural economies and societies. The future social and economic viability of rural communities will depend on their responses and adaptation to climate change (Woods, 2012).

2.2.1.7 Spatial Dimension

The transformation of rural landscapes and agricultural production has been driven by multiple spatial changes over time, primarily characterized by human-caused changes to the biosphere and the expanding influence of urbanization. According to Ellis et al. (2010), between 1700 and 2000, the terrestrial biosphere underwent a significant transition, shifting from predominantly wild landscapes to biomes dominated by agricultural land use and human settlements. By the year 2000, less than 20% of the semi-natural environment remained, and 39% of the world's ice-free area was comprised of agricultural territories and settlements.
Agriculture is the most prevalent human-induced land cover on Earth, encompassing approximately 38% of the planet's surface (FAO, 2020). Farina (2000) and Ritchie & Roser (2013) highlight the extraordinary capacity of agricultural practices to shape landscapes. Agriculture, according to Marsden (1997), is the primary driver of rural space change, with repercussions in socioeconomic domains via the exploitation and commodification of rural property rights.

According to Marsden (1997), change in rural space follows different paths in certain times and spaces depending on the locally specific combinations of local and external interrelations. Vliet et al. (2015) conducted a meta-study of agricultural land use change in Europe. Reviewing 218 case studies, the authors define two patterns of change: intensification and de-intensification. In contrast to intensification, which refers to increased land management and agricultural expansion, de-intensification refers to a decrease in land management intensity and agricultural land, sometimes to the point of abandonment. The results of Van Vliet et. al. (2015) show that almost 30% represents intensification and de-intensification occur in the same study area at different extents. This situation is explained by the heterogeneity in agricultural practices resulting from farmers’/land managers’ responses to the changes.

In the same vein, Beilin et. al. (2013) defines two distinct patterns of land use change trajectories with a specific focus of the impact of land use on biodiversity and natural values. While productive landscapes with an economic advantage have intensified especially in developed countries, remote and economically unproductive landscapes experience abandonment, reforestation or are designated for rewilding. Land abandonment represents another distinct pattern of land use change. Diaz et. al. (2011) asserts that land abandonment in agriculture has negative impacts including loss of traditional farming practices, loss of habitats with ecological value, increased tendency for wildfires, and invasion of exotic species, for the environment and rural areas.

With its vast array of functions, including recreation, tourism, and residential purposes, urbanization has had a substantial impact on rural landscapes and
agricultural production (Dymitrow & Stenseke, 2016; Primdahl et al., 2013; Primdahl, 2010). Notably, the expansion of urban areas and the migration of urban migrants into rural areas have accelerated the urbanization of formerly rural regions. Brenner (2013) coined the term planetary urbanization to describe the spread of urban uses such as transportation networks, power plants, and tourism across agricultural basins, natural protection areas, oceans, and deserts. While the extent of urbanization unprecedentedly shapes the nature of rural areas and agricultural production, the globally urban areas cover 0.69% of the Earth's surface and this rate increased from 0.22% between 1992 and 2020 (Zhao et al., 2022).

The transition from agricultural to urban land use has been extensively studied from the dimensions of urban form, agricultural policy, urban policy and development, economic development, environmental concerns, and governance (Adachi & Patel, 1999; Yeh & Li, 1999; Ding, 2005; Azadi et. al., 2010; Seto et. al., 2011; Akseki & Meşhur, 2013; Wang & Scott, 2013; Pandey & Seto, 2015; Pham et. al., 2015; Asadi et. al, 2016; Nyugen et. al., 2016).

The study of Seto et. al. (2011) reveal that the trend of urban expansion outpaces population growth. This trend suggests that urban growth is expansionist rather than compact, and it has resulted in a significant loss of agricultural land, especially in less developed nations experiencing rapid economic growth and economic structure transition (Azadi et al., 2011). Yet, a similar pattern of change might also exist in developed countries, such as Mothorpe et. al. (2013) show that the US has also lost 19.3% of its agricultural land between 1945 and 2007 due to urban expansion and suburban development.

Due to the dispersion of metropolitan activities across the countryside, the rural-urban dichotomy is blurring, which is a significant driver of change in rural landscapes (Brenner, 2014; Sieverts, 2002; Tekeli, 2016). According to Lefebvre (1970), agriculture has been integrated into industrial production processes, resulting in the absorption of the village or conventional rural community by industry. The
emergence of second residences, highways, and supermarkets in rural areas — what Lefebvre calls "urban tissue" — symbolizes the urban's dominance over the rural.

In addition to physical changes, the transformation of rural areas includes alterations in socioeconomic relationships (Madsen et al., 2010). Rural landscapes have shifted from being viewed primarily as spaces of production to spaces of living as a result of changes in farming methods, diversification of rural occupations, shifts in agricultural subsidies from production to land-based subsidies, and an increased focus on environmental protection (Primdahl, 1999). This transition has a substantial impact on landscape transformation and the land management decisions of producers.

Locally, property rights influence producers' long- or short-term perspectives on natural resource management (Hazell & Wood, 2008). For example, land leasing for agricultural purposes is common in many nations with diverse tenure systems. Tenant farmers may have varying degrees of rights over the land and its produce, depending on local conditions and the nature of property rights agreements.

In conclusion, the spatial drivers of change influencing rural landscapes and agricultural production are multifaceted and complex, characterized by human activity, altering agricultural practices, urbanization, and alterations in socioeconomic and property relationships. Understanding these forces can assist in navigating the challenges of land use and rural development in the face of increasing global urbanization and environmental concerns.

### 2.2.2 Resilience of Socio-Ecological Systems

The understanding of resilience in socio-ecological systems (SES) has been deeply studied and analyzed within academic circles. Gunderson (2000) offers one of the most quoted definitions of SES resilience as the system's ability to absorb disturbance without shifting into a distinct state or phase of an adaptive cycle. Alberti & Marzluff (2004) defines resilience as "the size of the basin of attraction
around a stable state, which defines the maximum perturbation that can be tolerated by the system without causing a shift to an alternative stable state." (p.242).

Subsequently, the Resilience Alliance (2015) enriched the definition, detailing resilience as the capacity of an SES to withstand deterioration and other stress factors, maintaining its structure and functions. This understanding casts light on the system's ability to self-organize, learn, and adapt. Extending this perspective, Nel & Nel (2012) view resilience through the lens of complexity, defining it as a property of complex adaptive systems that exhibit their ability to adapt and respond to environmental changes. This definition of resilience implies a system's capacity to persist functioning during intrinsic and extrinsic disturbances (Simon Levin et al., 2013).

The study of resilience has undergone a transformation in its scope, shifting from an emphasis on ecological resilience to encompassing resilience in socio-ecological systems. This shift recognizes the complex and adaptive nature of these systems. Contemporary research on resilience examines the ability of a given system to endure, adjust, and undergo transformation, as well as the complex interplay between these factors in the face of changing circumstances (Sinclair et al., 2017).

Recognizing this complexity, Walker et al. (2006) notes the difficulty in isolating social and ecological components of the system for analysis and modelling, which can lead to a loss of overall system resilience. Contrasting traditional perspectives, Folke et al. (2010) note the SES approach sees human actions such as fishing and harvesting as intertwined parts of the system rather than external factors impacting ecosystem dynamics. Thus, the concept of resilience extends beyond ecological science and ecosystem management, recognizing the profound interplay between social and ecological resilience (Mehmood, 2015). However, Guerrero et al. (2018) conducted a systematic literature review to evaluate the level of integration of social and ecological dimensions in sustainability research, finding a lack of genuine and comprehensive incorporation of social and ecological elements.
Within the broader concept of SES resilience, social resilience has gained significant attention as a response to approaches focusing on ecological dimensions of the resilience when studying socio-ecological systems. Adger (2000) defines social resilience as the ability of communities to cope with external pressures and disturbances triggered by social, political, and environmental changes. In the same vein, Mehmood (2015) discusses that studies concerning social resilience typically focus on preventing, preparing, and responding to major shocks such as protection from natural disasters, management of natural resources, social and institutional change. The author emphasizes that these approaches are reactive rather than adaptive but ignores the self-organization capacity that enables communities to overcome self-regulation and shocks through adaptation and social capital and innovation.

In sum, resilience in socio-ecological systems encapsulates the system's capacity to absorb disturbances and reorganize during change, retaining its function, structure, identity, and feedback (Walker et. al. 2006). It's a multifaceted concept dealing with systems' responses to shocks and stresses, their adaptation, and transformation in the face of both short and long-term shocks and changes. The ability of SESs to adjust to disturbances while preserving their operational and structural integrity is crucial for their longevity, particularly in a period of swift globalization and ecological transformation.

Kliskey and colleagues (2009) put forth a set of five overarching propositions aimed at understanding the resilience of SES. Factors that are taken into consideration include settlement size, availability of resources, variability in biophysical and social systems, technological advancements, and management and governance strategies. The study revealed that smaller settlements possessing limited social capital, but abundant resource access may demonstrate greater resilience compared to larger settlements. However, higher levels of social capital may render them vulnerable in the event of supply disruption. This suggests that the resilience of individuals from different socioeconomic backgrounds is not solely determined by their access to resources or their size, but rather by a multifaceted interaction of these and other
variables. The results of their research emphasize the significance of technology in strengthening the resilience of a community, as sustainable infrastructure assumes a crucial function in ensuring an equal distribution of vital resources. The significance of effective governance and management in maintaining a balance between growth and sustainability trade-offs cannot be overstated. Insufficient leadership can lead to systemic pressure and hinder the ability to respond to changing conditions. Kliskey and colleagues (2009) have provided a definition of a resilient socio-ecological system (SES) as being capable of satisfying its requirements from its immediate surroundings for extended durations. The comprehension of resilience is fundamental in understanding the response of socio-ecological systems (SESs) to complex and challenging real-world conditions.

Anderies et al. (2013) highlight the complex nature of social-ecological systems (SESs) and discuss the difficulties posed by globalization, which interlinks local SESs within a complex global network. The authors posit that the interdependence among these systems results in increased intricacy, attributable to the existence of processes that operate at multiple scales and levels. To effectively address the complex nature of the situation, the authors suggest a collaborative application of theoretical frameworks and models derived from the conceptual fields of sustainability, resilience, and robustness. The approach employed aims to mitigate the ambiguity arising from the presence of multiple definitions and elucidate the connections among these notions. The authors propose that a comprehensive framework incorporating these concepts is more effective at dealing with multifaceted issues related to policy on global change.

Sterk et al. (2018) elaborate on the notion of resilience in social-ecological systems (SESs), highlighting their non-linear dynamics, intrinsic uncertainties, and capacity for self-organization and adaptation through experiential learning. The aforementioned attributes are deeply linked to the notion of resilience within socio-ecological systems (SESs). The authors delineate seven fundamental principles that have the potential to enhance resilience. These principles encompass protecting
diversity and redundancy, regulating connectivity, and fostering complex adaptive system thinking, among other factors.

According to Sterk et al. (2018), the principles offer direction on how characteristics such as social learning, utilization of extensive datasets for enhanced understanding, and social networks that encourage innovation and participation at various levels can facilitate the adaptation or transformation of a system in response to changes. It is contended that the assessment and administration of ecological and social systems as integrated Social-Ecological Systems (SESs) is imperative for the sustainable utilization of natural resources. According to their perspective, the resilience of social-ecological systems (SESs) is linked to their capacity for self-organization, learning, and adaptation, particularly in response to disturbances. The way these systems interact with both social and biophysical processes is central to understanding their stability, change, and resilience.

The framework presented by Anderies et al. (2004) is a significant contribution towards identifying vulnerability of social-ecological systems (SESs) to disturbances. The authors emphasize the significance of the relationship between individuals who utilize resources and entities responsible for public infrastructure provision as a crucial factor. This framework contributes to our understanding of the design principles for more generalized SESs, thereby enriching the dialogue on their resilience and robustness.

In addition, Walker et. al (2006) put forth propositions that enhance our comprehension of the dynamics of complex socio-ecological systems and the factors that influence their resilience in diverse contexts. The mentioned propositions were formulated based on a comparative analysis of 15 case studies conducted in diverse geographical locations across the globe. Although these are not considered as formal hypotheses, they can serve as valuable heuristics for directing analysis. Walker et al. (2006) have identified four attributes that are associated with the transformability of SES. These attributes include incentives, particularly subsidies, that encourage or discourage change; cross-scale awareness and reactivity; a willingness to
experiment; and reserves and highly convertible assets in human, natural, and built capital. These components emphasize the intricate and ever-changing nature of Social-Ecological Systems (SESs), and the imperative for these systems to possess the ability to adjust and undergo significant changes in reaction to disruptions.

Nonetheless, this perspective is not without its critics. According to Ollson and Jerneck's (2018) analysis, it is important to avoid "holistic reductionism," which refers to the tendency to oversimplify a problem by incorporating an excessive number of aspects in a reductionist manner. The approach employed by Walker et al. (2006) in identifying a limited number of key variables as adequate for determining crucial changes in socio-ecological systems has been subjected to critique. The intricate nature of social dynamics, which encompasses various facets such as social, political, and economic aspects, poses a challenge in identifying a limited number of "key variables." This is the argument put forth by the authors. The authors argue that attaining agreement on these pivotal factors could prove to be difficult owing to the ideological and theoretical disparities present within the realm of social sciences.

The need to comprehend the dynamics of socio-ecological systems (SES) has been amplified due to the growing interconnections between biophysical and social systems, especially in ecosystems that are heavily influenced by human activities (Berkhout et al., 2006). Such requirement is further intensified by the phenomenon of social and economic globalization, which is typified by amplified movements of commodities, assets, individuals, knowledge, and concepts across extended distances and varying magnitudes. Therefore, comprehending these intricate and unpredictable interconnected systems requires a departure from conventional notions of risk, stability, and control towards a comprehension of the intricacies of resilience, susceptibility, and flexibility.

According to Gunderson's (2003) conceptual framework, abrupt changes in social-ecological systems (SESs) can be understood through five fundamental concepts, namely, adaptive cycle, panarchy, resilience, adaptability, and transformability.
According to Walker et al. (2006), the initial two elements pertain to the dynamics of the systems, whereas the subsequent three elements encompass characteristics that influence these dynamics.

The examination of disturbances and adaptability in socio-ecological systems necessitates a comprehensive methodology that acknowledges their complexity and the multitude of elements influencing their behavior. It also highlights the need for SESs to be resilient, adaptable, and transformative in the face of disturbances, underscoring the inherent dynamism and uncertainty of these complex systems.

According to Cote and Nightingale (2012) "resilience thinking plays an important heuristic role in shifting the focus away from the quantitative availability of resources, and towards the scope of available response options." (p. 478)

As it is discussed in-depth in this study, SES can be messy with less clear system interactions and presence of unexpected events compared to the frameworks that analyses SES in a compartmental manner. Kliskey et. al. (2009) asserts that "messy SES types will possess different dynamics of resilience and varying capacities to adapt to change, and ultimately require different approaches to management." (p. 38).

Schoon et. al. (2012) provides an adapted framework for analyzing disturbance-response relationships in complex SESs to explain responses to disturbances in socio-ecological systems. The framework consists of four different kinds of disturbances: flow disturbances, parameter disturbances, network disturbances, and connectivity disturbances. The authors discuss the need for a typology of disturbances and a framework for describing system change to gain insight across cases. Examples of responses to disturbances in socio-ecological systems include the extinction of keystone species, the emergence of new user groups, the modification of trade agreements, public infrastructure programs, market demand, and public policy. In addition, authors also discuss the tradeoffs between system robustness and sensitivity to various categories of disturbances, as well as the need for a typology of disturbances to facilitate the explicit formulation of such tradeoffs.
Walker et. al. (2006) conceptualize diversity in socio-ecological systems under two separate class: functional diversity as "the number of functionally different groups, which influences system performance" and response diversity as "diversity of types of responses to disturbances within a functional group, which influences resilience" (p. 7). Diversity of responses among actors/species in same functional group to disturbances can be also defined as "functional redundancy" which enhances resilience of socio-ecological systems (Ibid).

In similar manner, Leslie and McCabe (2013) introduced the concept of "response diversity" which refers to the range of responses to changes in environmental, socioeconomic, and political factors among distinct actors within a given system. Similar to ecological systems, where the presence of response diversity among species fosters ecosystem resilience, the diversity in decision-making and action within human systems can influence the resilience or transformation of a socio-ecological system in response to different challenges and opportunities. The presence of diversity may have implications for the vulnerability and welfare of individuals. Although the origins of response diversity have been extensively studied, the authors posit that further investigation is required to fully comprehend the implications of response diversity. The authors emphasize that response diversity may not always be advantageous or causative of change; it has the potential to trigger and change change, but it can also be crucial in maintaining stability within a given system. Understanding the functioning of social-ecological systems necessitates an in-depth understanding of response diversity, which encompasses various factors such as human responses to such changes, the efficacy of responses to environmental changes, and the resilience of the system.

The study of Hellin et al. (2018) demonstrates the importance of response diversity over a case study of agricultural production landscape in Guatemala. The authors investigate how climate change influences agricultural productivity and fosters competition over natural resources, ultimately exacerbating conflict risks. Here, the response diversity of actors plays a significant role in the management and adaptation strategies employed to combat these challenges. In the context of the Western
Highlands of Guatemala, for instance, a range of responses to climate threats and post-conflict circumstances are observed, showcasing response diversity. Initiatives such as the Buena Milpa agricultural development project demonstrate adaptive responses that leverage grassroots collective action to foster local adaptation and social-ecological resilience. These responses vary from community-level strategies like micro watershed management and local maize varieties conservation, indicating the diversity of responses to similar socio-ecological changes.

The adoption of various agricultural technologies to combat climate change also depicts response diversity. The research of Hellin et al. (2018) shows that some farmers may adopt drought-resistant germplasm, while others may opt for conservation agriculture or improved postharvest storage, indicating the different ways in which actors within the system respond to increased climate risks. Moreover, the collective action emphasized by Hellin et al. (2018) demonstrates another layer of response diversity, reflecting how groups within the system come together to achieve shared goals. This collective response can effectively enhance the system's resilience by managing resource competition and mitigating conflict risks. In conclusion, understanding the role of response diversity is essential for both understanding what affects resilience and how resilience and related properties of systems evolve.

2.2.3 Researching and Analysing Resilience in Socio-Ecological Productive Landscape

Resilience studies on socio-ecological systems (SES) have conventionally deployed indicator-based assessments to evaluate system robustness and adaptability in these systems. While these methods offer certain advantages, including the ability to provide quantitative analyses of socio-economic and ecological variables, they fall short in their capacity to reflect the intricate and complex nature of SES. One glaring area of neglect is the social component of these systems, specifically the dynamics of human decision-making and responses to change. This section, therefore,
critically examines the limited capacity of indicator-based assessments in fully encapsulating the multifaceted SES resilience, emphasizing the need for the inclusion of more nuanced social factors like human agency, cultural contexts, and diversity of social actors. In addition,

The investigation of resilience in socio-ecological systems (SES) has experienced substantial growth, with numerous studies concentrating on assessments based on indicators to evaluate and examine the robustness, adaptability, and transformability of the system. Although these studies have yielded valuable insights, they frequently fail to fully capture the multifaceted nature of SESs, particularly regarding the social components of human decision-making and the actions taken by individuals in response to change. The objective of this subchapter is to provide a critical evaluation of the commonly used, yet insufficient, practice of relying on indicator-based assessments in research on the resilience of SES.

The application of indicator-based assessments is prevalent in resilience research related to SES. This approach offers a quantitative means of evaluating the adaptability and robustness of ecosystems and socio-economic activities. As an example, UNU-IAS and colleagues (2014), derived from the Satoyama Initiative, formulated a set of 20 indicators aimed at evaluating the resilience of agricultural landscapes in rural areas. The aforementioned indicators encompass a diverse range of domains, such as livelihoods and welfare, landscape ecosystem diversity and ecosystem protection, biodiversity, knowledge and innovation, and governance and social equity.

In literature, Spiegel et al. (2021) identified two primary categories of resilience assessments, namely pre-defined indicator-based assessments, and perceived resilience assessments. The former approach entails the observation of significant socio-economic and ecological variables, which are primarily determined by researchers, and the application of statistical relationships at an aggregate level. The evaluations in question may exhibit a high degree of contextual specificity, yet they are subject to certain constraints, mainly stemming from their inherent inability to
encompass all relevant factors that impact resilience, encompassing economic, geophysical, sociocultural, and political domains.

Sahle et al. (2023) and Ciftcioglu (2017) have presented case studies on Ethiopia and North Cyprus, respectively, that utilize the indicator-based assessment approach for evaluating the resilience of socio-ecological landscapes. The research endeavors utilize various metrics, such as community-centered evaluation techniques and assessments of land-use and land-cover patterns.

Indicator-based assessments have faced criticism for their limited ability to comprehensively represent the complex nature of SESs, particularly in comprehending the decision-making processes of individuals and the impact of their responses to change. According to Spiegel et al. (2021), indicator-based assessments that are pre-defined may lack inclusivity of all the relevant factors that impact resilience and may be too specific to the context. These constraints may result in an oversimplified representation of the SES, which might cover up the significance of social dimensions. According to Dunbar et al. (2020), although indicator-based assessments can effectively determine areas of knowledge gaps and intervention needs, these models are frequently customized to a specific region and may not be universally appropriate. The authors contend that while these evaluations may not facilitate cross-regional comparisons, they can effectively monitor intra-community fluctuations over time, particularly if the evaluations are consistently conducted by a uniform cohort.

The study conducted by Ciftcioglu (2017) validates the limitations of assessments based on indicators. The research concludes that the socio-ecological production landscapes and seascapes in the Lefke Region of North Cyprus were examined using a participatory approach to investigate the ecosystems, agricultural systems, and social systems. The study particularly emphasizes the structures, components, and interrelationships of these systems. However, it is necessary to question whether these indicators sufficiently capture the complex social dynamics within the region,
including the nuances of human decision-making and individual actors' responses to change.

Natori and Hino (2021) have provided a critique of the indicator-based assessment developed by the Satoyama Initiative, which is a widely used indicator, citing its inability to incorporate the historical trends of land use and changes in land use. The authors propose that the neglect of temporal dimensions may result in an oversimplification of the complex dynamics within SES.

Given these limitations, it is imperative to transition towards a comprehensive and intricate comprehension of SES resilience. The authors, Spiegel et al. (2021) highlight the increasing focus on perceived-resilience evaluations that adopt a subjective approach, drawing on the perceptions and personal experiences of those directly engaged in the system. Such transition denotes a shift towards recognizing the inherent complexity of SES, including the critical social dimensions often overlooked in traditional indicator-based assessments.

To summarize, although assessments based on indicators have yielded valuable insights into the resilience of SES, their inadequacy in capturing the complex nature of SES highlights the necessity for more comprehensive and nuanced methodologies. It is imperative to incorporate social dimensions, such as human decision-making and the responses of actors to change, in order to comprehensively capture the resilience of social-ecological systems (SES). A critical assessment of the existing SES resilience research literature reveals a significant gap in our understanding of social dimensions and their impacts on resilience. As a result, it is important to delve into the limitations of the existing research, particularly its insufficient focus on social factors such as human agency, power dynamics, culture, and the diversity of social actors. As a result, considering the nuanced responses of individual actors within SES becomes an important area of inquiry when studying system dynamics and resilience.

The majority of SES resilience research uses a mechanistic approach, which Cote & Nightingale (2012) criticize as frequently ignoring the political, historical, and
cultural contexts of institutional systems. The authors contend that this results in an overly simplistic and mechanistic view of social change, with an excessive emphasis on the structural and functional aspects of institutional systems, which are frequently divorced from their political, historical, and cultural contexts. Their critique resonates with the findings of Fabinyi et al. (2014), who illuminate biases within the resilience literature that oversimplify human adaptation to environmental changes and neglect social complexity.

The authors point out three main biases: (i) the assumption that people's knowledge, values, and livelihoods within an SES are primarily concerned with the environment; (ii) the tendency to aggregate or homogenize social complexity, which leads to the assumption that people's interests, expectations, and experiences are the same; and (iii) the value-laden application of resilience within the social arena. According to the authors, these biases result in the resilience literature's emphasis on simplified notions of human adaptation to the environment, the role of traditional ecological knowledge, institutions, and organized social units, and the positive attributes associated with resilient SES.

Similarly, Davidson (2010) calls for more comprehensive resilience frameworks that incorporate the role of human agency, noting that the capacity for individuals and groups to make independent decisions is crucial for understanding SES resilience. Fischer et al.'s (2012) study is important in this manner as it focuses on the importance of community self-organization in managing the dynamics of social-ecological systems in the Saxon region of Romania. The authors analyze key factors associated with the capability of communities to self-organize, such as collective-choice regulations, regional governance, customary practices, communal resources, decision-making flexibility, and an understanding of the social-ecological framework. Following a thorough examination of social-ecological systems and various determinants, the study concludes by evaluating current conservation policies and suggesting an alternative strategy.
Sinclair et al. (2017) provide a further critique, noting the frequent failure of resilience thinking to account for the role of human agency and the variability of social contexts. In their view, the current understanding of resilience oversimplifies social systems by treating communities as homogenous entities, leading to unpredictable behaviors and consequences.

Another inadequacy in SES resilience research lies in its insufficient conceptualization of resource-based conflicts and imbalances of power. Guerrero et al. (2018) underscore the frequent neglect of significant social factors like culture, politics, and power in social-ecological studies. They argue for a more interdisciplinary approach that integrates social and ecological dimensions to capture the complexity of SES. In a complementary manner, Hodbod et al. (2019) address this concern by employing a political ecology framework that recognizes the uneven distribution of environmental impacts among different populations. Their work emphasizes the importance of understanding how changes in SES disproportionately affect different demographic groups, providing a nuanced perspective on resilience within the context of socio-political inequality.

Agent based modeling is an approach that has been increasingly adopted by SES researchers to explore the role of human agency and behavior (Murray-Rust, 2011, Rounsevell et al 2012, Filatova et. al., 2013; Gotts et al. (2019); Grêt-Regamey et al. (2019). Gotts et al. (2019) and Grêt-Regamey et al. (2019) highlight the underrepresentation of human actors in SES modeling. They propose the application of agent-based modeling, which has the capacity to represent individual behaviors and interactions. This approach provides a more nuanced understanding of the role of diverse social actors in maintaining the resilience of coupled SES. According to Gotts et. al. (2019), human actors play a key role in SESs, but their interactions with each other and their environment are often underrepresented in SES modelling. Authors underscore the significance of agent-based models (ABMs) for this aim, owing to their capacity to depict individual behaviors and interactions, which is pivotal in social-ecological systems (SESs).
In a similar manner, Grêt-Regamey et al. (2019) investigate the role of social actor diversity in increasing the resilience of social-ecological systems to socio-economic and climate changes. The study uses an agent-based modeling approach to analyze the impacts of both the number of actors (actor richness) and diversity of their abilities and skills (actor's functional diversity). Key findings suggest that high actor richness and functional diversity contribute significantly to the resilience of social-ecological systems under global change. Complementarity of actors' functional diversity helps buffer vulnerable mountain systems against socio-economic and climate change. Additionally, the diverse responses of actors can help moderate abrupt shifts in the social-ecological system, introducing new trade-offs in ecosystem services. Their study concludes that considering both diversity and complementarity of actors' management capabilities is crucial for ensuring the provision of ecosystem services amid global changes. The results highlight the importance of diversity among social actors in maintaining the resilience of coupled social-ecological systems, like the known relationship between biodiversity and ecosystem function. However, Grêt-Regamey et al. (2019) also notes a significant dependency on subsidized agricultural systems in many European mountain regions, which could make these systems more vulnerable to external drivers and potentially hinder innovations supporting adaptation to changes.

The utilization of agent-based modeling (ABM) has gained widespread acceptance in socio-ecological system (SES) research owing to its ability to replicate complex adaptive systems by means of the rules, behaviors, and interactions of individual agents. Notwithstanding its utility, agent-based modeling (ABM) is constrained by its incapacity to effectively incorporate and express qualitative perspectives, which are indispensable for understanding the complex nature of human behavior and decision-making mechanisms in social-ecological systems (SES). Furthermore, there exists a potential danger of favoring quantitative data, which can be readily incorporated into Agent-Based Models (ABMs), at the expense of significant qualitative data. The matter at hand has been acknowledged by Janssen and Ostrom (2006), who assert that although quantitative data can facilitate the identification of
patterns and trends, qualitative data are essential in providing comprehensive, context-specific perspectives and comprehending complex socio-ecological phenomena.

In conclusion, it is clear that the inadequacy of the social dimension in current SES resilience research stems from a variety of factors, including an oversimplified understanding of social dynamics and decision-making process, insufficient recognition of power dynamics and inequalities, a disconnection between social and ecological subsystems, and an underrepresentation of human actors in SES modeling. Addressing these gaps and incorporating a more comprehensive understanding of social dimensions will undoubtedly enrich understanding of SES dynamics and resilience. Future research should focus on adopting more nuanced, context-specific, and interdisciplinary approaches, as well as utilizing innovative methodologies like agent-based modeling to better capture the role and responses of individual actors in SES.

Understanding socio-ecological systems (SES) requires an in-depth understanding not only of their social and ecological constituents but also of the local knowledge deeply embedded within these systems. This local knowledge, also known as traditional ecological knowledge or indigenous knowledge, is comprised of generations' worth of experience, observations, and cultural understandings of local ecosystems.

Berkes and Folke (1998) were among the first researchers to emphasize the significance of local knowledge in SES research. Their research highlighted the significance of local communities' knowledge in influencing their interactions with and administration of local resources. This knowledge, which is profoundly rooted in cultural practices and belief systems, influences how communities perceive the environment, interact with it, and adapt to it. In addition, it influences the approach pertinent institutions take to managing and governing these resources. Numerous studies have emphasized the importance of local knowledge in managing and comprehending SES since their seminal work.
Despite its value, mainstream SES research has often been undervalued, giving precedence to scientific and technical knowledge. However, as Bergamini et al. (2013) noted, the history of the co-evolution of human and natural history has given rise to rich biocultural knowledge that has been crucial to biodiversity conservation. This local knowledge evolves as ecological and social conditions change, affecting the dynamics of SES in profound ways.

Berkes (2009) highlights the significance and value of indigenous knowledge systems, specifically in the domains of environmental management and conservation. He depicts indigenous knowledge as an adaptive approach to management that undergoes a continuous process of evolution through ‘learning by doing’. Berkes (2009) highlights the mutual benefits of the collaboration of indigenous and scientific knowledge systems due to their complementary nature. Indigenous knowledge offers a comprehensive and qualitative approach, whereas scientific knowledge typically provides quantitative data on a limited number of variables. However, the author also warns regarding the constraints of merging these two methodologies owing to their distinct epistemological and worldview orientations.

According to Cote and Nightingale (2012), resilience in ecology has been applied to society, but it fails to address normative and epistemological difficulties, limiting its conception of social change. Critically investigating local knowledge at the intersections of social and environmental dynamics can help answer normative concerns and show how power and competing value systems shape SES development.

Yet, synthesizing such diverse datasets into an accurate understanding of landscape changes is challenging. Bürgi et al. (2005) highlight the difficulty of studying processes behind landscape functioning, extrapolating results across different landscapes, linking qualitative and quantitative data, and acknowledging the role of culture as a driver of change. According to Levin et al. (2013), the management and policy of social-ecological systems pose a challenge due to their complex nature and
the need for diverse methodologies for understanding and modeling them. Effective models for policy assessment and design should integrate a transdisciplinary approach and depend on an in-depth understanding of the fundamental components of a specific problem. Indeed, the utilization of only quantitative tools, such as remote sensing, in analyzing Land Use Land Cover (LULC) data has proven inadequate in fully understanding the complex activities of the actors involved in landscape change models (Dimopoulos & Kizos, 2020). It is here that qualitative methods, such as surveys or face-to-face interviews, become invaluable. These methods provide insight into actors' activities, helping to decipher the intricate landscape change models.

Case studies, like that of Rescia et al. (2008) underpin the necessity of including local knowledge and human decision-making in SES resilience research. Their study of a mountainous rural landscape in northern Spain emphasized the importance of understanding social factors and engaging the local population in the decision-making process for landscape protection. They also critique the lack of integration of local knowledge in landscape analysis and land evaluation, suggesting a need for the design of economic incentives for farmers, the primary decision-makers affecting landscape sustainability.

Moreover, the research by Yager et al. (2019) aims to incorporate diverse knowledge types. The authors try to understand the changes taking place in bofedales, which are highland peatland pastures in five neighborhood communities in the Bolivian Andes, as well as the socio-ecological factors or "drivers" affecting these changes. By incorporating satellite image analysis, vegetation studies, and local knowledge, notably Traditional Ecological Knowledge (TEK), the authors followed a multidimensional approach. The study makes the case for combining scientific data with local knowledge to better understand the land cover change in bofedales and inform management decisions. According to the authors, recognizing and incorporating local initiatives could improve the sustainability of the landscape.
Tengö et al. (2014) introduce a research approach, namely the Multiple Evidence Base Approach, that offers a method for integrating indigenous, local, and scientific knowledge systems in biodiversity and ecosystem governance. The approach views these different knowledge systems as parallel and complementary, each contributing unique forms of knowledge. The author promotes the evaluation of systems within their context, enabling a nuanced understanding of issues. The approach proposed adopts triangulation, joint knowledge assessment, and knowledge generation in sustainable biodiversity and ecosystem management. Recognizing and valuing diverse knowledge systems, particularly those from local or indigenous communities, is crucial for understanding complex interactions and incorporating diverse perspectives.

According to Bristow & Healy (2014), mixed-methods approaches are needed to examine regional economic performance since quantitative analyses may miss essential phenomena. Quantitative methods can describe the frequency and impact of economic shocks and a region’s resilience and recovery, but they don’t show how regional actors respond to and protect against them. This gap requires qualitative, case-study research to capture people’s adaptation capacities and regional economies’ evolution through economic and industrial structure changes. Thus, resilience epistemologies, which view the world as an evolving object, may demand a localized and qualitative scientific approach.

Teschner et al. (2017) advocate for a transdisciplinary socio-ecological research framework to address the challenges of sustainable agricultural practices. Their approach integrates environmental science components from both the biological and social spheres, highlighting their interconnectedness. The authors propose that interdisciplinary socio-ecological research can help manage uncertainties and risk perceptions associated with agricultural sustainability, thereby facilitating a transition towards more sustainable farming practices.

In conclusion, incorporating local knowledge, human decision-making, and actor responses to change into SES resilience research is paramount. It not only improves
our understanding of the complex interplay of social and ecological dynamics but also informs and enhances management practices, contributing to the sustainability of these systems.

2.2.4 Adaptability and Adaptive Capacity in Socio-Ecological Productive Landscape

The examination of adaptive strategies to climate change has seen an increase in academic discourse over the past decade. Numerous studies have primarily focused on the impacts of climate change, vulnerability and its indicators, and adaptations to these impacts (Adger et al., 2005; Hodbod & Eakin, 2015; Jerneck & Olsson, 2008; Nelson et al., 2007; Nightingale, 2016; Smit & Wandel, 2006; Young, 2016). Amid this burgeoning literature, the concepts of 'adaptability' and 'adaptive capacity' have often been employed interchangeably, yet their distinct attributes require clarification. This section aims to discuss these terms as they apply to the socio-ecological systems (SESs) context.

Defined as the capacity of actors in a system to influence its resilience, adaptability within the SES approach refers to humanity's ability to manage resilience (Walker et. al., 2004). This capacity manifests in responses to perceived changes or disturbances, utilizing the system's potential capabilities to manage these events. It takes form in behaviors, decisions, and actions that alter the state or trajectory of a system. Folke et al., (2010) use the terms adaptability and adaptive capacity interchangeably by adopting the definitions of Walker et. al. (2004). The authors examine resilience, adaptation, and transformability in the context of socio-ecological systems (SESs). Resilience is an SES’s ability to adapt and evolve while remaining within specified boundaries. The ability of a SES to adapt its reactions in response to changing internal processes and external circumstances, allowing advancement within the present stable region or along the current trajectory, is a component of resilience (Folke et. al, 2010). Whereas authors define transformability as the ability to create totally new domains for development which means
establishing a new stability landscape. It also includes the ability to pass through thresholds and enter a new developmental trajectory. Nonetheless, they are distinct yet interrelated concepts in the field of system dynamics and resilience thinking.

The actions of individuals and groups managing the system, therefore, exert a predominant influence on SES. Walker et. al. (2004) consider adaptation as the social component of the system and define it as the effect of individuals and groups on the system. In this context, the study of Walker et. al. (2004) defines the criteria of adaptability as trying to control the direction of the system, changing the stable state of the system (resistance, tolerance, etc.) or changing the processes created by the dynamics reflected from other scales. These human activities shape the system's dynamics, potentially affecting its resilience either intentionally or unintentionally. Ultimately, the ability to govern resilience effectively - to prevent transitions into unfavorable states or revert to desirable ones - becomes a defining trait of adaptability.

Adaptability is primarily determined by two factors: the absolute and relative quantities of all forms of capital (social, human, natural, manufactured, and financial) and the system of institutions and governance. Both have substantial impacts on an SES's ability to respond to disturbances and changes in resilience. Institutions, for instance, monitor and respond to environmental and social changes, influencing the feedback between social and ecological elements (Walker et. al., 2006).

According to Smit & Wandel (2006), adaptation refers typically “to a process, action, or outcome in a system (household, community, group, sector, region, country) to better contend with, manage, or adjust to a changing condition, stress, hazard, risk, or opportunity” (p. 282), considering the human dimensions of response to change. According to the authors, adaptations are the manifestations of adaptive capacity. In other words, adaptations, or changes made to the system to better cope with problematic exposures and sensitivities,
IPCC (2014) uses a comprehensive definition for adaptive capacity by defining it as "the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (p.1758). The term 'adaptive capacity' carries distinct meanings within ecology and social sciences. While ecologists refer to it as the ability of system components to adjust to changing conditions (e.g., invasive species or climate change), social scientists focus on human traits, including agency, learning, creativity, and collaboration. Capacity, within the social sciences, is the ability to act or influence, influenced by both local and extra-local factors (Young, 2016).

According to Armitage and Plummer (2010), adaptive capacity is the ability "to learn, experiment, and foster novel solutions in complex social-ecological circumstances." In the context of communities, governments, and other social actors, the meaning of this term expands even further. It implies that these entities have the collective capacity to respond effectively to environmental issues and nonlinear change, which are becoming increasingly urgent challenges in our modern world. In line with these, Young (2016) highlights the importance of the concept of adaptive capacity for understanding rural resilience, and examining critical issues of local governance, power relations, norms, skills, knowledge, and equity (Young, 2016).

The term "adaptive capacity" is also frequently referred to as the system's coping capacity (Turner et al., 2003) or capacity of response (Gallopín, 2003). Turner et al. (2003) draws a distinction between the capacity to cope or respond and adaptive capacity, considering both as components contributing to the resilience of a system. In their work, they regard adaptations as the restructuring of the system following the responses to disturbances. The terms "coping ability" and "adaptive capacity" have been used with different nuances, with some scholars like Smit and Wandel (2006) applying "coping ability" to shorter-term capacities or survival abilities, and "adaptive capacity" to longer-term or more sustainable adjustments. Despite the variations in terminology and definition, the term "capacity of response" denotes the system's ability to adjust to disturbances, mitigate potential damage, capitalize on opportunities, and cope with the consequences of any transformation that occurs.
Importantly, the capacity of response is an inherent attribute of the system, existing before any perturbation occurs (Gallopin, 2003).

It is important to note that adaptive capacity is context dependent. It varies across nations, communities, social groups, and time, differing not only in value but also in its nature and characteristics. This variability points to the complexity of the concept and the importance of nuanced investigations into adaptive capacity, particularly in the context of SES.

The process of rural change is increasingly shaped by its capacity to adapt to external changes, including those driven by climate change (Li et al., 2019). As rural communities respond to these changes, substantial modifications to their internal structures and functions frequently occur. These internal factors may include, among others, social structures, economic systems, cultural traditions, environmental management practices, and technological adoption. For instance, a rural community may diversify its economic activities or seek out new market opportunities in response to economic challenges. Changes in climate patterns may also necessitate modifications to agricultural practices and land use planning.

Adaptive capacity, or the capacity to respond effectively to such changes, is crucial for rural communities and actors of the productive landscape. It allows them to manage potential risks, capitalize on emerging opportunities, and influence their development trajectory. However, this adaptive capacity is not uniform and can differ significantly between social groups within a community and is subject to spatial variation (Woods, 2012). The level of available resources (human, financial, natural), access to information and technology, social capital, and the governance structures in place all influence this capacity.

The dynamism of rural change can be understood through the lens of the adaptive cycle, a model proposed by Gunderson & Holling (2002). The adaptive cycle describes four phases of system change: growth, conservation, collapse or release, and reorganization. This framework captures the resilience and adaptability of
systems, representing their cyclical progression through these distinct stages over time.

The adaptive cycle exhibits two major phases (or transitions). The first, often referred to as the fore loop, from r to K, is the slow, incremental phase of growth and accumulation. The second, referred to as the back loop, from Omega to Alpha, is the rapid phase of reorganization leading to renewal. These phases are growth (r) where there are available resources, structural accumulation, and high resilience. Second phase is conservation (K) where there is slower net growth and where the system becomes less flexible and more vulnerable to disturbances from external dynamics. These two phases create the fore loop of the adaptive cycle which corresponds to "ecological succession in ecosystems and constitutes a development mode in organizations and societies" (Walker et. al., 2006, p. 2). Next phases correspond to the back loop of the cycle. While in the third phase which is referred as collapse or release (Ω) where accumulated structures collapse, the following phase represents reorganization (α) where transition of another growth phase (r) occurs. In resilience theory, the "adaptive cycle" concept represents the dynamic, cyclical character of complex systems as they progress through distinct stages over time. It is a model that is used to comprehend the behavior of complex systems and their potential to adapt, transform, and become more sustainable (Darnhofer et al., 2010).
Figure 2.2 Adaptive Cycle (Gunderson & Holling, 2002)

The process of rural change is increasingly shaped by its capacity to adapt to external changes, including those driven by climate change (Li et al., 2019). The adaptive cycle provides a valuable framework for understanding the behavior of rural communities as complex systems. Its application helps reveal the potential of these communities to adapt, transform, and become more sustainable.

To give an example on the application of the adaptive cycle in agricultural practice, Darnhofer et al. (2010) applied the concept to the New Zealand kiwifruit industry between 1970 and 2000, which constitutes a full adaptive cycle. Utilizing readily available resources (such as land and labor) and favorable market conditions, the kiwifruit industry experienced rapid growth and expansion during the exploitation phase. As the industry matured during the conservation phase, competition for resources intensified and production methods became more specialized. During this stage, established practices became the norm, and the system became both more resilient and rigorous. During the phase of release, a significant shock or unbearable stress, such as a disease outbreak, a drastic change in market demand, or a policy
change, could trigger the system's collapse, releasing the resources and causing the extant organizational structures and norms to disintegrate. After the release, the system enters a period of reorganization in which new arrangements and practices are possible to emerge. This phase is marked by high levels of uncertainty, but it also affords the opportunity for innovation and the development of more sustainable practices.

In the adaptive cycle, the transition from release to reorganization, also known as "the back loop to sustainability," is a crucial point. If properly managed, it could result in a reorganization that promotes more sustainable resource use, thereby laying the groundwork for a more resilient and sustainable system in the subsequent adaptive cycle (Darnhofer et al., 2010). However, Sinclair et al. (2017) criticizes the adaptive cycle framework that the defined four distinct phases of growth do not always align with human responses, adding to the unpredictability of change processes.

Several components contribute to a system's adaptive capacity. According to Simon Levin et. al. (2013), diversity and heterogeneity are important components of systems adaptive capacity. Authors assert that maintaining diversity and heterogeneity sustains the system’s adaptive capacity to compensate for losses of particular components, such as populations or species in ecosystems, people and organizations in social systems, or particular stocks in financial portfolios. In this context, Leslie & McCabe (2013) discussed the importance of response diversity. Authors define response diversity as the variety of responses to environmental, socioeconomic, and political changes among different actors within a system. In ecological terms, response diversity among species contributes significantly to the resilience of an ecosystem. This idea is extended to include human systems, where response diversity refers to the heterogeneity in human decisions and actions in response to challenges, opportunities, and risks. However, the concept of adaptability, encompassing adaptive capacity and adaptations, in social-ecological systems (SES), is often presented as an autonomous, harmonious, self-organizing
capacity of SES, neglecting aspects such as strategies, conflicting objectives, and power dynamics (Hahn & Nykvist, 2017).

The notion of adaptive capacity is complex due to the interaction across multiple scales of human and environmental systems. This complexity presents significant challenges for governance, science, and ultimately societal and environmental sustainability (Adger et al., 2005). Despite these challenges, Young (2016) argues that adaptive capacity remains a key concept for understanding rural resilience and investigating issues of local governance, power relations, norms, skills, and knowledge. Further, Hahn & Nykvist (2017) highlighted the importance of considering intentional actors with strategies and conflicting interests as part of complex adaptive systems. However, Smit & Wandel (2006) cautioned intentional actors such as local initiatives may be limited or negated by broader socio-economic and political forces.

Various methods are employed to assess adaptive capacity especially in rural areas. Capitals approach applied to several studies for understanding and assessing adaptive capacity of communities. Social capital is an important dimension of adaptability with respect to social capacity to respond to change. Walker et. al. (2006) classifies three elements of social capacity: leader social leadership, social networks, and trust. Young (2016) suggests researching "community capitals" for rural adaptive capacity. The study of Metcalf et. al. (2015) utilized a combined framework of basic vulnerability and livelihood analysis to comprehensively assess both the socioeconomic vulnerability and adaptive capacity of three coastal communities. The study utilizes the Sustainable Livelihoods approach (SLA) using five capitals. According to the authors, factors such as demographic characteristics, types, and availability of five capital types (human, social, physical, natural, and financial), and knowledge of local climate change drivers and impacts significantly influenced a community's adaptability to marine climate change. The results show that, while larger communities display higher adaptive capacities, smaller communities show greater resource dependence and lower human and natural capitals. In this research, common adaptation strategies identified from qualitative case study included
employment diversification, re-establishment of local fish markets, and improvement of education and communication.

Metcalf et al. (2015) utilized a combined framework of basic vulnerability and livelihood analysis to comprehensively assess the socioeconomic vulnerability and adaptive capacity of three coastal communities, demonstrating the value of quantitative assessments of adaptive capacity and ecological vulnerability. On the other hand, Cote & Nightingale (2012) argued for a more holistic approach, emphasizing the need to appreciate cultural traditions, historical context, and ethical perspectives of the actors involved. Moreover, authors urge for a need to shift in epistemological position of conceptualizing nature/society relations, specifically a shift away from focusing solely on institutional arrangements towards the processes and relations that support these structures.

Castonguay et al., (2016) studied the social-ecological system of the rice terraces of Southeast Asia, focusing on the region of Banaue in the Philippines. Authors used a mixed-methods approach through a questionnaire and semi-structured interviews, with 90 respondents selected from each of the three areas in Banaue. developed indicators to understand various stages within the system, providing insight into the system's resilience and capacity to adapt to pressures and potential impacts over time. Authors developed indicators to enhance adopted the DPSIR model, which includes drivers, pressure, state, impact, and response. The indicators serve as representations of various stages within the system. While authors particularly did not focus on the drivers to raise attention to responses in the system, the indicators developed used to develop understanding of pressure, state, impact, and response in the system. While presence of invasive alien species form indicators to represent pressures in the system, authors used the varieties of rice and food plants that depict ecosystem architecture as indicators to represent the state in the system. Forest multifunctionality, food self-sufficiency, and profitability were indicators of system impacts. The traditional ecological practices and the primogeniture inheritance structure are indicators to present responses of the system. The mentioned indicators
offer a comprehensive perspective on the resilience of the system and its capacity to adapt to pressures and potential impacts over time.

Despite the available methodologies for assessing adaptive capacity, certain limitations persist. One of the most significant is the difficulty of observing adaptive capacity until a stress event occurs, which is known as latency (Eagle, 2011). However, Eagle proposes two potential methods to improve these assessments: evaluating the impacts of recent stress events on similar systems and assessing a system's adaptation to stress over time.

Eagle (2011) proposed two potential methods to assess adaptive capacity. The first one is evaluating the impacts of recent stress events on similar systems, with the idea that systems with lower negative impacts have higher adaptive capacity. This would involve an examination of system variables related to management, institutions, and governance. The second one is assessing a system's adaptation to stress over time, which would offer insights into the dynamics of adaptive capacity. These methods, which integrate principles from vulnerability and resilience frameworks, aim to provide more rigorous and practical assessments of adaptive capacity, considering management, governance, and institutional analyses, directly measuring adaptive capacity, and examining actual adaptations across time and space.

In conclusion, adaptive capacity is the capacity of a system to regulate, cope, and adapt to changes in environmental, social, and economic conditions in the context of socio-ecological systems (SES). This adaptability is essential in determining the resilience of socio-ecological systems to disturbances and alterations, thereby enhancing their long-term sustainability. Understanding and assessing the adaptive capacity of rural communities requires an integrative and flexible approach. It involves considering multiple scales of interactions, diverse components of adaptive capacity, and a combination of quantitative and qualitative assessments. It also necessitates the appreciation of the cultural and historical contexts of these communities and a nuanced understanding of power dynamics and conflicting interests. This comprehensive approach is pivotal in facilitating the resilience and
sustainability of rural communities in the face of climate change and other external pressures.

2.2.5 Role of Farmers as Drivers and Respondents of Change in Socio-Ecological Productive Landscape

In recent years, agriculture has increasingly been recognized as a Socio-Ecological System (SES) that interconnects social, environmental, and economic dimensions. This systemic perspective reveals the intricate relationships between the biophysical and human aspects of agriculture, embodied in the roles of key actors such as farmers. This subchapter discusses the pivotal role of farmers as both drivers and respondents to change within SES, focusing on their influence on landscape patterns, resilience, and adaptability in the face of an array of disturbances or changes.

In the context of agriculture and farming, resilience is frequently associated with the capacity of farmers and agricultural systems to withstand, recover from, and adapt to a variety of disturbances or changes to their productive landscape. As discussed, these disruptions may be environmental (e.g., droughts, floods, parasites), economic (e.g., market fluctuations, commodity price changes), social (e.g., changes in consumer preferences or community structure), or political (e.g., policy changes, land tenure disputes). Therefore, research on methods for agriculture and the role of farmers has been critical in understanding the complex socio-ecological processes of productive landscapes. Farmers, as key actors, exert a significant influence on landscape patterns through their various roles as landowners, farmers, estate managers and foresters are actors that shape the landscape on the local level (van der Sluis et al., 2019).

Specifically, the role of farmers in landscape change received attention while some consider farmers as drivers of change (Busck, 2002; Primdahl, 1999) and others consider farmers as an agent of change (Kristensen et al., 2004; Kristensen et al., 2009; Valbuena et al., 2010). Knickel (1990) argues that farm-level changes in land use form and intensity are primarily the result of broader structural shifts in the
agricultural sector. Farmers' decisions and responses to adapt to these shifts are influenced by market prices, access to resources, knowledge, technology, labor market conditions, and policy environment. This recognition calls attention to the nuanced roles and influences of farmers, emphasizing the need to understand their motivations, decisions, and responses for effective landscape management and policy formulation (Kristensen et al., 2004; Kristensen et al., 2009; Valbuena et al., 2010).

Recognizing farmers' roles extends beyond their position as producers to their function as landowners. Primdahl (1999) emphasizes the necessity of this differentiation, arguing that the decisions made under these two capacities can lead to diverse landscape changes. For instance, producers' decisions on crop selection and rotational systems, influenced by technological, economic, organizational, and regulatory constraints, impact the landscape differently than those of landowners, who may be more focused on long-term considerations such as cultural traditions and aesthetic values. In this context, Primdahl et al. (2013) argue that traditional public policy measures tend to view farmers as sole producers, resulting in narrow approaches that disregard farmers' roles as landowners and citizens. To manage rural landscapes more effectively, it is necessary to incorporate these positions of farmers into research and policy development.

Farmers' responses to landscape changes can be quite diverse, even in the face of similar structural challenges. Individual beliefs, objectives, and the unique physical conditions of each property largely shape these responses (Busck, 2002; Kristensen et al., 2004, 2009). Understanding these dynamics allows for a more comprehensive grasp of the socio-ecological productive landscape, further highlighting the significance of farmers' roles in driving and responding to change. Valbuena et al. (2010) include the interactions between socioeconomic and biophysical processes in the discussion that have a significant role in the development of rural areas. Farmers' diverse decision-making strategies have a significant impact on landscape structure and regional responses to internal and external change. However, the dynamics of regional landscape patterns are not dependent solely on the actions of farmers,
indicating that other decision-making strategies and processes also influence landscapes. In addition, Schneeberger et al. (2007) emphasize the significance of delineating and comprehending the interaction of various actors and driving forces in landscape change. They assert that distinct constellations of actors and forces are responsible for specific landscape changes and affect the rate of change.

The adaptability of farmers and their farming knowledge, practices, decision making and responses to change greatly influences the resilience and overall sustainability of SES. Changes in these productive landscapes, driven by environmental shifts (such as climate change), socio-political transitions, or economic changes, can significantly impact agricultural productivity, biodiversity, ecosystem services, and livelihoods. In response to these shifts, farmers may adopt different strategies, such as transitioning to different crops or farming methods, adapting to the industrial agriculture model, or transforming into an agricultural enterprise to survive (Müller and Munroe, 2008; Holland et al., 2017; Conway et al. 2016; Inwood and Clark, 2012; Smith et al, 2019).

Several authors studied the diverse responses of farmers to disturbances and change in landscape and these research show that different constellation and characteristics of actors and contextual setting results in different cases. Müller and Munroe (2008) investigate the adaptation responses that producers give to the transformation in the rural landscape in Albania between 1988 and 2003. According to the research, while privatization of agricultural land became a part of economic reform, it is determined that the producers abandoned agriculture in the transition phase and developed strategies to support the division of agricultural lands in the later stages. It is stated that the most important reasons behind the abandonment of agriculture is the economic returns of production and the increasing importance of non-farm economic activities.

Holland et al. (2017) analyses the adaptation capacity of small-scale farmers in Central American countries. The authors adopt quantified research to assess the responses of farmers using variables under economic, social, physical, human and
natural dimensions. These variables are financial investments to improve crop production (fertilizers, pesticides, soil cultivation, irrigation, etc.) and access to these investments (loans, incentives, different sources of income); migration trends; avoidance of damage to agricultural production (chemical control of pests and diseases, integrated pest management); access to human labor, marketing, storage, and agricultural equipment, and finally soil conservation practices.

Niragira et. al. (2021) defines smallholders' strategies as actions that continue to transform so as their attitude and livelihood in extreme conditions and long-term pressures as endogenous adaptation. However, the study suggests that the adaptation processes of farmers are limited due to pressures from multiple dimensions creating the problem of food security and malnutrition which have been triggered by disappearance of fallowing, decrease of soil capability, fertility, deforestation, and erosion (Niragira et al., 2021).

Other adaptation strategies that are prominent in the literature are to adapt to the industrial agriculture model and the global market, to transform into an agricultural enterprise to survive, to sell farms, to use their land for non-agricultural activities and to start working in agriculture as a wage labor, and participating in producer markets and community-supported agriculture (Conway et al. 2016; Inwood and Clark, 2012; Smith et al., 2019).

The ability of a socio-ecological system to adapt to disturbances and changes in resilience is significantly influenced by governance in terms of institutional and collective action. Informal norms also form the institutions of a social system. The strength of feedback between social and ecological components is determined by institutions that monitor and respond to environmental and social changes (Walker et. al, 2006). This institutional influence, coupled with farmers' decisions and actions, shapes the trajectories of change in rural landscapes. Therefore, incorporating the different positions of farmers in research and policy development is vital for effective management of rural landscapes (Primdahl et al., 2013).
Despite its usefulness, resilience thinking has received some criticisms, notably for not sufficiently acknowledging human agency and the diversity of perspectives, as well as for not adequately emphasizing the significance of power relations and dynamics (Sinclair et al., 2017). Vliet et al. (2015) asserts that the recognition and understanding of farmers' motivations, attitudes, and decision-making strategies play an important role in studying agricultural land use change. The study focuses on the heterogeneity of farmers' responses to changing conditions and how these responses shape the future of landscapes. This heterogeneity of actors and responses leads to deeper understanding of human agency. Sinclair et al. (2017) emphasizes the significance of understanding human agency in relation to system resilience. Authors emphasize that individual capacities to comprehend change and make decisions based on personal beliefs can lead to diverse behaviors and unanticipated results. Their study also emphasizes the significance of acknowledging the existence of multiple interpretations of social contexts or phenomena.

Darnhofer et al., (2010) present an overview of the strategies that farms use to navigate the adaptive cycle. Authors provide a comprehensive understanding for farms to tackle different types of changes, both predictable and sudden, by adopting appropriate strategies. Authors depict two approaches adopted by farmers against stress and shocks. While stress means predictable and slow changes, shock refers to sudden or major disturbance. Farmers either persist or adapt against the stress and shocks. While persistence means no or marginal change at the farm's operations, adaptation refers to exploration of new options, change in activity combinations or use of resources innovatively.

According to Darnhofer et al. (2010), adaptation as a response to stress or shocks compromises two strategies: adjust or transform. The strategy of adjust is employed when the disturbance necessitates some modifications at the farm level, such as introducing new production methods, new crops or livestock, on-farm processing, or direct marketing. Whereas the strategy of transform comes into play when the disturbance necessitates a major realignment of resources and may involve
introducing activities beyond the scope of traditional farming, such as agri-tourism, care farming, or energy production.

In summary, according to Darnhofer et al., (2010), depending on the nature of the change (whether it is a slow predictable stress or a sudden shock), farms may need to exploit, absorb, adjust, or transform. These responses are context-specific and depend on a variety of factors, such as the severity of the change, the available resources, and the farm's inherent capacity for resilience. Importantly, the authors call for understanding the strategies that allow farms to both maintain current states despite stresses and shocks and adapt to implement new states when necessary. This combination of strategies is suggested as a way to successfully navigate change in the complex dynamics of farming systems, thus achieving long-term sustainability.

In summary, farmers as key actors within SES play pivotal roles as both drivers and respondents of change. Whether through decisions related to crop selection, land use, or response to shifts in market conditions, their actions significantly influence the dynamics and adaptability of the landscape. Therefore, recognizing and integrating the multifaceted roles, motivations, and responses of farmers is crucial for effective landscape planning, management, and policy making. Understanding farmers' responses and their context-specific implementation is critical for promoting long-term sustainability in the face of continuous change.
CHAPTER 3

METHODOLOGY

This chapter describes the methodological framework of the inquiry subject to this thesis. To do that, this chapter includes nine subchapters that introduce the research approach, the process of constructing methodological framework, case study selection, sampling strategy and the methods chosen for data collection, processing, and analysis. Thirdly, the chapter introduces the case study area and explains the reason behind the case study selection. The final part discusses the limitations of our case study and the methods we have applied.

3.1 Methodological Approach

The general strategy or framework of a research endeavor that directs data gathering and analysis is referred to as research design. It connects the research problem to a certain method or procedures to enable answering research questions. Therefore, it is defined as a blueprint, that specifies how the study will be carried out, including the methodologies and processes for data collection and analysis (Yin, 2018). The present research selects a mixed methodological approach that integrates qualitative and quantitative data collection and analysis based on a single case study. The research depends on feedback between qualitative and quantitative data that has been collected sequentially and combined under a landscape dataset. The core research design shows qualitative nature with the utilization of in-depth interviews while quantitative data is collected in the form of geospatial and secondary statistical data.

Although the present study adopts mixed methods, the overarching research paradigm of the research is interpretivism. While there are researchers who strictly believe that qualitative and quantitative research methods must fit to compatible
worldviews, some researchers call for flexibility and support integration of paradigms and methods in mixed-method studies (McChesney & Aldridge, 2019). Holistic, single paradigm stance accepts the use of both qualitative and quantitative methods under mixed methods research by adopting an umbrella paradigm. This study adopts interpretivist/constructivist paradigm as the framing paradigm that searches for philosophical and methodological paths to comprehend the social reality (Given, 2008). According to Schwandt (1998), interpretivist research aims to understand “the complex world of lived experience from the point of view of those who live it” (p.221). The present study adopts interpretivist paradigm as it aims to understand how farmers respond to changing conditions in the social-ecological productive landscape.

Overall, the focus of the inquiry is consistent with interpretivist stance as the study’s main purpose is to understand how the productive landscape operates under changing conditions from spatial, environmental, agricultural productive, and administrative point of view, separately and interrelatedly. The research questions of the study is composed of “how” and “what” questions that aim at exploring the productive landscape in Northwestern Ankara. The “how” questions show the interpretivist nature of the inquiry. These types of questions are considered content-focused mixed method questions (Creswell & Plano Clark, 2018). The “what” question seeks to situate the knowledge into the context with a descriptive nature by applying both qualitative and quantitative methods with a focus on content. This type of mixed method questions represent a combination of mixed method questions (Creswell & Plano Clark, 2018).

The reading of the changing conditions and responses to change in the landscape from the perspective of the actors’ experiences is conducted in pursuit of the hermeneutics approach. Hermeneutics originates from the study of biblical and philosophical texts but extended to the interpretation of unwritten sources such as human practices and situations to develop an understanding (Crotty, 1998). Bryman (2012) asserts that the theory and method of interpreting human behavior are the focus of hermeneutics. In this research, transcribed texts from in-depth interviews
and texts originating from reports, plans and policies are used to interpret the changing conditions in landscape (human-environmental situation) and responses to change by the actors (human action).

Mixed method research has gained more attention in the last decades as it bridges the gaps between qualitative and quantitative inquiry and minimizes the limitations of both approaches. Due to limitations on employing a single method, there is a growing interest in integrating both qualitative and quantitative methodologies to tackle complex research questions (Fusch et al., 2017). The present research adopts an **embedded mixed-method design** that uses both quantitative and qualitative data. Embedded mixed-method design is applicable when “a data set provides a supportive, secondary role in a study based primarily on the other data type” (Creswell & Plano, 2007, p.67). This design is utilized when a research question requires quantitative or qualitative data in a primarily qualitative (or quantitative) study. This study primarily relies on qualitative data in line with its interpretivist stance, but it also utilizes quantitative data to holistically explore the socio-ecological productive landscape.

The utilization of mixed methods initiates a rooted discussion of the division between qualitative and quantitative research. The traditional binary understanding towards research paradigms and research methods such as positivism/interpretivism, deduction/induction, qualitative/quantitative research methods questioned for their power of explanation to understand the world. This binary understanding also prevailed in human and nature interrelations, and their scientific background, natural and social sciences. A shift from Newtonian understanding that adopts deterministic approaches left its place to complex understanding of the world that necessitates a dialogue between social and natural sciences, as well as an integration of different methods for scientific inquiry. Methodological pluralism can occur at different levels. While the adoption of mixed methodology is one of the levels, the adoption of multiple epistemologies and multiple disciplinary efforts into a single inquiry are part of methodological pluralism.
In line with this need for complex thinking, the integration of mixed methods to case study research design is growing (Creswell & Plano Clark, 2018; Yin, 2018). Mixed method case study design refers to integrating a case study as a research technique into core research design. In comparison to case studies alone, mixed-methods research can help address broader or more complex research topics (Yin, 2018). Case study research can be utilized as a qualitative component in mixed methodology research, providing in-depth, detailed information on a specific instance or setting that can then be examined and interpreted quantitatively. Case studies are, in fact, born out of the need to understand complex social phenomena (Yin, 2018). The adoption of a case study research is also inevitable for this inquiry as it aims to understand a particular context in Northwestern Ankara. The study pursues an exploratory case study research strategy with a focus on exploring agricultural production and its change in reference to the contextual particularities through time.

There are basically three types of case study research design, namely, exploratory, explanatory, and descriptive (Yin, 2018). The exploratory research method aims to explore an understudied or emerging topic or phenomenon and to develop a deeper understanding of a research problem. While the explanatory case study seeks to explain how or why a condition developed (for instance, how or why a particular series of events occurred or did not occur), descriptive case study has the objective of describing a phenomena (the “case”) in its real-life setting (Yin, 2018). As the present study aims for a deeper understanding of the change, impact, and response mechanisms in rural productive landscapes from multiple dimensions, the study adopts exploratory case study research as an inquiry strategy.

Understanding landscape change from a complex socio-ecological perspective requires the integration of multiple sources of knowledge. By definition, a case study research entails finding a topic that lends itself to in-depth investigation in a natural environment while utilizing many sources of information (Hancock & Algozzine, 2006). As a result, case studies fit very well with mixed methods, which combine qualitative and quantitative research to achieve a more comprehensive
understanding (Guetterman & Fetters, 2018). Literature on socio-ecological systems points out different methodological approaches in inquiries about socio-ecological systems. While some studies focus on the conceptual development of SES through conducting bibliographic research (Binder et al., 2013; Gari et al., 2015b; Walker & Meyers, 2004) and developing conceptual frameworks (Anderies et al., 2004; Berrouet et al., 2018; Colding & Barthel, 2019), others focus on understanding the operation of SES through diverse methodological approaches. Researchers developed various spatial, participatory, modeling and statistical tools to integrate social with environmental aspects (Guerrero et al., 2018).

The bibliographic study of Guerrero et al. (2018) shows the main tendencies in SES research. According to the authors, only about a third of empirical SES studies use mixed methods designs, while the other half rely solely on quantitative approaches. In this vein, developing and using set(s) of indicators is a common quantitative approach in SES research. Alessa et al. (2009) developed an indicator-based approach to create a typology for socio-ecological systems to improve short- and long-term adaptive strategies in developing human settlements. Similarly, De Aranzabal et al. (2008) adopts a quantitative model using rural landscape characteristics and socio-economic indicators to understand the impacts of landscape change on socio-ecological system dynamics in a case study from a semiarid Mediterranean landscape.

There are criticisms about under-theorization and under-representation of social dimension in existing SES frameworks (Cote & Nightingale, 2012; Fabinyi et al., 2014; Gotts et al., 2019). Several authors suggest adoption of mixed methodological approaches and epistemological pluralism when researching SES (cccc). In line with this, an increasing number of scholars calls for the adoption of methodological pluralism in socio-ecological systems research (Biggs et al., 2021; Goddard et al., 2019). Such a need stems from advancing efforts for interdisciplinarity because complex problems of today’s world cannot be solved through single-disciplinary approaches Manfredo et al. (2014). For instance, Nightingale (2015) discusses the
relevance of adopting plural epistemologies and hybrid methodologies in climate change adaptation research from two perspectives. Firstly, climate change adaptation necessitates combining information of "complex biophysical processes with equally complex, individual, and social-political processes" (p. 42). Secondly, the author criticizes the tendency among scientific approaches to outline adaptation as a response to only biophysical change. The second issue underlines the ontological assumptions where the nature-human interrelation is positioned. In the same manner, this present study assumes that farmers’ responses to change not only occurs in an isolated social dimension but change and response occur through feedback relationships among social and biophysical systems which cannot be separated. Change in the landscape does not occur only through physical processes but through feedback mechanisms between ecological and social processes.

The incorporation of qualitative and quantitative data through survey and interview techniques is commonplace in the studies of socio-ecological systems. Williams & Kramer's (2019) research in the Pearl Lagoon Basin of Nicaragua's Caribbean combines survey and ethnographic field work to understand how shifting livelihoods caused by increased integration into global political-economic systems affect agrobiodiversity maintenance in coastal socioecological systems. Researchers intend to develop an in-depth understanding of social behaviors and, contrary to their hypotheses, reach a conclusion that access to road infrastructure can promote agri-biodiversity conservation rather than damage it. Similarly, Sunderland et al. (2017) investigates the transformation of six tropical landscapes in Zambia, Burkina Faso, Cameroon, Ethiopia, Indonesia, and Bangladesh as part of a larger socio-ecological system. They use a variety of research techniques, such as questionnaires sent to all residents, focus groups, and semi-structured interviews. The authors triangulate data on relative poverty, food security, dietary diversity and nutrition, agricultural output, land tenure, migration, and biodiversity to arrive at more holistic conclusions.

Holzer et al. (2018) provide an in-depth methodology for studying socioeconomic status. The researchers begin with a bibliographic investigation of the techniques and
interdisciplinary approaches employed in SES research. They continue with five categories of SES research methodologies including questionnaire models, mixed methods, environmental policymaking process evaluation, the research embedding and performance profile approach, and case studies. The researchers suggest a paradigm for assessing trans-disciplinary SES research by combining the most applicable features of each study technique mentioned above to synthesize narrative, quantitative, and visual representations and assessments of the research setting. Holzer et al. use the term "staged, adaptive approach" to describe this method, which allows for the possibility of adjusting previous data and foundational phases in light of newly acquired information. As such, the researchers devise a research framework that incorporates a case study methodology, qualitative research in the first stage, and quantitative research in the second stage. Similarly, Guerrero et al. (2018) adopt improved degrees of methodological integration despite small sample sizes when employing tools including modeling approaches, spatial integration tools, and the driver-pressure-state-impact-response (DPSIR) framework.

The literature review shows that there is a growing application of mixed methodological approaches in SES research concerning the equal and integrated representation of social and environmental dimensions and their interrelations. While quantitative approaches using metrics and indicators are common in the analysis of natural and ecological dimensions, geospatial data is also used to develop an understanding of the geographical and natural setting. However, when the evaluation of social and ecological dimensions is treated separately, the outcome becomes misleading considering the feedback mechanisms between both dimensions.

This study asserts that the actors’ responses change the landscape in spatial, environmental, productive, and organizational dimensions interrelatedly. This, thereby, makes individual decision making and the role of farmers an important element of analysis in an investigation of strategic responses to change because this, in turn, determines the future of the landscape. While a qualitative inquiry is carried out at the farm level by using semi-structured in-depth interviews and site
observations, the landscape-level analysis integrates spatial data with semi-structured in-depth interviews and secondary qualitative and quantitative data including official statistics, plans, policies, and reports. The qualitative data, gathered through in-depth interviews, is triangulated by geospatial data (qualitative and quantitative) and secondary data (quantitative and qualitative).

The use of geospatial data in qualitative and mixed-method research has gained more attention in the last 20 years (Nyerges & Green, 2000; Rucks-Ahidiana & Bierbaum, 2015; Sarfo et al., 2022). However, geospatial data with qualitative data is not commonly combined in SES research. There are advantages of using this combination. Spatial data, as quantitative data, can enable qualitative researchers to understand the spatial patterns of social processes. In addition, spatial data, when integrated with qualitative data can bring a different perspective to research issues. For instance, Jiang (2003) integrates remote sensing techniques to ethnographic research on cultural landscapes. The author suggests that remote sensing analysis provides other stories not told by interviewers or stories that enhance interviewees' accounts.

This study integrates geospatial data as secondary quantitative data using ArcGIS software. ArcGIS helps prepare the digital elevation model, develop hydrological analysis, calculate NDVI and its change between 2017 and 2021 using satellite imagery, prepare climatic maps using meteorological data, and calculate land use and landcover change from CORINE data between 1990 and 2018. The spatial data enables the understanding of the spatial and natural settings of the productive landscape as well as the trends of change.

3.2 Process of Constructing the Methodological Framework of the Study

This study starts from the assumption that the socio-ecological production landscape constantly changes with various triggers. In a process of change, the dynamics affecting the landscape leads to various consequences. This, in turn, creates opportunities for responses in interaction with each other in both social and
ecological dimensions. Understanding such dynamics of change, impact and responses can provide a basis for adaptive planning and management strategies. In particular, understanding the impacts, experienced by the actors of production landscape and their responses to social, environmental and economic changes that will affect the sustainability of agricultural production in rural areas, such as climate change, is of great importance for the development of locally specific policies and strategies.

Based on this background, the research aim is to delve into the socio-ecological landscape dynamics of Northwestern Ankara, understanding its connection with various systems like spatial, environmental, productive, and administrative, especially under changing conditions. Two key sub-aims are to pinpoint the present and changing states of this productive landscape, emphasizing the impact on water soil, and plants, and production processes, and to discern how farmers are responding to changes and experienced impact stemming from change.

Interrelatedly, this research has three objectives. The first one is to explore the socio-ecological productive landscape in Northwestern Ankara. To achieve that, the research examines the interrelations between spatial, environmental, agricultural production, and organizational dimensions at the intersection of socio-ecological system. The second one is determining the impacts of changing human-induced conditions and climatic conditions on the region's natural resources and agricultural outputs, and study how farmers react to these changes.

Investigate agricultural procedures within Northwestern Ankara's socio-ecological context by analyzing the present and modified states. This includes understanding the influences on, and farmers' responses to, stages of land preparation, seed sourcing, irrigation, plant protection, fertilization, harvest, processing, packaging, and marketing.

The main goal of this research is to contribute to a better understanding of the socio-ecological productive landscape in Northwestern Ankara and to identify potential strategies for enhancing the resiliency of the rural productive landscape. Ultimately,
the aim is to guide resilient planning and policymaking of the productive landscape by understanding the complex interrelations among the components of productive landscape and farmers' adaptive responses towards change in manmade conditions, climatic conditions and production process that impacts productive landscape in myriad manners. Exploration of the nuances and interrelations among the components of the productive landscape would result in change in the planning approaches that rule the current planning practice especially for rural areas.

Based on these aims and objectives, the research asks the following research questions:

**Main RQ.** How does the socio-ecological landscape of Northwestern Ankara operate through the interrelations between spatial, environmental, agricultural productive, and administrative systems in response to the changing conditions?

**Sub-RQ1.** What is the socio-ecological productive landscape of Northwestern Ankara, operated by spatial, environmental, productive, and administrative systems?

**Sub-RQ2.** How have changing conditions impacted natural resources and agricultural products within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?

**Sub-RQ3.** How has the production practice changed within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?

Mixed methods research is characterized as a research approach that combines quantitative and qualitative methodologies into a single project (Bryman, 2012). Answering research questions requires integration of data from in-depth interviews, geospatial data, and secondary qualitative and quantitative data to explore the socio-ecological productive landscape in Northwestern Ankara.

In this study, the aim is to deeply understand the socio-ecological landscape of Northwestern Ankara, its operation, and how it is shaped by the interrelations between spatial, environmental, agricultural productive, and administrative systems
in response to changing conditions. The main research question and its three sub-questions necessitate a variety of methodologies, data types, collection techniques, and analysis methods.

The central research question employs a mixed-methods approach, providing a broad view of the landscape's dynamics. It incorporates qualitative and quantitative measures to build a comprehensive picture. The data encompasses qualitative verbal data, secondary quantitative and qualitative data, spatial data, and visual materials such as photographs or recordings, providing multiple perspectives on the topic. Collection methods involve in-depth interviews, data requests from relevant institutions, exploration of open data sources, and on-site observation. The diverse data are then analyzed using simple statistical analysis, content analysis, and spatial analysis to extract meaningful insights and illustrate the interconnected dynamics of the landscape.

The first sub-question, similar to the main research question, employs the same mix of methods, data types, and data collection techniques to probe into the specifics of Northwestern Ankara's socio-ecological productive landscape. The data, likewise, are subjected to simple statistical analysis, content analysis, and spatial analysis to interpret the findings effectively.

The second and third sub-questions concentrate on the impacts of changing conditions on natural resources, agricultural production, and production practices within Northwestern Ankara's socio-ecological landscape. They also explore the adaptive responses of local farmers to these changes. For these sub-questions, I adopt a purely qualitative approach to capture the lived experiences and perspectives of the local farmers. The primary data type is qualitative verbal data, gathered directly from participants through in-depth interviews. These rich narratives are then examined through content analysis, using qualitative coding to categorize and understand responses. Simple statistical analysis is also employed to quantify these codes and reveal prevalent themes or patterns.
Figure 3.1 shows the detailed representation of processes for the data collection, processing, and outputs, and the interrelations among these processes and outputs. The following sections present this process and relevant data collection/analysis methods used and the analytical outputs generated as a result of analyzing the collected data. They also present how the experience in previous phase led to constructing the following methodological step and how these phases were constructed in relevance to the research questions. During the qualitative phases of the inquiry, I conducted 32 in-depth interviews with actors relevant to agricultural production in the case study region in two consecutive summer periods of 2020 and 2021. In addition to interviews, I also took field notes and photographs. Subchapter 3.7 on Data Analysis Methods/Techniques explains the analytical procedures for collected data in detail.

Table 1. Research Approach according to Research Questions

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<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Research Technique</th>
<th>Data Types</th>
<th>Data Collection</th>
<th>Data Analysis</th>
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<tr>
<td><strong>Main RQ.</strong> How does the socio-ecological landscape of Northwestern Ankara operate through the interrelations between spatial, environmental, agricultural productive, and administrative systems in response to the changing conditions?</td>
<td>Mixed Methods</td>
<td>- Qualitative (Verbal) Data&lt;br&gt;- Secondary Quantitative&lt;br&gt;- Qualitative Data Spatial Data&lt;br&gt;- Recordings/Photographs</td>
<td>- In-depth Interviews&lt;br&gt;- Data Request from Institutions (Official statistics and reports)&lt;br&gt;- Open Data Sources (Official Statistics, Spatial Data)&lt;br&gt;- Site Observation</td>
<td>- Simple Statistical Analysis&lt;br&gt;- Content Analysis&lt;br&gt;- Spatial Analysis</td>
</tr>
<tr>
<td><strong>Sub-RQ1.</strong> What is the socio-ecological productive landscape of Northwestern Ankara, operated by spatial, environmental, productive, and administrative systems?</td>
<td>Mixed Methods</td>
<td>- Qualitative (Verbal) Data&lt;br&gt;- Secondary Quantitative&lt;br&gt;- Qualitative Data Spatial Data</td>
<td>- In-depth Interviews&lt;br&gt;- Data Request from Institutions (Official statistics and reports)&lt;br&gt;- Open Data Sources (Official Statistics, Spatial Data)</td>
<td>- Simple Statistical Analysis&lt;br&gt;- Content Analysis&lt;br&gt;- Spatial Analysis</td>
</tr>
<tr>
<td><strong>Sub-RQ2.</strong> How have changing conditions impacted natural resources and agricultural produce within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?</td>
<td>Qualitative Methods</td>
<td>- Qualitative (Verbal) Data</td>
<td>- In-depth Interviews</td>
<td>- Content Analysis (Qualitative Coding)&lt;br&gt;- Simple Statistical Analysis (Quantified Codes)</td>
</tr>
<tr>
<td><strong>Sub-RQ3.</strong> How has the production practice changed within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?</td>
<td>Qualitative Methods</td>
<td>- Qualitative (Verbal) Data</td>
<td>- In-depth Interviews</td>
<td>- Content Analysis (Qualitative Coding)&lt;br&gt;- Simple Statistical Analysis (Quantified Codes)</td>
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Figure 3.1. The methodological approach of the research.
3.3 Rationale Behind Case Study Selection

For the case study, three districts, namely Gündül, Beypazarı and Ayaş, were selected from the northwestern region of Ankara. As discussed in the previous sections in details, the selection of the case study districts is based on multiple rationales including spatial and natural setting, landscape characteristics, agricultural production, administration and planning, and climatic dimensions. The following text summarizes and clusters the rationales under three categories.

First, the selected districts are in the Kirmir Creek basin of Sakarya River where different patterns of agricultural production exist such as irrigated and dry agriculture with the adoption of conventional, organic, and ecological production methods. The area produces the majority of green agricultural products in Ankara. Although the study area compromises nearly 12% of all agricultural areas in Ankara, agricultural production of these districts is composed of almost %90 of all vegetables produced in Ankara (TurkStat, 2021). This aspect is important considering that the dominant production of Ankara is dry agriculture and ensuring food security and diversity in the Ankara locality. Additionally, production is diverse considering that irrigated and non-irrigated agriculture, orchards, vineyards, husbandry, and beekeeping exist in the region. Due to topographical, geomorphological, and climatic features, Kirmir Creek valley shows microclimatic characteristics that allow the growth of products from the Mediterranean climate such as olives, pistachios, and artichokes. In fact, this situation represents the rich productive biodiversity in the region. Considering these facts, the study area is important in terms of Ankara’s agriculture and food system. Additionally, the emerging bottom-up agricultural organizations and cooperatives are another reason for selecting this region as a case study area. In order to understand how actors’ response to changes in the landscape, it is important to know whether there are emerging organizational structures as a response to the impacts of the changes experienced.

Secondly, the region is an important valley system that integrates key biodiversity areas, protected landscapes of natural and historical heritage sites, and agricultural
production areas. Therefore, it is important to explore the dynamic interactions of different productive landscape components and change and response mechanisms among the actors of the productive landscape. The region has two protected plains, nature conservation areas, and key biodiversity areas. In addition, the land use change was very limited in the last 30 years that enables the conservation of historical and natural heritages in the region. Like Beypazarı which got listed in the tentative list of the UNESCO World Heritage List with its architectural heritage, Güdül and Ayaş have similar architectural heritage. In this setting, Güdül has become the first Citta Slow town of Ankara in 2020. The biodiversity in Kirmir Creek, the bottom-up initiatives, natural agricultural production potential, preservation of biodiversity, and productive heritage. This shows the potential of the region to sustain the productive landscape together with its social and ecosystem components that impact agricultural production in an interrelated manner. Consideration of these components in planning processes is another dimension that the region lacks.

The third dimension focuses on planning initiatives in the region, which lack an overarching landscape plan to guide the region's balanced rural and urban development. This plan should address issues such as protecting ecologically and agriculturally crucial areas, the balancing rural and urban development, curbing rural-to-urban migration, securing rural income opportunities through sustainable agricultural production, and creating rural-urban food networks to ensure food security for the Ankara province. The absence of such a plan can result in several socio-ecological factors, such as the loss of agricultural land due to urbanization and industrialization, the intensified impact of climate change on crop yields, and vulnerability to pests and diseases.

The transition to a centralized metropolitan system, following Law No. 6360, has led to administrative adjustments that have significantly impacted regional planning. The reduction in municipalities' power has resulted in inadequate provision of public services, especially in rural areas. In addition, the transformation of villages into neighborhoods following Law No. 6360 has blurred the line between rural and urban areas, leading to a lack of clear planning and management strategies for these newly
categorized areas. This has led to issues for rural communities, which often have specific needs different from those in urban areas. Centralized decision-making has left these areas underrepresented, and their needs, such as access to education, healthcare, and basic infrastructure, are often not adequately met.

Climate change has also intensified, making the situation more complex by affecting crop yields and increasing vulnerability to pests and diseases. This creates a compelling need for strategies that integrate climate change adaptation and mitigation into landscape planning. However, the lack of resilience strategies, such as climate action plans, from local governments is a significant barrier to achieving this.

In conclusion, the lack of an upper-scale planning strategy in the region can be attributed to socio-ecological factors affecting rural areas and agricultural production, the impacts of the centralized metropolitan system, and the absence of resilience strategies from local governments. A comprehensive and integrated planning approach is needed to address these issues and ensure the sustainable development of the region.

Finally, although this research is practically based on administrative boundaries as the institutional data depends on those boundaries, it does not mean that the operation of a productive landscape is based on administrative boundaries. It is as Bürgi et al., (2005) asserted, studying landscape change across borders of administrative units can be valuable for understanding the impacts of regulations, subsidies, and political systems. In addition, the administrative boundaries between Ayaş, Beypazarı, and Güdül districts blur from the agricultural production perspective considering the type of products and river basins shared. Even the official administrative boundaries of Güdül and Ayaş are fragmented and intersect over the region.
3.4  Sampling Strategy, Sample Size and Characteristics,

The present research adopts a combination of **stratified**, **purposeful**, **snowball sampling strategy** to reach the targeted sample group that compromises the base for the qualitative dimension of the research.

The stratified sampling technique involves dividing the population into homogeneous subgroups, or strata, and subsequently selecting a random sample from each stratum. Stratified sampling is employed in the investigation of changes and responses in the productive landscape. This method is preferred as it enables a more detailed assessment of diverse farmer categories, including small and medium-scale producers. These groups may be impacted by changes in varying ways and exhibit different capacity to respond. This approach guarantees that every category of farmer is sufficiently included in the sample, irrespective of their prevalence in the overall population.

Purposeful sampling involves selecting participants based on specific criteria relevant to the research question. This method helps researchers identify and select individuals who are most likely to provide rich and detailed data about the research question. In this case, agricultural producers who have exhibited innovative or effective responses to changes in the productive landscape were deliberately chosen for interviews to provide comprehensive perspectives into their strategies and experiences.

Snowball sampling is a type of purposeful sampling that is often used in qualitative research. It involves identifying a few initial participants who fit the study's criteria and then using their connections to identify other potential participants. The initial participants are asked to refer to other people they know who also meet the study's criteria. This process continues until the desired sample size is reached. This approach can prove to be especially advantageous in engaging with farmers who may be challenging to reach or identify, thus ensuring an array of viewpoints in the study.
Determining the appropriate sample size for qualitative research depends on several factors, including the scope of the study, the research question, homogeneity of the population and the desired level of analysis. The data saturation and the definition of sample size in qualitative research are highly interlinked. Although data saturation originates from grounded theory, the term is diffused into qualitative research in terms of data or thematic saturation (Hennink & Kaiser, 2022). Fusch & Ness (2015) discuss the relevance of data saturation and data triangulation and assert that triangulation can be used as a method to achieve data saturation. The cross-site and cultural research of Hagaman & Wutich (2017) shows that sample sizes of 20 to 40 interviews are needed to obtain data saturation of meta-themes. Hennink et al. (2017) adds by stating that while the code saturation is reached at 9 interviews, 16 to 24 interviews are required to reach a meaning saturation that enables in-depth comprehension of an issue.

This study adopts multiple sampling methods for the selection of respondents. Firstly, stratified sampling method was used to create a sample that can represent small and medium-sized producers who resist or survive the changes in the productive landscape. Then, purposeful sampling was used to reach potential participants who could provide the most and richest information on the research topic. With this method, individuals who met certain criteria and had the potential to provide rich information to the research were specifically selected. In addition, the snowball sampling method was used together with purposeful sampling method. With this method, several pre-selected participants were asked to suggest other potential participants. This process proceeded in the form of one participant suggesting another participant, thus expanding the pool of potential participants.

For this study, I started contacting the farmers and agricultural engineers whom I met during my visits to Güdül and Beypazarı as part of my civil society volunteering experience. I initiated the interviewing process in the initial circle of farmers and organizations with I had already established this contact and asked for references for further interviews. This carried me to 36 farmers. I could conduct in-depth interviews with 32 of them.
I selected participants based on their relevance to the research questions and their knowledge and experience of the productive landscape in Northwestern Ankara. The study aimed to include a diverse range of participants in three selected districts to capture different perspectives and experiences. Based on this sampling strategy, the research targeted agricultural producers who continue agricultural production under changing conditions in Güdül, Beypazarı and Ayaş districts of Ankara. In addition, representatives of various public, private, and civil society organizations who carry out activities relevant to agricultural production, such as cooperative administrations, non-governmental and professional organizations, and public institutions operating on the field of agriculture, create the basis of the targeted sample group. I conducted interviews with the local actors residing in 21 neighborhoods across the region as represented in the figure below.

![Figure 3.2 The distribution of interviews among the neighborhoods in the region](image)

During the field studies, I conducted 32 in-depth interviews with 36 respondents. Three of the interviews were focus group discussions with 2–3 respondents. While
24 in-depth interviews were conducted with agricultural producers across the region, 12 in-depth interviews were conducted with non-producers, who are representatives from several institutions across the regions and in central Ankara. In all, 34 of the interviews were conducted with actors operating in the region.

Additionally, I conducted two interviews with representatives from institutions operating at the Ankara level to understand the context of agricultural production in the province. These interviews include one officer from the Department of Rural Services of the Ankara Metropolitan Municipality and the director of the Rural Working Group of the City Council of Ankara. I interviewed with these institutions to get deeper knowledge on the state of agricultural production and agricultural organizations operating in the region and in Ankara. These interviews followed the interview form but did not get information on the production processes. Therefore, they were not included in the analysis but used to frame the context in Ankara and support the knowledge gained during the data collection process.

Table 2 Categories of Interview Types

<table>
<thead>
<tr>
<th>Type of Respondent</th>
<th>Ayaş</th>
<th>Beypazarı</th>
<th>Güdül</th>
<th>Ankara</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Producers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Including producers from Cooperatives, Public Officers, Muhktars]</td>
<td>3</td>
<td>9</td>
<td>12</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>(2) Non-Producers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Including Muhktar, Representatives from Public Bodies, Cooperatives and NGOs]</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Number of Interviews per District and in Ankara</td>
<td>5 (% 13,9)</td>
<td>10 (% 27,8)</td>
<td>18 (% 50,0)</td>
<td>2 (% 5,6)</td>
<td>36</td>
</tr>
</tbody>
</table>

Overall, interviews in Güdül district comprised half of the sample, with 18 respondents in 16 interviews. In Beypazarı, I conducted 10 interviews with 10 respondents, with almost 30% of all respondents. This rate is approximately 14 percent, with 5 respondents in 4 interviews in Ayaş. I conducted two interviews with key people in Ankara (%5, 6%). The unequal distribution of respondents among districts stems basically from time and budget limitations, along with COVID-19
restrictions. The field process showed that the interviewees did not split sharply into two categories. For example, there are interviews where the neighborhood headman (muhktar) is both the head of the cooperative or the representative of the public institution and an agricultural producer at the same time. Therefore, the respondents are divided mainly into two categories: agricultural producers and non-producers. Table 3 presents the total number of interviews and the distribution of interviews according to two respondent categories among districts.

Of all 23 agricultural producers, 17 do not operate under any institution. In addition, two interviewees are producers working in cooperatives operating in the region; two are producers working in non-governmental and professional organizations; and two are in public institutions. Additionally, I interviewed a mukhtar who engaged in agricultural production in Güdül. Producers in the Güdül district constitute about half of the respondents among agricultural producers, with twelve respondents. Beypazarı follows Güdül with eight interviewers and Ayaş with three interviewers. Table 4 presents the types of agricultural producers interviewed during the research.

Table 3 Type of Agricultural Producers Interviewed

<table>
<thead>
<tr>
<th>Type of Agricultural Producers</th>
<th>Ayaş</th>
<th>Beypazarı</th>
<th>Güdül</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Agricultural Producers with No Affiliation</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>(2) Agricultural Producers working in Cooperative</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(3) Agricultural Producers working in Non-Governmental and Professional Organizations</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(4) Agricultural Producers working in Public Institutions [Agricultural Directorates]</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(5) Agricultural Producer working as Muhktar</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Number of Agricultural Producers Interviewed per District</td>
<td>3 (12.5%)</td>
<td>8 (37.5%)</td>
<td>12 (50.0%)</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 5 presents twelve of the interviews held with representatives from various institutions and organizations that do not carry out agricultural production but operate in agricultural production in the region. These interviews consist of
respondents from non-governmental organizations, professional organizations cooperatives, neighborhood administration (mukhtar) and public institutions. Among the twelve, 5 respondents were from Non-Governmental and Professional Organizations, three from Public Institutions, and two from cooperatives. Additionally, two of the respondents were mukhtars.

Table 4 Type of Non-Producer Respondents

<table>
<thead>
<tr>
<th>Type of Non-Producers</th>
<th>Ayaş</th>
<th>Beypazarı</th>
<th>Güdül</th>
<th>Ankara</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Non-Governmental and Professional Organizations</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>(2) Public Institution</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>(3) Cooperative</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(4) Mukhtar</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5. Age distribution of interviewees

<table>
<thead>
<tr>
<th>Age</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65+</th>
<th>Unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frq.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% in Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ayaş</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>% in Ayaş</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Beypazarı</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>% in Beypazarı</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Güdül</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>% in Güdül</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>% in Unknown</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>21</td>
<td>26</td>
<td>21</td>
<td>3</td>
<td>8</td>
<td>34</td>
</tr>
<tr>
<td>% in Total</td>
<td>100</td>
<td>60</td>
<td>80</td>
<td>60</td>
<td>12</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

Socio-demographic and economic information, including age, gender, and residential information, was collected from agricultural producer and non-producer respondents operating in the region. Table 6 shows the distribution of respondents among age categories. Two age groups are dominant among respondents. Almost half of the respondents (n = 18) are over 45 years old. There are only two respondents whose ages are between 25 and 34. Only one is a female agricultural producer (G1-2).

Table 6 shows the distribution of respondents among age categories. Two age groups are dominant among respondents. Almost half of the respondents (n = 18) are over 45 years old. There are only two respondents whose ages are between 25 and 34. Only one is a female agricultural producer (G1-2).
In terms of gender, almost one-fourth of the respondents were male. Interviews with female respondents clustered in Güdül district with six interviews, and only two of them were conducted with non-producers. In Beypazarı and in Ayaş, only one female respondent was reached and interviewed per district. It is notable to add here that age and gender were not set as criteria for sampling (See Table 3.2.2.5).

Table 6. Gender distribution of interviewees

<table>
<thead>
<tr>
<th>Gender</th>
<th>Freq.</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Male</td>
<td>26</td>
<td>76</td>
<td>4</td>
<td>80</td>
<td>10</td>
<td>91</td>
</tr>
<tr>
<td>(2) Female</td>
<td>8</td>
<td>24</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>100</td>
<td>5</td>
<td>100</td>
<td>11</td>
<td>100</td>
</tr>
</tbody>
</table>

Considering the condition of the place of residence of the respondents, 21 respondents out of 34 replied as they are local people whose birthplace is the region in which they still live (Table 3.2.2.6). While 4 respondents moved to Ankara Center and other villages in the region, there is only 1 respondent who moved back from Ankara to the village of birth. Almost 20% of the respondents are in the category of "not producers," and their residence information was not obtained.

Table 7. Place of residence of interviewees

<table>
<thead>
<tr>
<th>Condition in Place of Residence</th>
<th>Freq.</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Local</td>
<td>21</td>
<td>62</td>
<td>3</td>
<td>60</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>(2) Not a Producer</td>
<td>7</td>
<td>21</td>
<td>2</td>
<td>40</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>(3) Migrated out [Ankara, other villages]</td>
<td>4</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>(4) Migrated in</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(5) Unknown</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>100</td>
<td>5</td>
<td>100</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

Overall, the respondent profiles cover the general characteristics of the participants, including producer or non-producer information, age, gender, and place of residence.
3.5 Variables

This study adopts multilayered categories of variables based on three primary dimensions: **Productive Landscape Components, Man-Made and Climatic Conditions, and Agricultural Production Steps.** These broad categories enable a comprehensive, organized examination of the factors influencing productive landscape in the study region. The data gathered to answer the research questions are analyzed under these variables.

The first dimension, **Productive Landscape Components,** is further divided into subcategories: (i) interrelations among socioecological components and (ii) agricultural production context and producer characteristics in the region. The former subcategory covers spatial (including geomorphology, land use and land cover, land capability, vegetation); ecosystem components (including water, climate, soil, flora, and fauna); and socio-economic context (accounting for population and demography). These components seek to provide a comprehensive understanding of the productive landscape's socio-ecological characteristics, considering interrelations and feedback mechanisms among both biophysical and human factors. This dimension predominantly relies on secondary qualitative and quantitative data gathered from a variety of sources.

The second subcategory includes the variables of agricultural production context and producer characteristics focuses on the type of agricultural practices, number of farmers, pattern of landownership, crops and product types, agricultural production characteristics such as time in agriculture, income and labor, and agricultural organization. Understanding these variables facilitates contextualization of responses and adaptations to agricultural landscape changes. This subcategory aims to explore the productive characteristics of the farmers in the regions before delving into the change, impact and responses among farmers. This dimension uses primary qualitative data gathered in the field and secondary qualitative and quantitative data gathered from a variety of sources.
The second dimension, **Man-Made and Climatic Conditions**, focuses on changes in the man-made conditions, climatic conditions and resulting natural disasters, and their impacts on water, soil, and plants. It also investigates the responses of farmers to these impacts. The climate plays a significant role in determining agricultural productivity and sustainability, and understanding its changes and outcomes can inform adaptation strategies.

**Agricultural Production Steps**, the third dimension, delves into the complex relationships of agricultural processes that provide a comprehensive understanding of agricultural practices in this region. This dimension examines the steps of farming, including land preparation, seed selection and obtainment, irrigation, plant protection, and fertilization, as well as harvesting, packaging, processing, and marketing. This dimension provides a comprehensive depiction of the operational aspects of farming through focusing on current state, changed state, experienced impact and response of the producers to explore the adaptive responses of farmers. In addition, such analysis presents interactions among socio-ecological system components at different steps of agricultural production.

### 3.6 Data Gathering Techniques

The present research is composed of five phases of data collection that each step builds over the knowledge from the previous phase. These stages are

i. Initial Observation Phase

ii. Secondary Qualitative and Quantitative Data Collection,

iii. 1st Phase Qualitative Data Collection,

iv. Quantitative Data Collection (Secondary and Spatial Data),

v. 2nd Phase Qualitative Data Collection

In the initial observation phase when I was residing in Ankara, I held five short visits between 2017 and 2019 to the region to understand its landscape characteristics and
agricultural production. I was actively voluntarily engaged in a village-based NGO working on rural-urban interrelations to actively support agroecological agricultural production of small-scale farmers in Güdül with the activities based on Ankara. The visits started with an exploration of the district and then of the wider bioregion of the study area. This allowed me to establish my initial connection with the locals, to meet with farmers and to get to know existing farming practices in the region. Then, I planned a more systematic field work in Spring 2020 so that I could conduct interviews with farmers, but Covid-19 restrictions prevented this plan. During this phase, however, I conducted 5 interviews with experts from different backgrounds on rural and agricultural studies in Ankara to gain deeper understanding of the region.

In the third phase of the inquiry, which stands as the quantitative phase, I collected spatial and statistical data from national and international open data sources and from relevant central and local institutions by sending petitions for data requests. Some types of data also were qualitative such as agricultural support program descriptions. Overall, I collected 90 data categories including statistical and spatial data from the Ministry of Agriculture and Forestry and its several General Directorates, the Ministry of Environment, Urbanization and Climate Change (former Ministry of Environment and Urbanization), and Ankara Metropolitan Municipality. Additionally, open data sources and spatial data providers such as European Environmental Agency, USGS, Open Street Map and TurkStat. A detailed list of the received data is available in Annex B (List and Characteristics of the Secondary Data and Spatial Data).

Each step builds over the data and knowledge produced from the previous phase. Spatial, statistical, and descriptive data sets were prepared to reposit the collected data. Within the context of this research, qualitative data is triangulated by geospatial data (quantitative) and secondary data (quantitative and qualitative) to explore the socio-ecological productive landscape in Northwestern Ankara and to explore the changing state in climatic conditions and production processes and responses to the changes experienced.
3.6.1 Data Collection Process and Analytical Procedures for Secondary Qualitative and Quantitative Data

In the following phase after first observation, I gathered secondary qualitative and quantitative data on regional landscape characteristics, agricultural production patterns and practices, as well as planning approaches adopted in the region from institutions and open access data sources. The results of this phase feed the main research question through exploring landscape components and their dynamics. This phase help me to design the following qualitative phase of the research.

The collection of secondary data started in July 2019 after the initial site observation period and continued after the Qualitative Data Collection Phase 1 during Autumn and Winter 2020-2021. The secondary data consists of “Statistical Data” and “Document/Maps/Plans/Programs and Reports”. Secondary data is gathered through both online databases, requested by petition and desk research. The collection of the secondary data started with a petition and a visit to the Ministry of Agriculture and Forestry’s Provincial Directorate in Ankara. The institution responded with the limited data on agricultural statistics of Ankara which exists in the Turkish Statistical Institute (TurkStat) open-access database. From the open-access database of TurkStat, I collected data on socio-economic, socio-demographic, and agricultural production (arable land, productive area, product type, volume etc.). In some cases, data is requested from institutions through informal ways such as finding a contact in relevant institutions.

During this phase, I also conducted desk-based research to acquire information to frame the research context in Ankara and in Turkey. This part of the research covers an internet search for governmental and non-governmental institutional reports, national-level policies, programs, and regulations on agricultural production, local-level programs and projects, agricultural organizations in Ankara, spatial planning and rural planning in Ankara, and a literature review on Ankara and her districts on the topics of agricultural production pattern, practices, and organization.
The outputs of this phase feed the qualitative data collection through in-depth interviews in the field. Overall, this phase enabled the initial exploration of the case study area in terms of landscape characteristics, agricultural production patterns and practices, and planning approaches in the region.

3.6.2 Qualitative Data Collection Process (Phase 1 and 2)

Qualitative data collection has several sub-phases. The knowledge from the previous phase is integrated in the first step for qualitative data collection, design of the field research.

Data collection through field visits to conduct in-depth interviews consists of two phases. In the first phase, a field study is conducted in Summer of 2020, and two follow-up field visits in Summer 2021. The reason behind a year gap in field visits is the impact of Covid 19 outbreak in Spring 2020 and pandemic restrictions covering the Autumn, Winter and Spring periods of 2021. As a result, field visits were held in two consecutive summers to conduct in-depth interviews. Apart from these visits, site observation and several visits to the region were held before and during the data collection process. I took field notes, recordings, and photos throughout the field visits.

In the first phase of the qualitative data collection, I conducted 13 interviews in the region. I took notes and voice records during the interviews and deciphered all interviews from this phase. I categorized the responses among thematic groups under four categories of interview questions in a systematical database in Microsoft Excel. I quantified thematical clusters showing frequencies of current situation of practices in each four dimensions, namely, general profile of agricultural production, production processes, climatic and environmental conditions, and agricultural organization.

The outputs of the first phase were descriptive texts from the interviews and photographs from site observation to understand landscape characteristics,
observations and narratives of change and response patterns. This phase of qualitative data collection facilitated the identification of agricultural production pattern in the region and called the need for requesting more detailed data on agricultural products, different production patterns, organization, and support programs. Besides, this phase led to the exploration of landscape characteristics to request spatial data.

In the second phase of the qualitative data collection, I conducted 19 interviews. I used the same interview questions as the previous phase. After the field research, the recordings from interviews were deciphered and integrated into the same systematical database along with the interviews from the previous phase.

While most interviews were face-to-face, I also used phone and online mediums to conduct interviews between Summer of 2020 and Summer of 2021. I held 5 phone calls and 1 Zoom interview while the rest were face to face. In my experience, face-to-face interviews yielded more in-depth information and more detailed site observation. Therefore, rather than continuing with remote interview techniques, I preferred site visits and face-to-face conversations with respondents. It also supported enlarging the sample group through the snowball technique as respondents interviewed over the phone tended to give less detail or even refuse to interview. For instance, an officer from Beypazarı District Directorate of Agriculture refused an interview over the phone but accepted the interview when I visited the office. The period between the two site visits, I continued the collection of secondary data and prepare an initial analysis for the first phase of qualitative research to guide the second phase and collection of secondary data (statistical and spatial data).

Among all interviews, 3 of them were conducted as joint interviews where I posed the questions to more than one respondent. The conduct of joint interviews was not intended, they happened coincidentally. One focus group interview was conducted in each district. As a result, the nature of joint interviews was different from each other. In one case, I conducted with a family of farmers (G1). In the Beypazarı case, I interviewed the director of a cooperative and an agricultural producer who was
visiting the director. The producer contributed to the conversation without being able to get answers to the general and production profile questions. In Ayaş, the joint interview included the Director of Ayaş Chamber of Agriculture and his guest, the Director of Ayaş District Directorate of Agriculture (DDoA), whom I was planning to conduct an interview with.

Interview locations were diverse. While interviews with institutional representatives are generally conducted in the premises of the institutions (such as District Directorate of Agriculture, Cooperatives and Chamber of Agriculture), interviews with the agricultural producers were conducted in farms, farmers’ markets, and bazaars, and in the offices of Chamber of Agriculture in the districts where farmers frequently visit for several purposes.

The average duration of the interviews is 42 minutes. While the longest interview lasted around 83 minutes, the shortest interview lasted only 3 minutes. I conducted the shortest interview (G13) over phone, and it gave only contextual information. Therefore, I did not integrate this interview into the analysis. Annex C presents the interviewer list and Annex D presents the field diary of the research.

The data and knowledge from the observation and secondary data collection phase supported the development of the interview questions and structure. Design of the interview questions aimed at exploring four dimensions: general information on respondents’ profile and expertise in agricultural production; state, change, impact, and response in the steps of agricultural production; state, change, impact, and response in climatic and environmental conditions. I asked the same questions to individual farmers and organizations to get the answers on the farm and landscape level.

The first section of the interview focused on general information (age, gender, place of residence, household, and income sources) and general information about agricultural production (time in production, type of production, land ownership, land size, labor, product selection, old/new agricultural practices adopted) on the farm level. The interviews with the agricultural institutions and organizations at the
district and landscape level enable access to the information on the local level (village level) and landscape level (district, region) on the above-mentioned dimensions. In addition, organizational interviews enable access to data on the number of producers, agricultural land size, and infrastructure that are triangulated with the quantitative data gathered from institutions.

The second part of the interview focused on gathering in-depth information related with the steps of agricultural production (land preparation, seed selection and sowing, irrigation, input selection, and use, fertilization, harvesting, storage/processing, and marketing) and the changes, problems/impacts experienced as a result of the change, and responses to problems/impacts in each step on the farm level. In addition to the farm level, the interviews with the agricultural organizations allowed an understanding of their agricultural practice on the district level to get a holistic picture of practices and their differences across regions. The questions are systematically asked but also adapted to the flow of the conversation, thus, not always asked in order. Therefore, the answers to the questions are extracted and systematized after deciphering the interviews.

The third part aims to explore the state, change, problems/impacts experienced, and responses of farmers and organizations towards the changing conditions at the intersection of environment, climate, and agricultural production. Particularly, this section focused on understanding the impact of changing climatic and environmental conditions on the dimensions of water, soil, and plants, and farmers’ responses to the impacts on these three dimensions.

The last part of the interview aims to develop an understanding of the current situation and the perception of farmers toward existing agricultural organizations and support mechanisms. This part aims to provide input to future policy and planning processes by aiming to determine the current situation and problems of agricultural organizations in the region. It contributes to understanding and evaluating whether the responses of agricultural producers to the impacts and problems given in the previous sections are included in the organization model. The dimensions that this
part covers are agricultural support mechanisms, collaboration, education, membership status to agricultural organizations, and state programs. Annex A shows the semi-structured interview form that guided the interviews.

3.6.3 Secondary Data Collection Process

Geospatial and Secondary Qualitative Data gathering, and analysis aimed to support the qualitative phase of the research. The purpose is to answer the first research question in a comprehensive manner. This subchapter presents the data collection process and analytical processes on the geospatial and secondary quantitative data. Between two phases of qualitative data gathering, I conducted data collection for secondary quantitative and geospatial data during Autumn 2020 and Spring. Both forms of data were gathered from open-access data sources and from institutions upon request. The statistical data collected in this phase enable preparation of the spatial mapping of certain aspects of the case study productive landscape and Ankara province on population, agricultural production, agricultural land size, socio-economic development.

For institutional requests, I sent petitions to the Ministry of Agriculture and Forestry (MoAF), several directorates of MoAF, the Ankara Provincial Directorate of Agriculture and Forestry, and the Ministry of Environment and Urbanization (MoEU) to gather both geospatial data concerning the natural and spatial setting and secondary statistical data to understand the agricultural production pattern of the case study area.

Institutions and directorates replied separately with different data details. Only MoUE negatively and advised using the data of ATLAS which is an online geographical database of the Ministry. Yet, the data is limited for citizen access and the data is view-only data which does not allow geographic inquiries on GIS. Similarly, MoAF did not share data on hydrology and water resources both in statistical and geospatial format. Therefore, the spatial data and secondary quantitative data that were intended for the analysis within the scope of this research
were limited. This situation restricted spatial analysis in two ways. First, the spatial data is gathered mostly through open-access data which has limited data existence. Secondly, the data gathered did not allow assessment of the changes in ecosystem components within specific time periods. For instance, it was not available to assess hydrological changes or the changes in underground water levels. In addition, the existing data had problems in terms of metadata details, data production periods, responsible organizations, conflicting numbers from different institutions on the same data items. For example, collected geospatial data from national institutions, such as soil and drought maps, the metadata details and methodologies were not accessible. This situation, again, hindered understanding changes in spatial and ecosystem dimensions.

Overall, I collected 90 different data categories including geospatial and secondary quantitative data during the data collection process. I included these different data sets in the triangulation of analysis of the qualitative data the categories of agricultural production patterns and practices, climatic and environmental conditions, and agricultural organization. In addition, I used geospatial and secondary quantitative data to understand the productive landscape’s natural setting and its interrelation with the agricultural production in the region.

Satellite images were utilized to conduct topographical, hydrological, and vegetation maps to understand natural and spatial context in the productive landscape of Northwestern Ankara. Table 9 shows the type, source and description of the geospatial data collected.
The statistical data collected has different temporal scales depending on institutional differences in data collection and renewal periods and units producing data. Therefore, the selection of the time period in this study goes back and forth in the last two decades. While some data covers more recent time periods such as the 2010s, some data goes back to the 1990s. This limited access to the periodical data allowed me to adapt a nested approach that I tried to combine data parts from different sources and time series to present in a meaningful manner to help explore the state-change-impact-response pattern in the socio-ecological productive landscape.

Next subchapters narrate the analytical procedures for the geospatial data and secondary quantitative data.
3.7 Data Analysis Methods/Techniques

This subchapter introduces the different analytical procedures adopted for qualitative, spatial, and secondary qualitative and quantitative data.

3.7.1 Analytical Procedures of Qualitative Data

The present study uses qualitative content analysis to analyze interview transcriptions. By emphasizing the content and underlying themes and meaning that emerge in a text, qualitative content analysis techniques aim to explore and investigate patterns of meaning in the communicative language components in either written or spoken form (Biggs et al., 2021). It aims to draw reproducible and valid inferences about the context by textual and narrative-based content such as documents, interviews, observation notes, and stories, pictures, and sounds (Biggs et al., 2021; Krippendorff, 2019). Through content analysis, the words and phrases which have similar meaning distilled into smaller number of content-based categories (Cavanagh, 1997). Researchers can use qualitative content analysis approaches to uncover certain phenomena and the range of viewpoints that different individuals or groups may have in connection to a certain topic, the variations in meaning assigned to phenomena, and the prevailing opinions that exist in given context (Biggs et al., 2021). In this thesis, I used qualitative content analysis to understand and explore the state, change, impact, and response mechanisms of agricultural producers in a socio-ecological productive landscape.

The analysis of interview data involves identifying patterns, themes, and relationships within the data and interpreting them considering the research questions and objectives. There are multiple approaches and methods to conduct qualitative content analysis. To begin with, there are inductive and deductive approaches in qualitative content analysis. Adoption of one approach over the other depends on the research design. Researchers recommend inductive approach when there is fragmented or limited former knowledge about the phenomena (Kyngäs et al., 2020).
Whereas deductive approach is used when the starting point of the analysis is the previous knowledge with the purpose of theory testing (Elo & Kyngäs, 2008). The present research adopts inductive approach to content analysis as there is limited knowledge on the case study area from the perspective of socio-ecological systems approach and from the perspective of state, change, impact and response mechanisms in the productive landscape.

According to Kyngäs et al. (2020), there are three phases of inductive content analysis: data reduction, data grouping and the formation of concepts support answering research questions.

Data reduction starts with selecting unit of analysis which can be a word, sentence, or a theme relevant with research questions and continues with extracting open codes from the transcribed text through re-reading the text. Codes aim to organize text in a systematic order and coding helps researcher to organize and group similarly coded data that show similarities into categories (Saldaña, 2013). The next step, the researcher groups open codes according to similarities and differences in the content and create sub-themes. The process of grouping sub-themes is a part of data abstraction process and can continue until meaningful themes and main theme developed that is relevant with the research questions.

Despite its wide use in social research methods, qualitative content analysis has criticisms. There are no predetermined rules for inductive content analysis which forms one of the challenges in qualitative content analysis. As a result, the researcher's objectivity, reliability, trustworthiness, and replicability of the research is criticized (Graneheim et al., 2017). For instance, scholars of content analysis have emphasized that the procedure of developing open codes is particularly sensitive since researchers might readily interpret the data subjectively (Kyngas, 2020). There are similar concerns on credibility when applying multiple levels of abstraction and interpretation (Graneheim et al., 2017). To ensure objectivity, the familiarity of the researcher with the text is very crucial and the researcher should read the text multiple times in the process of data reduction and abstraction to avoid
misinterpretation and over abstraction. Additionally, qualitative results, when fed with the quantitative data in a mixed method research, can yield more objective and credible interpretation of the context at focus.

For the present study, the qualitative data collected through semi-structured in-depth interviews creates the base of the content analysis. I conducted qualitative data analysis in several steps. The first step covers data collection and transcription process. I used voice recording during the interviews. After the interviewing phase is over, I transcribed the recordings into text using Microsoft Office Word document. The recordings of the interviews were transcribed into approximately 400 pages long text. The transcription process allowed me to listen to recordings multiple times.

Secondly, I conducted thematical analysis using the transcribed text to identify patterns, themes, and relationships in the data related to the research questions. The transcriptions are categorized naturally under the four dimensions of interview structure. With the initial categories in mind, namely, state, change, impact, and response patterns (subcategories) in production processes, climatic and environmental conditions, and agricultural organization (categories), I transferred transcribed text into Ms Excel for coding and clustering the themes. I started developing initial codes under these four dimensions. However, in order to not lose reoccuring themes throughout the conversation, all categories are reviewed for initial coding. Not changing or misinterpreting the discourses of the respondents is highly important in coding process to ensure the credibility of the research.

Thirdly, after open coding for each category and subcategory, I transferred the codes into Microsoft Office Word document to start clustering codes into themes and subthemes through looking for patterns and connections between the codes. In this way, main themes emerged under four representative categories which are also relevant to the research question. Although the transcriptions were in Turkish, I developed themes and subthemes emerged from the text in English.

Fourthly, I go over the themes and subthemes in each category and subcategory to review and refine the themes to ensure that they are accurate, comprehensive, and
represent the data. Then, I transferred them into Microsoft Excel File to quantify the
data through calculating the frequencies of the themes and subthemes based on the
distribution in Güdül, Beypazarı and Ayaş districts. The quantification of the data
aimed to increase credibility and reliability of the data. Additionally, the themes and
subthemes emerged from the text are triangulated with the secondary qualitative and
quantitative data to increase the reliability of the qualitative analysis.

The final step is to interpret the data and create a narrative based on the themes. This
entails investigating the links between themes and delving into the relevance of the
findings.

### 3.7.2 Analytical Procedures on Geospatial Data

This section focuses on analytical procedures for preparing geospatial data for spatial
analysis, interpretation of the results and establishing interrelations with the
qualitative side of the research. In this case, this subchapter briefly presents
analytical procedures on the digital elevation model, satellite imagery, Corine Land
Use Land Cover data, and spatializing statistical meteorological data. Overall, the
integration of spatial analysis into mixed methods research needs interdisciplinarity.
The analysis I conducted below represents a methodological approach and these
analyses can be deepened with interdisciplinary knowledge. I overviewed the central
steps in preparing and analyzing the geospatial in the subchapters below.

#### 3.7.2.1 Digital Elevation Model (DEM)

Digital raster representation of the terrain of the ground surface is called the Digital
Elevation Model (DEM) (Abrams et al., 2020). I obtained The DEM of the case
study area from ASTER GDEM V3 products which are available on the website of
The ASTER GDEM Version 3 offers digital elevation of the planet through processed images at a spatial resolution of 1 arc second (approximately 30 meter horizontal posting at the equator) which were taken between March 1, 2000, and November 30, 2013 as explained in the Astergtmv3 User Guide 2 (Table 9. Characteristics of the ASTER data products).

Table 9. Characteristics of the ASTER data products (Abrams & Crippen, 2019)

<table>
<thead>
<tr>
<th>Tile Size</th>
<th>3601 x 3601 (1 degree by 1 degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posting interval</td>
<td>1 arc-second (30 m)</td>
</tr>
<tr>
<td>Geographic coordinates</td>
<td>Geographic latitude and longitude</td>
</tr>
<tr>
<td>DEM output format</td>
<td>DEM: GeoTiff, signed 16 bits, and 1m/DN for DEM; NUM: GeoTiff; unsigned 8 bit number of individual scenes used to compile each pixel (maxed at 50); and source of fill for missing ASTER data (see index below)</td>
</tr>
<tr>
<td>Special DN values</td>
<td>-9999 for void pixels and 0 for sea-level water body</td>
</tr>
<tr>
<td>Ellipsoid/Geoid</td>
<td>Referenced to the WGS84/EGM96 geoid</td>
</tr>
<tr>
<td>Coverage</td>
<td>North 83 degrees to south 83 degrees, 22,912 tiles for GDEM</td>
</tr>
</tbody>
</table>

I choose ASTER GDM V3 as it provides the most updated digital land surface model of the Earth which is available to the public. I manually selected the DEM files the most cloud free images that covers the Sakarya River Basin in Turkey. The dataset is composed of 25 tiles and was downloaded on December 12, 2019.

I merged, configured, projected the dataset to datum of WGS84 N36 and exported file as ASCII Grid format. I converted the file to raster image through ArcGIS (10.8.1).

Use of DEM for planning purposes is widespread with the applications for topographical, hydrological, geological and land suitability analysis for land use planning and mitigation planning (Dewan et al., 2007; Vasu et al., 2018). In this

1 https://earthexplorer.usgs.gov/
study, I used DEM for topographical, climatical and hydrological analysis to explore the natural setting of productive landscapes.

### 3.7.2.2 Land Use and Land Cover Data

I used the CORINE land use and land cover data of the European Environment Agency (EEA) to detect spatial changes in the productive landscape. Procedures for land use change using the Corine Land Use Land Cover (LULC) data aim to understand the change in land use land cover spatially and quantitatively in Ankara and the case study region. The source of CORINE land use and landcover data that is used in the analysis is the data of the Ministry of Agriculture and Forestry in a vector format. The analysis follows the procedures below. Firstly, I imported the CORINE LULC data for 1990 and 2018 in the ArcGIS environment. After clipping into the borders of the case study area, I intersected the two vector layers consisting of 1990 and 2018 Corine LULC data into a single layer. This will create a new layer that shows the land use changes between the two time periods. The geometry in the new layer was calculated in the attribute table of the layer file to assess the transformation from one land use category to another. I exported the attribute table to a pivot table in Microsoft Office Excel. The pivot table, which is in matrix format, shows the LULC changes among different land use categories defined in the CORINE project. The analysis chapter will present the evaluation of the analysis in more detail.

### 3.7.2.3 Normalized Difference Vegetation Index (NDVI)

The NDVI assesses the quality of vegetation by determining the amount of chlorophyll in plants. Healthy green regions absorb a lot of visible light, but the leaves reflect a lot of near-infrared light. I used Sentinel 2 satellite imagery for the remote sensing process to calculate vegetation and water indexes for the case study area. I used Sentinel 2 satellite imagery for spatial calculation of the NDVI.
Sentinel 2 is a satellite program launched by European Space Agency (ESA) in 2016. This program is composed of two satellites S2A and S2B that offer satellite imagery that enables Earth observation in terms of oceanic, atmospheric and land monitoring. Sentinel 2 program was preferred among other imagery programs such as Landsat or MODIS (Moderate Resolution Imaging Spectroradiometer) because this program offers images from ground resolution of 10m. Therefore, it offers more precise input data that can be used for classification of land cover, assessment of land cover change and assessment of bio-geophysical parameters such as Leaf Area Index (LAI) and Leaf Chlorophyll Content (LCC) (ESA, 2013). Spatial planning; agro-environmental monitoring; water, forest and vegetation monitoring and crop monitoring are some of thematic fields that satellite data can be used. In line with these fields, there are several indices used for the assessment and monitoring of vegetation, including agriculture. Among all, Normalized Difference Vegetation Index (NDVI) is used for agricultural purposes. The NDVI measures the quality of vegetation through identifying density of chlorophyll in plants. Healthy green areas strongly absorb visible light, while the leaves reflect near-infrared light. NDVI is commonly used vegetation index that is a ratio calculated with the Red and NIR bands:

\[ NDVI = \frac{(NIR - Red)}{(NIR + Red)} \]

In this study, Sentinel 2 imagery is retrieved from the ONDA-DIAS platform\(^3\). To assess NDVI change, images from two different time were downloaded respectively from July 2017 and July 2021. The image of 2017 was selected because it is one of the earliest images since Sentinel 2 started operation in 2016. Sentinel 2 images that offer 10m resolution are preferred for higher precision in calculation. I selected images from summer months when agricultural production is commonly held in the

\(^3\) ONDA- DIAS platform https://www.onda-dias.eu/cms/
case study area. I used two granules from the same time period for July 2017 and July 2021 with the characteristics described in Table 11.

Table 10. Products of Sentinel used in the study

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Creation date</th>
<th>Instrument</th>
<th>Processing level</th>
<th>Product type</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2B_MSIL2A_20210730T083559_N0301_R064_T36TUK_20210730T113227</td>
<td>30/07/2021</td>
<td>MSI Multi-Spectral Instrument</td>
<td>2A</td>
<td>S2MSI2A</td>
</tr>
<tr>
<td>S2B_MSIL2A_20210730T083559_N0301_R064_T36TVK_20210730T113227</td>
<td>30/07/2021</td>
<td>MSI Multi-Spectral Instrument</td>
<td>2A</td>
<td>S2MSI2A</td>
</tr>
<tr>
<td>S2B_MSIL1C_20170731T084009_N0208_R064_T36TUK_20191219T153204</td>
<td>31/07/2017</td>
<td>MSI Multi-Spectral Instrument</td>
<td>1C</td>
<td>S2B_MSIL1C</td>
</tr>
<tr>
<td>S2B_MSIL1C_20170731T084009_N0208_R064_T36TVK_20191219T153204</td>
<td>31/07/2017</td>
<td>MSI Multi-Spectral Instrument</td>
<td>1C</td>
<td>S2B_MSIL1C</td>
</tr>
</tbody>
</table>

Then, I conducted NDVI analysis using ArcGIS software. These bands were used for calculating NDVI using the below equation. The Raster Calculator function was operated under Mab Algebra tool of Spatial Analyst feature in ArcGIS.

\[
NDVI = \frac{\text{Float} \ (\text{Band 8} - \text{Band 4})}{\text{Float} \ (\text{Band 8} + \text{Band 4})}
\]

The float function was added to the equation because the raster images that are used in this operation uses integers as pixel values. The float function allows ArcMap to assign pixel values as floats rather than integers as NDVI value ranges between 1 and -1.

The range of NDVI images determines the density of vegetation. For the purpose of this study, I classified the NDVI image from 2017 by using a range suggested by
(Altun et al., 2020; Zaitunah et al., 2018) to identify the density of vegetation through attaining classes. (See Table 12)

Table 11. NDVI classification for vegetation ranges

<table>
<thead>
<tr>
<th>NDVI classes</th>
<th>Vegetation Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.0</td>
<td>No Vegetation</td>
</tr>
<tr>
<td>0.0–0.3</td>
<td>Sparse Vegetation</td>
</tr>
<tr>
<td>0.3–0.5</td>
<td>Moderate Vegetation</td>
</tr>
<tr>
<td>&gt;0.5</td>
<td>Dense Vegetation</td>
</tr>
</tbody>
</table>

Source: (Altun et al., 2020; Zaitunah et al., 2018, modified by the author)

NDVI change between 2017 and 2021 was calculated again by Mab Algebra tool of Spatial Analyst feature in ArcGIS. This calculation subtracts cell values of two raster NDVI images. After the calculation, output raster image shows subtracted cell values ranging from negative and positive values\(^4\). While negative values show losses, positive values show gain in vegetation cover. Value “0” indicates neither gain nor loss\(^5\). Then, the raster was classified manually into categories to show the extent of change. “Loss”, “No change”, “Gain” are the categories that are used in this study. For this operation, “Reclassify” tool of Spatial Analyst was used. The table below presents the classification for change in NDVI between the images of 2017 and 2021. While negative values represent loss in vegetation, positive values represent gain in vegetation. The category of no change has a range between -0,001 – 0,001, representing minor changes in the vegetation.

Table 12. Classification of NDVI Change between 2017-2021

<table>
<thead>
<tr>
<th>Change in Vegetation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Loss</td>
<td>-1,544553 – 0,001</td>
</tr>
<tr>
<td>(2) No Change</td>
<td>-0,001 – 0,001</td>
</tr>
<tr>
<td>(3) Gain</td>
<td>0,001 – 1,376398</td>
</tr>
</tbody>
</table>

\(^4\) [https://support.esri.com/en/technical-article/000001209](https://support.esri.com/en/technical-article/000001209)

\(^5\) Including deviation between -0,01 and 0,01
The areas corresponding to this re-classified NDVI image were calculated through applying field calculator tool in the attribute table of the image. Spatial distribution number of areas in hectare representing the areas lost and gained in terms of vegetation quality was retrieved as the result of the operation. This operation is calculated by multiplying the count of pixels in each class with 100 sqm as pixel size of Sentinel 2 images is 10 meters to 10 meters.

3.7.2.4 Preparation of Hydrological System Mapping

The initial stage in generating a stream network from a DEM is to collect the requisite data and any extra hydrological data, such as surface water and land cover data. After acquiring the data, it is important to preprocess the DEM data by filling sinks and producing a flow direction process in ArcGIS using hydrological analysis tools.

After preprocessing the DEM, the next step is to construct a flow accumulation grid, which determines the amount of cells that contribute to flow at each grid point. After probable stream sites have been located, it is required to use a tool, such as the Stream Extraction tool in ArcGIS, to extract the stream network from the flow accumulation grid.

After the network of streams has been retrieved, it was further processed to get additional stream order data which ranks the streams from the main rivers to creeks. The Stream Order tool of ArcGIS is utilized. The last part concern integration and evaluation of the stream order data with the other types of data gathered to explore the socio-ecological productive landscape in the Northwestern Ankara.

3.7.2.5 Spatializing Meteorological Data

The General Directorate of Meteorology provided the annual precipitation average data for 3 stations, and those stations’ coordinates were stored in the ArcGIS as points to be used for creating the precipitation and temperature maps of the region covering
Güdül, Beypazarı and Ayaş districts of Ankara. In addition to the points of the meteorological stations, The General Directorate of Meteorology provided the temperature, precipitation monthly days with hail, snowy days, amount of snow water, the height of snow cover, wind direction, maximum temperature and precipitation, minimum temperature and precipitation, average temperature and precipitation rates of the case study area. Apart from mapping the existing temperature and precipitation map, I used these data to triangulate with qualitative data gathered through in-depth interviews and secondary qualitative data.

I used yearly average precipitation and temperature data using the average values between 2005 and 2020 to prepare temperature and precipitation maps using the ArcGIS software and the Inverse Distance Weighted (IDW) interpolation method. Spatial interpolation is the method for estimating the value of attributes at unobserved locations within the observational region (Keskin et al., 2015). After setting the points of the meteorological stations, I created 500 random points in the region to define unobserved locations. I calculated in ArcGIS the precipitation and temperature values by using a very basic calculation using elevation data from DEM.

In order to spatialize the temperature data, I used the Lapse Rate Method which is the rate of decrease or decreases in temperature with respect to height. The basic assumption is that temperature decreases by 1°C with every 200 meters increase in elevation. I calculated the temperature values of each random point by applying this basic formula in the field calculator tool in ArcGIS. After setting the temperature values, I used a spatial analysis tool in ArcGIS, IDW interpolation tool, to prepare map representation of the data. The use of the Lapse Rate Method in a complex landscape patterns and topographical conditions requires more delicate calculation methodology (Tercek et al., 2021), which is limitedly presented in this study.

Similarly, I used the Schreiber Method to calculate the precipitation value for the random points created. Schreiber Method is one of the most preferred formulas for showing the topography-related change of rain (Doğru & Güngöroğlu, 2022). According to the formula, the amount of rain increases by 54 mm depending on the
increase in elevation at every 100 meters. I applied the same procedure as in temperature mapping for the precipitation data. Interpreting the findings of the meteorological study and generating conclusions is the final phase. The outcomes will be integrated to understand high and low temperature and precipitation regions and agricultural production patterns in the region.

3.7.3 Analytical Procedures on Secondary Qualitative and Quantitative Data

Secondary qualitative and quantitative data had different procedures to prepare for analysis and integrate into the overall analysis of the data gathered. Content analysis is utilized for secondary qualitative data including reports, policies, plans, and literature. The output of the analytical procedures of the secondary qualitative data is the collection of relevant policies and regulations, descriptive texts, and literature reviewed on thematic areas.

The quantitative data, including statistical data collected under tables that were used for descriptive statistical explanations. Thematic tables and graphs were prepared using statistical data showing the past and current situation and changing trends in agricultural production, socio-economic and demographic situation. I utilized descriptive statistics and data visualization techniques. In descriptive statistics, essential properties of the acquired data are summarized numerically. The list of data may be seen in Annex B. Data visualization, on the other hand, gives a graphical representation of the data, which can highlight patterns and trends that may be less obvious when examining the raw data alone. I produced spatial maps representing statistical data such as agricultural areas, population distribution, meteorological maps. The combination of these two methodologies allowed me to get a more extensive and nuanced comprehension of the data, so facilitating the formation of well-informed decisions based on their results.
3.8 Ethical Considerations

The study obtained ethical clearance from the relevant institutional review boards. Informed consent will be obtained from all participants before the data collection process. Anonymity and confidentiality ensured throughout the study, and data will be stored securely. The ethical approval of the research is in Annex A.

3.9 Limitations of the Methodology

The procedure of gathering data for my doctoral thesis was not without obstacles. One of the greatest challenges was ensuring that all respondents gave the same quantity and quality of data. When interviewing producers at a bazaar or farmers at their workplaces, when time was restricted and they were more focused on their immediate activities than answering comprehensive questions, this proved especially difficult.

In addition, the collected general profile data was inconsistent since some interviews were difficult to schedule due to institutions' reluctance or time limitations to provide data and perform interviews. As a result of the COVID-19 pandemic, some interviews had to be performed by phone or online. In certain instances, trust difficulties, particularly with government officials, led to the refusal of interview invitations. Face-to-face interviews were scheduled as frequently as feasible given the constraints of COVID-19 and personal funds.

Another difficulty was that Turkish institutions lacked consistent and thorough data management. This made it challenging to gain access to relevant and consistent data at the neighborhood, district, and province levels. In addition, there was a paucity of databases with open access for public geographic databases, as well as contradictions in the same data item from various institutional statistics. In addition, the geographical data collected from public institutions lacked knowledge of how the data was generated and metadata, making it impossible to evaluate the data's accuracy.
Reduced site visits because of the COVID-19 epidemic and personal moves provided further obstacles to data collection. Due to the absence of literature and reporting, access to ecological data and environmental occurrences was restricted. Considering the breadth of the PhD thesis, there was a limited interdisciplinarity.

Despite these obstacles, I was able to collect and evaluate a substantial quantity of data for my PhD dissertation. Although the process was not devoid of obstacles, it provided me with invaluable lessons in patience and flexibility.
Ankara is the capital city of Türkiye. The city is the second-largest city in Turkey by population and the third-largest city by size, located in Central Anatolian Region. The city is located in Upper Sakarya Basin part of the Central Anatolia at 30° 33’ and 40° 47’ latitude at North and 30° 52’ and 34° 06’ longitude at East. The population of Ankara is 5,747,325 as of 2022 and the city spreads to almost 26,000 km² in central Anatolia. The distance of Ankara to other large agglomerations and ports in the country are 453 km to Istanbul, 579 km to Izmir, and 544 km to Antalya.

The city has always been central to many civilizations. The history of the Ankara region dates to the Bronze Age. The Hittite civilization ruled the region during the second millennium BC. Throughout history, the region has been home to several civilizations such as the Phrygian civilization, Lydians, Persians, Macedonians, Galatians, Roman Empire, Byzantine Empire, Seljuk Dynasty, and Ottoman Empire periods. Although there are several different names that were used in history for the region (i.e. Ankyra, Ankuva, Angora), the name Ankara started to be used in 16th century when the Ottoman Empire rule the region. The locals use the name Engürü, as Evliya Çelebi, an Ottoman Traveler, used both names in his traveler records from the 17th Century (Çelebi et al., 2011).

Today the city continues to be in the center of the highway network that connects the city of Ankara to other major and minor cities. The high interconnectedness of the road network to other cities enables easier marketing and transportation of agricultural goods and products from and to other cities. The case study area is located on the D140 (Beypazarı - Nallıhan) road that leads to Bolu and connects to Istanbul. The case study districts, Ayaş, Beypazarı and Güdül, are in the Northwestern part of Ankara. Ayaş lies 55 km away from Ankara center. Beypazarı
lies at the western of Ayaş and is located 100 km away from Ankara. Güdül is 92 km away from Ankara center and located in the Northwestern part of the province. These three districts create a triangle in the Northwest part of Ankara.

The Northwestern Ankara region offers a unique case study for examining socio-ecological productive landscapes due to its characteristics of administrative structure, sociodemographic and socio-economic context, landscape setting, climatic conditions, land use and land cover, patterns of agricultural production and planning context.

The region's administrative geography has undergone significant changes since the Phrygian civilization era to the contemporary Republic of Turkey, primarily due to shifts in trade and transportation networks, urban expansion, and governance approaches. Recent legislative changes, such as laws 5216 and 6360, have transformed rural-urban dynamics, affecting social, economic, and ecological interrelations. The continuation of agricultural and husbandry practices in rural villages although being referred to as urban neighborhoods, exemplifies the unique relationship between administrative structure and agricultural production.

In addition, the districts under study consist of a unique combination of environmental, demographic, and socioeconomic elements. The region is experiencing demographic shifts, with an aging population and a decrease in younger generations due to migration. The region's agricultural sector has been replaced by service sectors and tourism enterprises, resulting in economic changes. Law no. 6360, which redefines villages as neighborhoods, further complicates the interaction between rural and urban areas. In addition, these districts serve as an example of socio-economic inequality, ranking lower on the socio-economic development index (SEGE6) compared to central districts of Ankara.

6 https://www.sanayi.gov.tr/merkez-birimi/694224510b7b/sege/ilce-sege-raporlari
Furthermore, the region exhibits a range of agricultural diversity, encompassing both irrigated and non-irrigated agriculture, as well as a variety of field crops, fruits, and vegetable farming. The region serves as an example of the current trends in agricultural practices, including the transition from conventional agriculture to alternative approaches such as organic and ecological farming. Additionally, the existence of diverse agricultural entities such as cooperatives, unions, chambers, and civil society organizations offers a dynamic social structure for examining the interplay between social and ecological dimensions of the agricultural landscape.

The region exhibits an interplay between urban and rural areas, as well as the history of partially coordinated planning efforts that have notable implications for agriculture and rural development in Ankara province. The case study area covers a comprehensive range of socio-ecological factors, such as immigration patterns, farming methods, tourism prospects, the effects of climate change, and their combinations, which require regional and strategic planning efforts. and highlights the need for comprehensive planning, including an approach to productive rural landscapes. This makes it a relevant paradigm for understanding and enhancing the sustainability and resilience of rural productive landscapes.

4.1.1 Administration

The region of Ankara has served as an administrative center across different historical periods, beginning with the Phrygian civilization at the city of Gordion, situated on the plains of the Sakarya River (formerly known as the Sangarius River). By the 19th century, Ankara had become the administrative center of Ankara County (Ankara Vilayeti), which oversaw the provinces of Ankara, Çorum, Kayseri, Kırşehir, and Yozgat. Ayaş and Beypazarı were established as districts within the Ankara province, which had an administrative division similar to the present day, while Güdül was initially a sub-district of Ayaş in the early 20th century.

Upon the establishment of the Republic of Turkey in 1923, the city of Ankara became the country's capital. Subsequently, the administrative borders of the province and
its districts gradually evolved into their current shape. The district administrative borders of Beypazarı, Ayaş, and Güdül have been modified multiple times since the Republic's establishment, largely influenced by the proximity of certain villages to key trade centers (Doğaner, 2018). In 1957, Güdül became a separate district from Ayaş. Ankara was accorded the status of a metropolitan municipality in 1984, through the enactment of Law no 3030 titled "The Administration of Metropolitan Municipalities". Consequently, Ankara was among the first metropolitan areas in Turkey, with the Metropolitan Municipality boundary encompassing the five central districts of Ankara, specifically Altındağ, Çankaya, Yenimahalle, Mamak, and Keçiören.

The scope of the Ankara Metropolitan Municipality's administrative responsibility underwent significant changes following alterations in the metropolitan municipality system, particularly after the 2000s. Enacted in 2004, Law no. 5216, known as "The Law on Metropolitan Municipalities," designated the service area boundary of the Ankara Metropolitan Municipality as a 50 km radius from the city's central Altındağ district. This law incorporated 18 districts into the metropolitan municipality area, partially including districts such as Kalecik, Çubuk, Kızılcahamam, Ayaş, Polatlı, Haymana, and Bâlâ. Owing to its proximity to Ankara center, the Ayaş district partially became part of the Ankara Metropolitan Area, whereas Beypazarı and Güdül remained outside the metropolitan borders. The jurisdiction of the Ankara Metropolitan Municipality extended to provincial boundaries, covering all 25 districts of Ankara, following the adoption of Law No. 6360 in 2012.

This law no. 6360 transformed 672 villages into neighborhoods in Ankara, thereby increasing the number of neighborhoods from 802 to 1433. The number of district municipalities reduced from 45 to 25. Overall, the law diminished the number of local government bodies, causing rural areas to lose their representative and administrative power, previously centered on district municipalities, to the metropolitan municipality. The law has changed the administrative structure of the districts as a tier of local government, town municipalities, were closed and their representative power were transferred to the district municipalities. Before the law,
Güdül (Çağ'a, Sorgun, Yeşilöz town municipalities) and Beypazarı (Uruş, Kırbaşi ve Karaşar town municipalities) had three town municipalities in addition to the district municipality these districts had. Ayaş had one district and one town municipality. Compared to the other rural districts of Ankara such as Evren, Çamlıdere and Polatlı that had one municipality, the districts in the case study region were more powerful with the number of town municipalities in representing the rural parts of the districts. In this case, the law served as a tool for centralization rather than increasing participation and extending municipal services as the law originally suggested. The shift towards centralization also resulted in the closure of Special Provincial Administration (SPAs) operating outside of metropolitan municipality borders, centralizing governance mechanisms within metropolitan municipalities. These changes in administrative structure are intricately tied to the region's planning practices.

Table 13. The number of villages, neighborhoods, and municipalities in the case study area and in Ankara before and after law no. 6360.

<table>
<thead>
<tr>
<th>District</th>
<th>Before the Law no. 6360</th>
<th>After the Law no. 6360</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># villages</td>
<td># neighborhoods</td>
</tr>
<tr>
<td>Ayaş</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Beypazarı</td>
<td>64</td>
<td>19</td>
</tr>
<tr>
<td>Güdül</td>
<td>23</td>
<td>12</td>
</tr>
<tr>
<td>Ankara</td>
<td>672</td>
<td>802</td>
</tr>
</tbody>
</table>

Source: TurkStat, 2022

In the study area, there are now three municipalities located in the district centers of Beypazarı, Güdül, and Ayaş, compared to the 10 municipalities that previously existed based on towns. This shift highlights the decrease in local representation and the centralization of decision-making within the region. Furthermore, towns that once functioned as district centers have been converted into neighborhoods, blurring the distinction between rural villages and urbanized neighborhoods. Prior to the law, all three districts had villages. A total of 100 villages in the region were transformed
into neighborhoods. For instance, in Beypazarı case, the number of villages was higher than the number of neighborhoods located in the district center of Beypazarı (Table 14). Both laws (5216 and 6360) resulted in the gradual transformation of rural villages into urban neighborhoods.

Currently, all three districts (Ayaş with 33 neighborhoods, Beypazarı with 78, and Güdül with 31) are under the jurisdiction of the Ankara Metropolitan Municipality and maintain their respective district municipalities. These neighborhoods, whether situated in the district center or the rural parts of the districts, carry the same legal status as those in central Ankara. The preceding chapter, discussing the context of agricultural production in Turkey, explains the binding conditions of neighborhood status with the continuation of agriculture and husbandry in rural areas. Notwithstanding Law No. 6360, agricultural production and husbandry persist in rural neighborhoods.

Figure 4.1. Map of neighborhoods in the study area

Although district and metropolitan municipalities constitute the local administrative tier, there is no regional administrative tier in Turkey. Geographically, Ankara is
located within the Central Anatolian Region, one of Turkey's seven regions. However, these regions do not represent an administrative structure. Turkey adopted a three-level Nomenclature of Territorial Units for Statistics (NUTS) region as part of the EU accession process. Under the NUTS regional division, Ankara is part of the Western Anatolian NUTS 1 region and simultaneously functions as both a NUTS 2 and 3 region. The Ankara Regional Development Agency (RDA) was established for the TR 51 region, which covers Ankara province. Although the Ankara RDA prepares regional development plans, it does not serve as a regional administrative tier between central and local governments, functioning instead as a semi-public body coordinating efforts at both levels.

4.1.2 Socio-demographic context

The city grew from a rural town to a metropolitan area in a century after being the capital city. The population of Ankara province including Ayaş, Bala, Beypazarı, Haymana, Kalecik, Nallıhan and Yabanabad (Kızılcahamam region in current state) was 84,665 in the Ottoman census on 1914 (Karpat, 1985). The population of Ayaş and Beypazarı was both around 24,000 in this census. When the city became the capital, the population of Ankara province with new borders including the center and districts (Ayaş, Beypazarı, Bâlâ, Polatlı, Çubuk-âbâd, Haymana, Kalecik, Keskin, Nallıhan and Yabanabad) was 404,726 according to the 1927 Census data (İUM, 1927). After becoming the capital city and developments in the industrial sector in the city, Ankara started receiving migration from cities from Anatolia. The population of Ankara increased rapidly. In the period of 1927-1975, the population of Ankara increased approximately 6 times reaching 2,585,293.

Table 14. Change of Rural, Urban and Provincial Population in Ankara between 1985 and 2021
The population increase was not even considering rural and urban population. Table xxx shows the change of rural and urban population in Ankara between 1985 and 2021. According to the data, the rural population of Ankara decreased from 569,118 in 1985 to 123,406 in 2012. After the enactment of Law no. 6360 in 2012, the rural population decreased to 0 (zero) as villages started to be considered neighborhoods. Although the small settlements in Ankara province are not considered as villages, agricultural production continues to be the main livelihood activity. Between 2012 and 2021, the overall population of Ankara increased by almost one million. In addition, migration continues from outer districts to central districts of Ankara.

Source: TurkStat, 2022
Currently, the population of Ankara is 5,782,285 in 2022 (TurkStat, 2022). The population density of the province is distributed to the central districts of Ankara as 90% of the whole population is concentrated in 10 central districts of Ankara (TurkStat, 2022). The population living in Ayaş, Beypazarı and Güdül districts constitutes 1.20% of the entire population of Ankara. During the period between 2007 and 2020, the population of Ayaş increased almost by 7%, Beypazarı increased by 5% and Güdül decreased by 19%. Overall, this means a 2% increase of population in the region. This means that while Ayaş and Beypazarı have slight increase in population, Güdül experiences exodus of population, especially at young age.
The population change of Ayaş, Beypazarı ve Güdül districts between 2007 and 2020 shows important results regarding the socio-demographic structure of the region. Overall, the population under age 45 had a decreasing trend between 2007 and 2020. Specifically, the population change in the age group of 0-14 shows that the child population decreased drastically in the region between 2007 and 2020. In Güdül, the population among this age group decreased by 55% in the given period. The population in this age group decreased by 34% in Ayaş and 5% in Beypazarı.

Similarly, the population between the age of 15 and 29 decreased in both districts. While the population between the age of 30 and 44 slightly (3.5%) decreased in Ayaş and increased 4% in Beypazarı, this age group has decreased by 42% in Güdül. The age group older than age 45 has an increasing trend in all districts. Overall, figures show the decrease in the young population in the region and the dominance of the aging population. The results of the field study also confirm this, which will be presented extensively. But just to highlight this statistical trend, this section shares some interviewees’ statements on the population’s backwards migration. The population who migrated from the village to the city in the past and who are now retired tend to return to their villages because previous migrants saved their lands in these villages.

Table 15. The change of population among age groups between 2007 and 2020
<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>age group/district</td>
<td>Ayas</td>
<td>Beypazarı</td>
</tr>
<tr>
<td>0-14</td>
<td>1813</td>
<td>6692</td>
</tr>
<tr>
<td>15-29</td>
<td>2955</td>
<td>10807</td>
</tr>
<tr>
<td>30-44</td>
<td>2734</td>
<td>10389</td>
</tr>
<tr>
<td>45-59</td>
<td>2389</td>
<td>8603</td>
</tr>
<tr>
<td>60-74</td>
<td>1573</td>
<td>4727</td>
</tr>
<tr>
<td>75+</td>
<td>740</td>
<td>2156</td>
</tr>
<tr>
<td>Total</td>
<td>12204</td>
<td>43374</td>
</tr>
</tbody>
</table>

Source: TurkStat, 2022

Additionally, it is crucial to evaluate socio-demographic and socio-economic situations together. This means that the ratio of the young population decreased and was replaced by the elderly population. In the interviews held in the field, the points supporting this situation were mentioned. The following quote can be considered as an example: “Young people do not prefer jobs in agriculture. Women do not prefer men who work in agriculture. They want to find a job with minimum wage by immigrating to Ankara and other cities apart from Güdül.” (G11)

4.1.3 Socio-economic Context

The sectoral distribution of GDP in Ankara between 1990-2000 shows that the share of the agricultural sector was 5.30% in 1990 and decreased to 4.70% in 2000 (ABB, 2006). Recent data shows that the share of agriculture (including forestry and fishing) decreased to 1.8% in 2020. This picture shows the decreasing impact of the agricultural sector on the economy of the city. Whereas services and manufacturing have the largest share of GDP with 17%, as illustrated in Figure 4.4.

In terms of employment size, Ankara accounts for almost 7% of Turkey's population by 2020 (TurkStat, 2022). Previous studies show that the employment rate in the agricultural sector in Ankara was 27.6% in 1980. This rate decreased to 16.2% in
2000. This ratio increased from 58.5% to 70.4% in the services sector between 1980 and 2000, indicating that the services sector gained dominance (ABB, 2006).

![Figure 4.4. Share of Sectors in Gross Domestic Product (Based on 2009) in Ankara by 2020](image)

The Ankara Regional Plan, prepared in 2012, shows that the 72% of total employment in Ankara is distributed in the services sector. Industry followed this rate by 23%, followed by agriculture with 5% shares (Ankara Regional Development Agency, 2015). There is no accessible data or resource on the current state of the distribution of employment among sectors in Ankara.

Another dimension of the status of agriculture in Ankara is exports. While the industry sector has the highest percentage of Turkey’s exports with 81.67%, the share of exports by the agricultural sector is 15.59%, and the mining sector is 2.73%. Ankara ranks as the sixth city (Ankara Regional Development Agency, 2015).
In terms of the economic structure of the districts of Ayaş, Beypazarı and Güdül, agricultural production is the dominant economic sector. Additionally, there is growing attention toward diversified tourism opportunities in Ankara, centralizing particularly around Beypazarı and Güdül. Beypazarı Historical City was temporarily listed on the UNESCO World Heritage List in 2020. Güdül became a CittaSslow city again in 2020. Research shows that historical tourism, ecotourism, rural tourism, and natural tourism initiatives have been growing in the province, and the case study area conveys many historical and ecological assets to be considered for tourism development.

Recently, the Directorate of Development Agencies of the Ministry of Industry and Technology conducted research on the socio-economic development situation of the districts in Turkey\(^1\). According to this study, the socioeconomic development index scores of 973 districts in the country were produced, and the districts were ranked according to six basic development levels, ranking from 1 (the highest) to 6 (the lowest) (Acar et al., 2022). According to the results, Çankaya district of Ankara ranks 2nd in the whole country, while the Bala district ranks 725th in the list. This shows that Ankara does not have a balanced socio-economic development among its districts. According to the list, Beypazarı district in the study area ranks 264th, Ayaş 330th, and Güdül 630th. Güdül district lags behind compared to many districts in Turkey and in Ankara. While Beypazarı and Ayaş are in the 3rd development level, Güdül is in the 4th development level.
4.1.4 Landscape Setting

Ankara province is in the northwest of the Central Anatolian Region, at 39° 55' north latitude and 32° 50' east longitude. Kırşehir and Kırıkkale are in the east of Ankara, Eskişehir is in the west; and Çankırı in the north. Konya Province is located in the southern part of the province. The average altitude of Ankara is 890 m above sea level. While the northern parts of the province have the physical characteristics of northern Anatolian mountainous and forested regions, the arid regions of Central Anatolia surround the southern parts of the province. In the northern parts, Köroğlu Mountains separate northern and central Anatolia and form the natural borders of the study area in the north.

The administrative borders of Ankara province are located within the borders of Sakarya Basin with 70.6%, Kızılırmak Basin with 20.8%, Konya Closed Basin with a ratio of 8.4%, and West Black Sea Basin with 0.2% (Kale, 2020). While the western
part of the province and central Ankara are in the Sakarya basin, the eastern part is located in the Kızılırmak basin. Eskişehir and Ankara share the provincial border on the Sakarya River, and Saryar Dam is in the northern region of the Sakarya basin. The main tributaries of the Sakarya River are Aladağ Creek, Nalderesi Creek, Kirmir Creek, and Ankara Creek. Kirmir Creek is 116.7 km long, and 101.6 km of the creek is within provincial borders (MoEUCC, 2022). The productive landscape in the Kirmir Creek basin forms the case study area of the present study. Figure 4.6 shows the location of Ankara and the case study area in the Sakarya basin.

Figure 4.6. The location of Ankara and the case study area in the natural setting of Sakarya Basin

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The Kirmir Creek catchment's location was a significant factor in the choice of the case study site for this research, demonstrating the significance of catchment geography in contrast to administrative boundaries. The landscape it maintains is highly productive and serves as the main focus of the study. Rather than being based on arbitrary administrative boundaries, the intersection of natural hydrology and human activity within the Sakarya basin has shaped the analytical scope of this research.

Other water resources in Ankara are manmade structures covering dam lakes for drinking water, agricultural irrigation, and dams built for hydroelectric power plants, such as Sarıyar Dam on the border of the case study area. Dams for drinking water were established mostly in the northern parts of the province, in hilly areas that are rich with creeks and streams. In addition to these, there are Asartepe, Çanıllı, and Doğanözü ponds for agricultural irrigation purposes within the provincial borders, located in the case study area of the present study. Apart from surface water resources, underground water resources also exist and are used for agricultural purposes.

Water resources not only include surface water bodies but also underground water resources. As of 2021, the underground water potential in Ankara province is 286.2 hm³/year, with 16 sub-watersheds contributing to this total. Among these, Kirmir sub-watershed has the fourth highest underground water potential (23.5 hm³/year), trailing Polatlı İliça (72 hm³/year), Ankara Stream (Hatip) (40.5 hm³/year), and Salt Lake Peçeneközü (33 hm³/year) (MoEUCC, 2022a). Approximately 75% of the dynamic potential of the underground water exists in the northwest of the Ankara province, with other productive areas along the western axis (Kale, 2020).

There are several plains located across the province’s borders. In 2016, the major plains of Ankara, namely, Çubuk, Haymana, Polatlı, Sarayköy, Sarıyar, İlhanköy, Şereflikoçhisar Plains, were announced as Large Basin Protection Areas. Among these plains, Sarıyar and İlhanköy plains on Kirmir Creek and its tributary İlhan Creek are in the case study area.
The climatic and geographical factors have resulted in forming two distinct plant groups, namely steppe, and forest, in Ankara and its surrounding regions. The region's steppe vegetation is present on plateaus and in places with limited rainfall. The vegetation in the steppe includes bushes and herbaceous plants. Along the riverbeds, the steppe vegetation includes trees such as oleasters and willows. From south to north, the steppe formation leaves ground for forests as the mountainous areas begin and the rainfall increases. This is the transition area between the Black Sea and Central Anatolia regions, and the vegetation of the region is coniferous.

The biodiversity studies of Ankara show that there are 2770 taxon in the province. Among all, while 14.5% are endemic, 85% are non-endemic. Endemic taxa mainly consist of plants and inland-water fishes. According to IUCN criteria, 129 taxa are in danger of extinction. By 2020, Ayaş (Aysanti Hill) and Beypazarı (Kirmir Creek) were announced as the main biodiversity monitoring areas in Ankara. Additionally, the study indicates the importance of taxon according to their economic value. The results show that plant taxon have high economic relevance in terms of herbal medicine, food, and pasture or meadow plants. This fact shows the case study has

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high importance for the protection of biodiversity in Ankara within the nexus of plant production, economic returns, and protection measures.

The transition from steppe to forest vegetation is the most visible in the case study region in Ankara province. Agricultural areas spread across steppe lands and river basins, especially in the southern parts of the case study area, while the northern landscape is a mixture of transition vegetation towards denser forests and more hilly lands that only enable agriculture in river basins. Northern plateaus are used for husbandry when the land is not capable of agriculture. This transition also led to a difference in climatic conditions between the northern and southern parts of the province, as in the case study area.

4.1.5 Climates Conditions

Different climate types meet in Ankara. While the continental climate of Central Anatolia is observed from the southern and central parts of the province, the temperate and rainy characteristics of the Black Sea climate are observed in districts such as Kızılcahamam, Güdül, and Çamlıdere towards the northern parts. The characteristics of the continental climate are cold and snowy winters and hot and dry summers. The average temperature for 2020 is 14.1 °C, and the annual average precipitation is 381.3 mm. The hottest month is July-August, and the coldest month is January. The most precipitation falls in June, the least in July, August, and September. In regions where the continental climate is dominant, there are significant temperature differences between night and day, summer, and winter seasons. The mean temperature recorded during the period from 2005 to 2020 was 12.3°C, whereas the average annual precipitation corresponded to 397.0 mm.

The 2021 data of the Turkish Statistical Institute shows that the average temperatures fluctuated between about 12° and 14° between 2005 and 2020. Figure 4.9 shows the change in temperature and precipitation in Ankara between the time periods given.
According to the data obtained from General Directorate of Meteorology, the year exhibiting the highest recorded temperature was 2010, registering at 14.6°C, while the year experiencing the lowest recorded temperature was 2006, measuring at 12°C. In terms of precipitation, the year 2010 recorded the highest amount with a total of 540 mm, while the year 2007 observed the lowest amount with a total of 216 mm.
Figure 4.9. Temperature and precipitation values of Ankara between 2005 and 2020

However, climatic parameters might vary from year to year and for longer periods (decades) due to natural reasons, and shorter time intervals might not represent the actual state of the change in climatic conditions.

As a result, studies with a longer time interval can help understand the changing climatic conditions. The recent studies conducted under the local climate change action plan for Ankara show the longer-term temperature and precipitation pattern of the province between 1975 and 2020. According to the study, the monthly average temperature values show warming as of 1995, and the temperature anomaly values as of 2000 are above 2°C (AMM, 2022). Such an increase in temperature could have negative impacts not only on agricultural production but also on the broader ecosystem. The evaluation of the impacts of the increasing temperature on the productive landscape of the case study area will be in the next chapters.

Figure 4.10. Temperature Anomaly in Ankara between 1975 and 2020 (AMM, 2022)

In terms of precipitation, the long terms analysis shows that the rainiest years are 1983, 2001 and 2015. The driest years are 1992, 2001, 2006, 2013, and 2015. Yet, there is no significant trend detected for annual total precipitation (AMM, 2022).
The climatic conditions of the case study area are under the continental climate and Black Sea climate, which are observed together in the study area, similar to Ankara. While Southern Beypazarı and Ayaş districts show more continental climate characteristics, Güdül and Northern Beypazarı show precipitation and temperature characteristics like the Black Sea climate. Due to the topographical and geological characteristics of the study area, the Güdül-Kızılcahamam direction of the Kirmir Valley exhibits microclimatic features. In this way, it provides a suitable environment for the growth of plants such as olives, artichokes, and pistachios, which are not unique to the Central Anatolian climate. Chapter xxx will give a more detailed analysis of the change in climatic conditions in the case study area and the responses in the landscape.

4.1.6 Land Use Land Cover and Settlement Structure

As mentioned, Ankara has transformed from a medium-sized town into a metropolitan capital with a population of close to 6 million in a century. Rapid urbanization accompanied population growth and the expansion of the built
environment over the surrounding rural landscape. CORINE land cover data show that the city doubled its built-up area between 1990 and 2018. Figure 4.15 represents the landcover change in Ankara province in the mentioned time period.

Ankara province is the second largest city in Turkey after Konya in terms of the agricultural areas it covers. Corine Land Use Land Cover Data of 2018, which is the most up-to-date land use data available in Turkey, shows that the dominant land use in Ankara province is agricultural areas, including arable lands, permanent crops, pastures, and heterogeneous agricultural areas.

Figure 4.12. Simplified Corine Land Cover of Ankara Province for 1990 and 2018
Agricultural areas cover almost 55.5% of the whole province, and this rate has decreased by 3% between 1990 and 2018. Considering the distribution of agricultural areas among districts of Ankara, the southern districts have more arable land compared to the districts on the northern and west-east axis of Ankara.

Forests and seminatural areas have the second largest coverage with 36%. The total forest areas in the province are 452,548.3 ha as of the end of 2021, and the ratio of forest areas to the provincial surface area is approximately 18% (MoEUCC, 2022b). Sparsely vegetated areas and natural meadows are the most widespread land cover types.
Although the areas covered by the natural areas in Ankara are high, the number of protected natural areas are limited. There are protected areas with different statuses. The land, water and sea areas that are declared by the Council of Ministers are called "Special Environmental Protection Area (SEPA)". Among 19 SEPAs across the country, the southern parts of the Ankara province home to two SEPAs, namely Gölbaşı and Tuzgölü. Additionally, there are natural sites with different degrees. According to the data General Directorate of Protection of Natural Assets, 86,032,59 hectares have protection area status. Among all, 1st degree Natural Protected areas cover almost 79%. Qualified natural reserve areas follow with 9% and Sustainable Conservation and Controlled Use Area follows with 6%. While 1st degree-protected areas are mostly centered around the central districts of Ankara, there are Strictly Protected Sensitive Areas, Qualified Nature Reserve, Sustainable Conservation and Controlled Use Areas within the case study area. Parts of Kirmir Creek valley towards Güdül announced as Protected Sensitive Area and Qualified Nature Reserve. Additionally, Inozü Valley in the upper parts of central Beypazarı is Qualified Nature Reserve area. The surrounding region of Sorgun Plateau including Pond and Natural Park has the status of both Strictly Protected Sensitive

Figure 4.14. 1990-2018 Simplified Land Use Change in Ankara Province

http://says.csb.gov.tr/istatistik
Areas, Qualified Nature Reserve, Sustainable Conservation and Controlled Use Areas.

Additional to natural protection areas, that are highly interrelated with rural productive landscapes, some important plains of Turkey announced as Large Basin Protected Areas. Between 2017 and 2022, 440 regions in 72 provinces were declared "Large Plains Protected Areas". In Ankara, there are 11 plain protection areas distributed across the province. Among all, Sariyar Plain and İlhanköy Plain are in the case study area.

Figure 4.15. Types of Protected Areas in Ankara

The study of Doğa Derneği \(^9\) presents a different natural site categorization through defining Key Biodiversity Areas. According to the study, there are several key

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\(^9\) https://www.dogadernegi.org/onemli-doga-alanlari/
biodiversity areas fall into the case study area, which includes Kîrmir River, Ayaş Hills, Köroğlu Mountains, Sarıyar Dam area.

Artificial land uses, including urban-related land uses, almost cover 4% of the whole province. Water bodies experienced a slight decrease between 1990 and 2018. Although the rate is lower than the coverage of natural and agricultural areas, the impact of human activities in this urban concentrated area that tends to expand over natural and agricultural areas is far larger. Concerning the expansion of Ankara center, the study of Sezgin & Varol (2012) shows that the central agglomeration of Ankara has been expanding over fertile agricultural lands in the west, southwest and south directions for low-density housing developments since 1990. In the south, this expansion especially threatens the Gölbaşı Special Protection Area. This situation opens the question of the role of planning in protecting agricultural and natural areas in rapidly growing metropolitan areas. Extension of this discussion to the role of planning in managing productive landscape where ecological, social, spatial and productive systems are embedded is also crucial and one of the central topics of this present study. The following parts of this chapter will explain the planning processes concerning rural and agricultural areas in Ankara.

Accessibility and topography are important when explaining the trend of urban expansion in Ankara. Central Ankara is located on the Hatip Creek Plain (that connects with Çubuk Creek and forms Ankara Creek (a major branch of Sakarya River) and on a lower elevation region geographically surrounded by hills. This geographical formation allows expansion to the south-western axis of the city. Whereas northwestern region, where the case study area is located, is separated by a series of hills (Ayaş and Kazan Hills) that does not allow the expansion of central Ankara towards this axis. Such topographical thresholds also allowed the protection of the landscape in the case study area.
4.1.7 Agricultural Production

Ankara's agricultural character has altered through time, shifting from a primarily grain-dominated terrain to a broad palette of field crops, fruits, and vegetables. This research investigates the region’s agricultural history, current production patterns, the prevalence of various farming practices, and the dynamics of pesticide and fertilizer use. It also discusses socioeconomic issues, such as trends in farmer registrations and the role of agricultural cooperatives, unions, and rising community initiatives.

The Ankara region was rich in terms of agricultural areas that enabled grain production accompanied by vegetables and fruits. Agricultural production, husbandry, weaving, and trade were the most prominent economic sectors in the history of Ankara. Yet, there was limited development of agricultural production due to limited accessibility to agricultural fields until the 19th Century (Tekemen Altındaş, 2021). The Mohair, a fabric from the wool of Angora goat, had been one of the income generators of the region especially until the Silk Road lost prominence and railway systems expand during the 19th century. The introduction of the railway in the region led to an increase in the export of grains due to enabling irrigation and transfer of goods (Tekemen Altındaş, 2021), which resulted in an increase in grain production from 216,000 tons to 405,000 tons between 1892 and 1896. This increase is relevant considering the introduction of modern machinery for agriculture also started during the 19th century. In the 20th century, the increased accessibility in the region and the development of modern techniques in agriculture has resulted in an increase in agricultural productivity. The records from the late 19th century show that grain was produced in 80% of all cultivated areas. Additional to grains, rice, and fruits were other dominant export products of the city.

The current agricultural production structure of Ankara shows that non-irrigated agriculture is dominant in all districts, especially in the southern districts. In the northern districts of Ankara, irrigated agriculture, and fruit/vine-growing are
common in addition to non-irrigated agriculture. The climatic conditions and the presence of water play a role in this diversity of agricultural products.

The product pattern of Ankara has the following main categories: Field crops, vegetables, and fruits. Overall, field crops have almost the total share with 93% among all planted areas in Ankara. Whereas vegetables and fruits have the shares of 4% and 3% respectively. While Ankara has a production area for field crops above the Turkey level, vegetable production has a similar share. Only fruits have a lower share than Turkey. In terms of the amount of production, field crops have the share of 62.5%, vegetable 34.5% and fruits 2.5% of all production. Ankara produces almost 5% of all vegetables produced in Turkey but 2% of field crops (TurkStat, 2021).

Figure 4.16. The share of the planted agricultural area according to product types in Ankara and Turkey in 2021

In terms of field crops, the most dominant types are wheat, barley, sugar beet, oat, and chickpea in Ankara, similar to the Anatolian geography. Although this product pattern is widespread in all districts of Ankara, specifically southern districts such as Polatlı, Şereflikoçhisar produces larger amounts than other districts. Ankara produces almost 17% of all chickpeas and 3.5% of all wheat produced in Turkey in 2021 (TurkStat, 2021). Vegetable production in Ankara holds a critical position in Turkey. Ankara produces almost 33% of onions, 26% of carrots and 14% lettuce produced in Turkey in 2021. In vegetable and fruit production, the northern districts are more dominant. Especially, Beypazarı produces the largest amount of carrot and
lettuce in Ankara. Beypazarı is the second in Turkey in spinach and radish production and the first in Turkey in lettuce production by 2019.

According to the data received from the Ankara Provincial Directorate of Agriculture, there are 46,339 registered farmers in Ankara by 2020. Although fluctuating in the last 19 years, the number of producers in Ankara has been constantly decreasing since 2007, when the highest rate was observed in the last 20 years. Nearly 10,000 farmers stopped registering to Farmers Registry System between 2007 and 2020. The case study districts, Ayaş, Beypazarı, and Güdül experiences the same situation proportionally since 2007.

Table 16. Largest number of products and amounts produced in Ankara according to districts in 2019

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Product</th>
<th>Amount/ton</th>
<th>The Largest Producer District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td>Onion</td>
<td>402677</td>
<td>Polatlı</td>
</tr>
<tr>
<td></td>
<td>Carrot</td>
<td>144000</td>
<td>Beypazarı</td>
</tr>
<tr>
<td></td>
<td>Lettuce</td>
<td>64475</td>
<td>Beypazarı</td>
</tr>
<tr>
<td>Fruits</td>
<td>Grape</td>
<td>10834</td>
<td>Kalecik</td>
</tr>
<tr>
<td></td>
<td>Sour Cherry</td>
<td>6711</td>
<td>Çubuk</td>
</tr>
<tr>
<td></td>
<td>Apple</td>
<td>3958</td>
<td>K.Kazan</td>
</tr>
<tr>
<td>Crops</td>
<td>Wheat</td>
<td>275180</td>
<td>Polatlı</td>
</tr>
<tr>
<td></td>
<td>Barley</td>
<td>120761</td>
<td>Polatlı</td>
</tr>
<tr>
<td></td>
<td>Chickpea</td>
<td>17837</td>
<td>Şereflikoçhisar</td>
</tr>
</tbody>
</table>

According to the data from Social Security Institution, the number of people with active agricultural security registration is approximately 13,000 (the average value of 12 months) in 2020\textsuperscript{10} (SGK, 2022). This number decreased almost by 40% between 2010 and 2020. The percentage of decrease is %51 in Turkey in the same period (SGK, 2022).

\textsuperscript{10} https://veri.sgk.gov.tr

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The registered farmers and agricultural security data show different numbers. While Farmers Registry System (FRS) records are higher than social security registration which can be the result of support received from FRS. In addition, this also might mean that almost 33,000 farmers in Ankara do not have social security registration from agricultural practice.

The pesticide usage in Ankara decreased from 209,500 kg in 2015 to 181,908 kg in 2019. The data was limited within the period between 2015 and 2019. Unlike pesticides, fertilizer use increased in Ankara by 62% with fluctuations between 2002 and 2019.

Although conventional agricultural practice is dominant in the region, alternative methods including organic farming, good farming practices and ecological farming are emerging in Ankara province. Between 2012 and 2013, there is a sharp increase as the number of organic farmers increased from 71 to 105 in a single year. The number gradually decreased to 50 farmers by 2019. The area allocated to organic farming is 33250 decare. According to 2019 data from MoEUCC\textsuperscript{11}, the area of

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure417.png}
\caption{Number of people with active agricultural insurance in Ankara between 2010 and 2020}
\end{figure}

\textsuperscript{11} https://cevreselgostergeler.csb.gov.tr/organik-tarim-alanlari-ve-uretim-miktarlari-i-85837#--:text=T%C3%BCrkiye%2Cde%20toplam%20tar%C4%B1m%20alan%2Corganik%20tar%C4%B1m%20yap%C4%B1m%20maksat%C4%B1%5Bi%5D.
organic farming within the total agricultural area in Turkey has a share of 2.2%. The case study districts show a similar pattern of change during the same period. The case of good farming is different from organic farming. According to the data from the Ministry of Agriculture and Forestry (MoAF), General Directorate of Plant Production (GDoPP), while there were 10 farmers adopting good farming practices in Ankara in 2012, this number sharply increased to 400 in 2016. By 2019, this number increased by %50, reaching 612 farmers. Between 2012 and 2019, the area dedicated to good farming increased sharply from 1800 decare to 81175 decare. The data from Provincial Directorate of Agriculture (which is a local level presents a different dataset which is not contradictory but not similar to the dataset from the above given data set of the Directorate of Plant Production on the number of farmers and area dedicated to good and organic farming. The differences in the dataset of different directorates of the same ministry might point to the problem of monitoring and data integration of agricultural statistics. However, having reliable data can be considered the first step, which is assessment of the current situation towards planning for sustainability of the socio-ecological productive landscape.

Figure 4.18. The number of producers adopted organic farming and good farming practices in Ankara between 2012 and 2019

The data obtained from GDoPP presents support to good farming practices at Turkey level. The support to good farming has experienced transformation in supporting
scheme third times between 2007 and 2018. While good farming practices started in 2007, there were no support given based on size of the area. In 2008, the unit price of support was determined as 18 TL per decare. In 2009, the support scheme diversified in terms of the plant type cultivated on the land. This has led to differentiation of vegetable and fruit production, greenhouse agriculture and cultivation of medical herbs. By 2017, individual and group certificated production was differentiated in terms of support and rice cultivation was integrated to the support scheme.

Another important finding from the data on good farming practices, the data shows that from 2013 onwards, the unit price support given to both vegetables and fruits (50 TL/da), greenhouse farming (150 TL/da) and cultivation of medical herbs (100 TL/da) became stagnated and did not experience change between 2014 and 2018. The data is limited between a certain period of 2007 and 2018. Recent changes in the dataset are not integrated and analyzed as a part of this study. However, the existing data shows that amount of support stabilized between 2014 and 2018.

At the provincial level, Ankara shows a steady increase in the number of farmers and the total area dedicated to good farming practices from 2012 to 2019, both for the data provided by the Provincial Directorate of Agriculture and Forestry (PDoAF) and the General Directorate of Plant Production (GDoPP) of the Ministry of Agriculture and Forestry. Although two different datasets present different numbers, the area dedicated to good farming reached its peak in 2019 at approximately 10088 hectares according to the data from GDoPP.

The agricultural organizations in Ankara include several cooperatives, unions, chambers, and civil society organizations. There are 164 cooperatives established for agricultural purposes in Ankara in 2020. However, this number was 214 in 2012. Cooperatives for agricultural purposes cover agricultural credit, sales and development cooperatives, beet growers’ cooperatives, irrigation cooperatives, and fisheries cooperatives. The case study regions own %23 of all agricultural cooperatives in Ankara. There are 10 agricultural unions in Ankara and this number
increased from 1 between 2005 to 2019. In recent years, there are emerging civil and cooperative initiatives with agricultural production purposes in this part of Ankara such as community supported agriculture organizations, farmers’ market initiatives, numerous agricultural production cooperatives and civil society organizations at the village and district level.

4.1.8 Planning of Rural Areas in Ankara: Existing Practices

The planning history of Ankara centers on the urbanized central region. After the establishment of the republic, a need for a plan to guide the development of the capital city became a necessity. Several authors discussed the planning efforts and the actual urban development of Ankara (ABB, 2006; Keleş & Duru, 2008; Tekeli et al., 1985), rural areas and agriculture received limited attention in these planning processes which had dominant urban characteristics.

While the metropolitan laws defined the planning borders of metropolitan areas through a series of laws, the districts outside the metropolitan borders that include dominantly rural areas were left to uncoordinated planning practices without the guidance of upper-scale plans. Law numbered 3030 enacted in 1984 and law numbered 5216 enacted in 2004, ruled the preparation of development plans by district municipalities outside metropolitan municipalities. In this sense, both laws created a binary situation when defining metropolitan borders. The areas inside the metropolitan borders and the areas outside of metropolitan areas but inside provincial borders were differentiated. The planning practices of the district municipalities sought urban area-based planning practices focusing on town centers. Rural settlements and agricultural production in the districts were not integrated into planning practice. The district municipalities and rural areas surrounding them did not become the subject of the planning process that depends on comprehensive analysis and creates suitable spatial decisions that consider socio-ecological interactions. The next metropolitan municipality law, the law numbered 6360 enacted in 2012, created an impact as a response to the concerns about the
uncoordinated and partial planning approach. With the legal regulation numbered 6360, the metropolitan municipality borders stretched to provincial borders that cover all 25 districts and 1423 neighborhoods in Ankara. There is a growing body of literature criticizing the law in terms of planning approach, citizen participation and democracy, administrative, political, financial and constitutional dimensions, population and boundaries, service provision, rural/urban division and environmental problems depending on the experiences of the cities that changed status (see Alkan, 2015; Ersoy, 2013; Günal et. al., 2014; Karagel and Karagel, 2014; Yıldırım and Selçuk, 2013; Ürkmez and Çelik, 2016). Despite criticisms, the law ruled metropolitan municipalities to prepare environmental regulation plan, master development plan, and implementation plan inside the provincial border.

Upon law no 6360, Ankara Metropolitan Municipality prepared a 1/100,000 scaled Ankara Environmental Plan for 2038 in 2017. This plan was the first high-scale plan to cover Ankara's provincial borders. Although the plan integrated variety of land uses including natural and archeological protection areas, and areas to protect the existing land use, such as agricultural areas, husbandry and agricultural facilities, irrigation areas, and common lands, these definitions and representations were only land use items drawn on the map. This plan received multiple criticisms concerning the expansion of artificial land uses over natural and agricultural areas and not developing actual strategies to reach the defined spatial outcomes. For instance, the plan suggested a new settlement between Ayaş and Beypazarı over the fertile agricultural production areas. The suggested development covers larger than already existing settlement areas and proposed large scale residential, tourism and industrial development in addition to the infrastructural developments. The plan did not actually planned the subregions of Ankara by offering a scientific background for proposed spatial trajectory for 2038.
Based on the similar concerns, professional organizations under UCTEA\(^2\) requested the annulment of the plan considering the problems of the plan with the zoning legislation, urban planning principles, planning principles and public interest. As a result, the plan was canceled in 2020. Currently, Ankara does not have a comprehensive spatial plan including rural and natural areas surrounding the central urban districts.

Additionally, the plan aimed to support development of agriculture, animal husbandry, agriculture-based industry, and ecological farming practices in the province without suggesting measures or pathways for the sustainability of the productive landscape including social, demographic, economic, ecological, and productive dimensions interrelatedly.

On the regional level, Ankara Regional Development Agency prepared the regional plan for TR51 Ankara region covering the municipal boundaries of Ankara. The regional plan is strategic documents and aims at the inclusion and coordination of various actors for activities to reach strategic decisions. Ankara Regional Plan

\(^2\) https://www.spo.org.tr/detay.php?sube=1&tip=3&kod=10100
prepared for the period between 2014-2023. The regional plan has developed various strategies and measures for Beypazarı, Ayaş and Güdül defined under the 4th subregion. However, there is not enough information to monitor the extent of the implementation of these measures. For example, the plan suggested the preparation of the anti-immigration action plan for Güdül who has tendency to emigrate. However, there is not any sign on whether such plan developed. Increasing the added value of agricultural production and developing rural industries constitute another strategy package of the plan concerning the region. In this context, the issues of conducting awareness-raising activities on the field, geothermal greenhouse cultivation, and directing production by considering the existing land and climate structure were discussed under the agricultural dimension. On the other hand, the development of the tourism potential of the region is another development area. The basis of this approach lies in the goal of diversifying economic activities in rural areas. In this context, the development of ecotourism activities, the development of the Silk Road Tourism route as a historical trade route, the promotion of thermal tourism, and nature and health tourism are the strategies developed by considering the potential of the region. A new regional development plan is in the preparation process.

On the strategical level, recently Ankara Metropolitan Municipality prepared Ankara Local Climate Change Action Plan. This action plan defines Agriculture/Forestry, Food Security and Biodiversity as one of the key climate change adaptation strategies and recommendation areas (AMM, 2022).

The actions include two actions. First action is increasing the resilience of agricultural practices to climate change through:

- Determining the negative effects of climate change on plant and animal breeding.
- Raising awareness of the producers about the measures.
- Dissemination of systems that will reduce water consumption in agricultural areas.
- Providing training to municipality teams and agricultural cooperatives on combating invasive species and taking necessary precautions.
- Improving logistics activities in order to increase food safety, conscious use of fertilizers in agriculture.
- Mulch laying on the land within the framework of agricultural studies based on natural precipitation.

The second action concerns the planning activities aiming to increase biodiversity through inventory studies specific to Ankara by

- Ensuring the planting of trees and plants with less water need in green areas as a precaution against the risk of a decrease in expected precipitation in Ankara.
- Increasing biodiversity by establishing orchards.
- Ensuring that a vegetation plan is made against special situations related to climate adaptation.
- Disseminating technical practices and awareness-raising activities that will increase pollination by supporting the bee population.

The above-mentioned actions are highly interrelated with the productive dimensions of landscape. However, these actions should be coordinated with the upper-scale spatial in action and related sectoral strategies for the region to enhance sustainability and resilience of the rural productive landscape.
CHAPTER 5

EXPLORING THE SOCIO-ECOLOGICAL SYSTEM IN A RURAL PRODUCTIVE LANDSCAPE OF NORTH-WESTERN ANKARA

This section presents the data obtained during the first and second phase of qualitative data gathering in the field, spatial data and secondary qualitative and quantitative data obtained from several resources. The aim of this section, therefore, is to answer the main research question and three sub-questions that form the pieces of main research question which is “How does the socio-ecological landscape of Northwestern Ankara operate through the interrelations between spatial, environmental, agricultural productive, and administrative systems in response to the changing conditions?”

Three subsections address the main research question through answering particular sub-research questions. The first subsection aims to explore components of the socio-ecological productive landscape of Northwestern Ankara and their interrelations through emphasizing the interconnectedness of spatial, environmental, agricultural productive, and administrative systems in the context of changing conditions. Furthermore, this subchapter delves into the context of agricultural production and producers in the case study region.

Second subchapter seeks to understand the changing man-made and climatic conditions of the socio-ecological productive landscape through focusing on the impacts of changing conditions on natural resources which are water and soil and plants, as agricultural outputs, with a particular focus on the adaptive strategies employed by farmers.

The third subchapter aims to explore the current and the changed state of the steps of agricultural production and experienced impact, and responses of agricultural producers for the changes in each step. There are seven steps of agricultural
production that emerged with expert opinions and site observations. These are: (i) land preparation, (ii) seed selection and obtainment, (iii) irrigation, (iv) plant protection, (v) fertilizing, (vi) harvesting, packing, and processing, and (vii) marketing.

5.1 Components of the Socio-Ecological Productive Landscape

In order to unravel the complex socio-ecological productive landscape of Northwest Ankara, it is essential to delve deeply into the complex web of interconnected systems that regulate it. Collectively, these systems, which operate across spatial, environmental, productive, and administrative dimensions, determine the agricultural potential and patterns of a region. The region's topographical and geomorphological characteristics, coupled with its climatic conditions, provide the background upon which human and ecological interactions take place. In the meantime, population dynamics and demographic shifts provide insight into the availability of human resources in agricultural production. Understanding the land use and land cover, along with the region's agricultural land capabilities, reveals the region's capacity for various types of cultivation, while hydrological systems provide an understanding of water availability for irrigation. The diverse flora, fauna, and vegetation highlight the ecological diversity and constraints, laying the basis for agroecological practices. Beyond the natural systems, it is essential to comprehend the human-driven components, such as the type of agricultural practices, number of farmers in the region, land ownership pattern and characteristics, and crop patterns. This includes insights into their experiences, economic motivations, and agricultural organization and support structures exist in the region. This comprehensive analysis functions as an path to answer the first research question of this study: “What is the socio-ecological productive landscape of Northwestern Ankara?”
5.1.1 Interrelations of Socio-Ecological Components and Natural Resources

The northwestern Ankara region offers a vivid socio-ecological landscape shaped by its geomorphology, topography, climate, hydrology, vegetation and diverse flora and fauna. The region exhibits a distinct **geomorphological composition** which is characterized by varying elevations, valleys, plateaus, and basins that significantly impact its agricultural capacity. The agricultural suitability of the northern region, particularly in proximity to the Köröğlu Mountains, is comparatively lower. In contrast, the Kirbaşı Plateau located in Beypazarı exhibits diverse farming capabilities owing to its geomorphological characteristics. Kirmir Creek enhances the local area by providing fertile valleys that support a wide range of agricultural endeavors. According to existing research, the utilization of land in a particular location is influenced by many landforms, including valley floors and terraces, which play a significant role in determining their suitability for agricultural, orcharding and grazing purposes. For example, topographically problematic locations are predominantly utilized as grazing lands. Terrace areas are conducive to the practice of irrigated farming, but the badlands primarily serve as pastureland due to their restricted agricultural viability.

**The climatic conditions** of the productive landscape, comprising Ayaş, Beypazarı, and Güdül, are deeply intertwined with their topographical and geomorphological features, leading to distinct agricultural practices. Ayaş, characterized by a mix of flatlands and hilly terrains, experiences a continental climate with cold winters and hot, dry summers. Beypazarı, lying between the Black Sea and Central Anatolia, undergoes transitional climatic influences. The terrains of the district, a mix of alluvial plains and hilly topography, are appropriate for rainfed and irrigated agriculture as much as the soil limitations allows. Güdül, on the other hand, presents a varied climate due to its rough topography and the proximity to the Köröğlu Mountains. Northern forest covered parts of the district presents a different climate than the Kirmir Creek valley that curving river valley interwoven with the rising
topography enable microclimatic characteristics. As being the most rainiest district among others, the challenging geographical features encourage cultivation of rainfed crops like barley and wheat, and favor animal husbandry in steeper areas. Rainfall patterns also varied, with Beypazarı and Güdül witnessing notable increases in rainy days, while Ayaş experienced more fluctuations.

The districts of Ayaş, Beypazarı, and Güdül are currently experiencing noteworthy demographic shifts that have substantial implications for the continuity of agriculture in the region. From 2007 to 2020, the population trends in Ayaş and Beypazarı have exhibited moderate growth, whilst Güdül has undergone a significant decrease. The observed decline, which is particularly prominent among the younger population, underscores the declining labor force in the agricultural production within the region.

In terms of land use and land cover, the region witnessed subtle shifts in land use between 1990 and 2018. A slight rise in artificial surfaces, particularly around town centers with Beypazarı registering the highest increase. These expansions in artificial surfaces predominantly transformed agricultural areas.

As a part of expansion of urban tissue, the region faces a growing number of mineral extraction sites, especially in the Beypazarı and Ayaş districts, with Ayaş witnessing an abrupt emergence from nonexistence in 1990 to a staggering 335 hectares by 2018. These extraction sites, largely at the expense of forest and semi-natural areas, further complicated the agricultural production landscape. Such shifts pose consequences for agricultural yields, as highlighted in sections discussing change in climatic conditions and impact over natural resources. Agricultural areas, especially arable lands, form significant proportions, accounting for roughly 47% of the region's land. These lands, however, saw a marginal decline of 314 hectares signaling the stablity of landuse dynamics between 1990 and 2018.

The region's horticultural practices, referred to as permanent crops like vineyards and fruit trees, saw substantial growth, that might indicate a shift in agricultural focus. Meanwhile, pastures faced a significant decline, especially in Ayaş, that can
signal a change in livestock-based agricultural systems. Pastures experienced the most significant decline in the region, with many converting to shrub or herbaceous vegetation. Forests and semi-natural areas, making up over half of the land cover, remained relatively stable. While there was a minor reduction in forest areas, shrub and herbaceous vegetation saw growth, particularly natural grasslands.

In the examined rural regions, **land use capability** plays a pivotal role in defining productive landscapes. Land use capability classes I, II, and III represent the most favorable lands for agriculture due to their soil quality and manageable topographies and comprise approximately 22.2% of the region, with the majority concentrated around the basins of Kirmir Creek and its tributaries. However, the more significant portions of the land, specifically falling within classes IV (somewhat limited for farming), VI, and VII, suggest the presence of limitations for agricultural activities.

Kirmir Creek, situated in the Sakarya River Basin in Turkey, is an essential tributary in the **hydrological system** of the region, influenced by diverse geological and topographical elements. Kirmir Creek, originating from the Northern Kızılcahamam mountains, flows towards Sarıyar Dam, collecting water from its tributaries, Süveri Creek and İlhan Creek, along the way. These creeks are vital water sources in the study area. For irrigation, the region relies on both surface and underground water sources. Nine artificial water bodies serve the irrigation needs, predominantly in Ayaş, Beypažar, and Güdül. As water resources fluctuate, the impacts on producers and their adaptive responses are worth noting, especially in the face of changing climatic and environmental conditions which would be the subject of the following sections.

The region exhibits a diverse range of **biodiversity**. The floral composition of the region exhibits an array of shrubs, trees, native herbs, and wildflowers, combined with cultivated crop varieties including grains, legumes, fruits, and vegetables. Agriculturally, the region thrives with vineyards producing an array of grapes, orchards for cherries, apples, and pears, and fields cultivating grains and legumes. Additionally, the presence of the Angora goat along with other sheep and goat
breeds, the region is of both ecological, cultural, and economic asset as a traditional practice.

Despite the region's inherent riches, attempts to protect its natural assets continue to be fragmented. Although several Key Biodiversity Areas (KBAs), such as the Kirmir Valley and Ayaş Mountains, have been studied, there is a notable deficiency in the official designation of these areas and implementation of effective conservation measures. In addition, there are officially designated protection areas such wildlife zones, natural parks, and protected areas, such as the Sarìyar and İlhanköy Plains, and the Kirmir Creek Basin.

The productive landscape spanning the Güdül, Beypazarı, and Ayaş districts exhibits a diverse array of flora and fauna, contributing notably to the socio-ecological fabric of the region. Influenced by factors like climate, topography, soil conditions, and human activity, the vegetation varies from shrubs and trees to both wild and cultivated plants. The Normalized Difference Vegetation Index (NDVI) analysis between 2017 and 2021 reveals significant dynamics in vegetation cover over these districts.

The following subsections delve into the detailed analysis for the current and changed state of the above-mentioned dimension (as long as the obtained data allows).

5.1.1.1 Geomorphology and Topography

The geomorphological composition of the Ankara region, encompassing districts like Güdül, Beypazarı, and Ayaş, significantly impacts the agricultural possibilities, land management, and overall productive landscape. Divided by diverse natural features, the region presents a complex tapestry of elevations, valleys, plateaus, and basins, all influencing land use.

The region extends towards the foothills of the Köroğlu Mountains to the north. The Karaşar Plateau and the high fields located on the Lower-Middle Miocene erosion
surfaces in the north of the region are not well-suited for agricultural activities due to their high elevation. These areas are heavily vegetated and have developed dense forest communities. They also have pasture areas, which highlights the prominence of animal husbandry in these areas.

The region is topographically separated from central Ankara by the Ayaş Mountains. These mountainous areas form the eastern border of the region, whereas the northern border of the province with Bolu, marked by the Köroğlu Mountains. The southern part, on the other hand, surrounded by elevations separating Beypazarı and Ayaş from the Polatlı district, is part of the low-sloped Kirmir Stream basin.

![Figure 5.1. Digital Elevation Model (DEM) of the region](image)

The Kırbaşı Plateau forms the southern part of Beypazarı district. At an elevation of 1000-1100 m2, it is surrounded by deep valleys opened by Sakarya, Ankara, and Kirmir Creeks. Gürgen (1993) studied the geomorphological composition of the plateau. The author states that the land use in the Kırbaşı Plateau is predominantly influenced by geomorphological factors. The management of land utilization here
is predominantly influenced by geomorphological factors. Dry agriculture, valley agriculture, and partially irrigated agriculture are commonly practiced on the low-slope areas surrounding the plateau surface. The presence of vineyard-garden areas over extensive weathering, and steep slopes are noted, while areas unsuitable for agriculture are utilized for grazing purposes.

The Kirmir Creek basin, running through Beypazarı, has shaped the geography and vegetation of the region. Over millennia, it has created a valley filled with sediment-enriched alluvial soils, making it productive for agriculture. Areas like the Upper Pliocene erosion surfaces and Kırbaşı Plateau are generally used for dry farming, while Lower Pleistocene erosion surfaces, especially in the north of the Kirmir Stream depression, are suitable for irrigated agriculture.

The study of Türkan (2013) analysis the interrelation of geomorphological units with land use characteristics of Beypazarı district. The author further illuminates this land-use diversity, demonstrating how different landforms like valley floors, water gaps, and terrace formations accommodate varying practices, from irrigated farming to grazing. The author found that most of the valley floor as a geomorphologic formation is characterized by the prevalence of irrigated farming, accounting for 65% of land use in these areas. This indicates the utilization of these fertile areas for productive agricultural activities. On the other hand, the formation "water gaps (yarma vadi)" which is characterized by its challenging topography, primarily serves as pastureland, 82% of land use in these areas. The geographical features known as "tabansız vadi" and "sirt ve yamaç" encompass a combination of arid agricultural practices, grazing lands, as well as forested and shrubland regions. Additionally, the former also accommodates small-scale settlements.

The terrace (seki) formation is predominantly characterized by the presence of irrigated farming, accounting for approximately 66% of land use, while dry farming occupies around 20% of the area. In sharp contrast, the badlands (Kırğıbayır in Turkish) formation predominantly consists of pastureland, accounting for approximately 97% of lands in this form. This prevalence of pastureland may be
attributed to the inherent limitations of these areas for agricultural purposes or settlements. In addition, alluvial cone areas display a mixture of dry (35%) and irrigated farming (49%), pointing to a geomorphological structure that encourages agriculture.

Figure 5.2. Slope map of the region intersected with agricultural areas

In conclusion, the diverse geomorphological characteristics of the Ankara region, specifically in districts such as Güdül, Beypazarı, and Ayaş, significantly influence its agricultural landscape, land management, and productive potential. The region's complexity, with its varying elevations, valleys, plateaus, and basins, creates a multifaceted land-use tapestry. Yet, while the geomorphology of Beypazarı represents the region, comprehensive studies on the relation of geomorphology and agricultural land use focus on the wider region covering the Kirmir Stream basin lacks.
5.1.1.2 Climatic Conditions

Climate, as a key component of the physical environment, plays a critical role in shaping the vegetation, biodiversity, and agricultural practices of a region, together with the region's geomorphology.

The terrain of Ayaş is formed by a combination of flatlands and hilly areas. Therefore, the district presents favorable climatic conditions for agriculture especially in the stream basins. Typical characteristics of the continental climate are observed in Ayaş, and winters are cold and summers are hot and dry (MoAF, 2017a). The data from General Directorate of Meteorology presents data for Ayaş which is available from the year 2013. The mean temperature recorded during the period from 2013 to 2020 was 12.4°C, while the average annual precipitation amounted to 342.0 mm. The year displaying the highest recorded temperature was 2018, having registered at 13.4°C, while the years 2015 and 2017 experienced the lowest temperatures, both measuring 11.9°C.

In terms of precipitation, the year that exhibited the highest amount was 2014, recording a total of 450 mm. Conversely, the year that experienced the lowest amount of precipitation was 2020, registering a mere 208.1 mm. These climatic and geographical conditions enable the cultivation of a wider range of crops, including fruits, and irrigated and non-irrigated crops. The region is renowned for its Ayaş cherry, demonstrating how the climate and landforms can give rise to unique local agricultural products.
Beypazarı, the northern part of which borders Çamlıdere and Kızılcahamam districts of Ankara in the north, is a transition zone between the Black Sea and Central Anatolia and is under the influence of the climate of the Western Black Sea and Central Anatolia regions. In the South, Southwest and Southeast parts of the district, the climate of the Central Anatolia Region is dominant. The basins of Kirmir Stream and Sakarya River offers a unique microclimatic area for Beypazarı, and as well as
The geographical area is characterized by wavy topography, featuring a combination of alluvial plains that facilitate both rainfed and irrigated agricultural practices.

As a result, Beypazarı experiences a relatively milder continental climate characterized by less pronounced temperature fluctuations in comparison to Güdül. Beypazarı, a region under study, exhibits an average temperature of 13.8°C over the period spanning from 2005 to 2020. Additionally, the average annual precipitation in this area amounts to 388.2 mm. In 2020, the recorded temperature reached its peak at 15.3°C, while in 2006 and 2011, the temperature reached its lowest point at 12.5°C. In terms of annual precipitation, the year that recorded the highest amount was 2010, with a total of 547.4 mm. Conversely, the year 2006 experienced the lowest amount of precipitation, measuring at 271.6 mm.

The southern parts of the districts, The Kırbaşi Plateau and surrounding areas experience greater drought due to reduced summer rainfall, distinguishing it from other parts of the district. Conversely, the southern extensions of the Köroğlu Mountains, bordering the district's northern half, receive surplus rainfall, allowing for substantial forest growth like the Western Black Sea region. The southern slopes have shrubs instead of grass communities and forests, reflecting the lower rainfall in those areas (Türkan, 2013).

These conditions have led to the development of a varied agricultural system, characterized by a combination of field crops, fruits, and vegetables. Beypazarı has gained significant recognition for its carrots, which have come to symbolize the local area. The presence of diverse crops stems from the climate and topography, contributing to the development of a distinctive agroecological system.
Figure 5.5. Average yearly temperature between 2005 and 2020

Figure 5.6. Average yearly precipitation between 2005 and 2020
Güdül, characterized by its rough terrain and variable climate from north to south. The northern regions receive more rainfall due to the proximity to the Kőroğlu Mountains, resulting in dense forests akin to the Western Black Sea region. The obtained temperature and precipitation data from GDoM (2021) for Güdül starts in 2013. The mean temperature recorded between the years 2013 and 2020 was 13.1°C, while the average annual precipitation during the same period amounted to 436.4 mm. In 2018, the highest recorded temperature was 14.1°C, while the lowest temperatures were observed in the years 2013, 2015, and 2017, all measuring 12.4°C. The year exhibiting the highest amount of precipitation was 2018, recording a total of 551 mm, while the year experiencing the lowest amount of precipitation was 2013, with a mere 313.1 mm. Figure 5.7 presents the monthly precipitation and temperature pattern in Güdül districts for 2020.

Local agricultural practices have been influenced by the adverse climate conditions and challenging geographical features. Barley and wheat, which exhibit enhanced resilience and tolerance to arid conditions, are frequently cultivated. Animal husbandry is more prevalent in regions with steeper terrain, primarily due to the land's suitability for grazing rather than crop cultivation. The region's ecological balance has been preserved due to the less-intensive farming system, which is a result of the climatic conditions and landforms.

Figure 5.7. Monthly precipitation (mm) and temperature (°C) for Güdül in 2020
When considering the overall climatic conditions, it appears that Güdül exhibits marginally higher temperatures and notably elevated levels of precipitation in comparison to the surrounding regions. In contrast, it is observed that Ayaş exhibits the least amount of precipitation, whereas Ankara demonstrates the lowest average temperatures.

In addition to the temperature and precipitation patterns of the districts, the present study considers the number of days with hail, number of snow-covered days, and number of days with rainfall in a year as a criterion to understand the changes in the climatic conditions of the region.

The data from the GDoM (2021) shows that there has not been a day with hail between 2013 and 2020 in Güdül and Ayaş. In Beypazarı, the recent record of hail from the meteorological station of Beypazarı dates to 2011. However, the interviews with the farmers provide a contrary result. Farmers stated that they have experienced hail during the mentioned time. The reason behind this gap between the experience and documentation could stem from the fact that climatic events such as hail might occur at the local level that the meteorological station cannot record due to being in another locality in the region. In addition, understanding climatic patterns and locations of hails are not easy to detect and needs long term monitoring which cannot be complete with the data limited between 2013 and 2020 as it is in this study.

In terms of snow-covered days, only data from Beypazarı district is available. The data presents a considerable variation in the frequency of snow-covered days between the years 2000 and 2012 (Figure 5.8). The maximum number of such days, amounting to 41, was observed in 2002, while the minimum, totaling 4 days, occurred in 2001. This situation indicates sharp change between consecutive years but more comprehensive data that focuses on longer time periods is necessary to assess the trends.
Figure 5.8. Days covered with snow cover in a year in Beypazarı (2000-2020)

In contrast, an observable shift occurred between the years 2013 and 2020, during which no snow-covered days were documented. Such a change might indicate a noteworthy transformation in the climatic conditions of the region during the previous ten years. It is worth mentioning that in the dataset, the year 2013 marks a significant transition period, characterized by a complete absence of snow days which persists in the subsequent years. The sudden change observed might imply factors beyond natural variability, potentially indicating the influence of climate change or significant modifications in regional weather patterns.
In terms of precipitation, Beypazarı's number of rainfall days fluctuated throughout the years, with a noticeable increase in 2008, 2009, and 2010 followed by a general decline until 2013. From 2014, however, there was a surge, reaching its peak in 2018 with 130 days. Data for Güdül and Ayaş is only accessible starting from the year 2013. During the mentioned time frame, Güdül witnessed a gradual increase in the frequency of rainfall occurrences, culminating in the year 2018 where the highest number of rainy days, amounting to 125, was recorded. Conversely, Ayaş exhibited a greater degree of fluctuation in terms of the number of days with precipitation, ranging from 89 to 119.

Subchapter 5.2. presents and analysis the change in climatic conditions, their impact on farmers and farmers’ responses to these impacts in more detail.

5.1.1.3 Population and Demography

The population living in Ayaş, Beypazarı and Güdül districts constitutes 1.20% of the entire population of Ankara. While the population of Ankara is 5261842 by 2020, the population of Ayaş is 13099, Beypazarı is 45479, and Güdül is 8173. During the
period between 2007 and 2020, the population of Ayaş increased almost by 7%, Beypazarı increased by 5% and Güdül decreased by 19%. Overall, this means a 2% increase in population in the region. This means that while Ayaş and Beypazarı have slight increase in population, Güdül experiences exodus of population, especially at young age. Figure 5.10 describes the population change of three districts between the given period.

The distribution of population in certain age groups shows important results regarding the demographic structure of the region (see Table 18). Overall, the population under age 45 had a decreasing trend between 2007 and 2020. Specifically, the population change in the age group of 0-14 shows that the child population decreased drastically in the region between 2007 and 2020. In Güdül, the population among this age group decreased by 55% in the given period. The population in this age group decreased by 34% in Ayaş and 5% in Beypazarı.

![Population Change Graph](image)

Figure 5.10. The population change of Ayaş, Beypazarı ve Güdül districts between 2007 and 2020 (TurkStat, 2022)

Similarly, the population between the ages of 15 and 29 decreased in both districts. While the population between the age of 30 and 44 slightly (3.5%) decreased in Ayaş and increased 4% in Beypazarı, this age group has decreased by 42% in Güdül. The age group older than age 45 has an increasing trend in all districts.
Table 17. The change of population among age groups between 2007 and 2020

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>age group/</td>
<td>Ayaş</td>
<td>Beypazarı</td>
</tr>
<tr>
<td>district</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-14</td>
<td>1813</td>
<td>6692</td>
</tr>
<tr>
<td>15-29</td>
<td>2955</td>
<td>10807</td>
</tr>
<tr>
<td>30-44</td>
<td>2734</td>
<td>10389</td>
</tr>
<tr>
<td>45-59</td>
<td>2389</td>
<td>8603</td>
</tr>
<tr>
<td>60-74</td>
<td>1573</td>
<td>4727</td>
</tr>
<tr>
<td>75+</td>
<td>740</td>
<td>2156</td>
</tr>
<tr>
<td>Total</td>
<td>12204</td>
<td>43374</td>
</tr>
</tbody>
</table>

Source: TurkStat, 2022

Overall, figures, overall, show the decrease in the young population in the region and the dominance of the aging population. One of the highlighted points in the discussions is that those who have migrated from villages to cities have not given up their agricultural lands in their villages. The population who migrated from the village to the city in the past and who are now retired tend to return to their villages because previous migrants saved their lands in these villages. Farmers in the village or relatives of the landlord continue using the land for agricultural purposes.

"In recent years, retired people come back to villages, but they do not contribute much to production. They even do harm. He says you can't do animal husbandry in the village. It's a neighborhood, we're having more trouble. It raises land prices, no one can take place to produce. It is taken for sitting, walking, they reduced production." (B2)

The shift from villages to district centers within the region was another topic that came up in producer interviews. One of the causes of this movement, as highlighted in the interview with farmer B2 in Beypazarı, is the closure of village schools and the people's resistance to sending their children to school with a transportation-based education. In addition to demonstrating their migration to Ankara's city center and
district centers, this circumstance separates their living and working places while conserving their agricultural fields.

Similarly, B11 states that he commutes to the village from Beypazarı center every day to conduct agriculture.

"I live in the city; I have a house here. I also have a house in the village. Every day, I go to the village and come back. I don't stay in my house there. My mother and father live there. For instance, I went this morning, took care of my tasks, and then came back. My equipment, like my tractor and other tools, are there, but I am here." (B11)

Additionally, it is crucial to evaluate socio-demographic and socio-economic situations together. This means that the ratio of the young population decreased and was replaced by the elderly population. In the interviews held in the field, the points supporting this situation were mentioned. The following quote can be considered as an example:

“Young people do not prefer jobs in agriculture. Women do not prefer men who work in agriculture. They want to find a job with minimum wage by immigrating to Ankara and other cities apart from Güdül.” (G11)

Given the ongoing trend of urban migration and shifting demographics, the traditional agricultural practices and socio-economic structure of the region are experiencing substantial changes. The aging population, on one hand, continues to maintain connections with their family's land, while the younger generations, on the other hand, are increasingly drawn to urban centers in pursuit of alternative economic prospects and lifestyles.

5.1.1.4 Land Use and Land Cover (LULC)

Land use and land cover (LULC) patterns shape socio-ecological systems and the populations that depend on them. These patterns affect biodiversity, ecosystems,
economic activity, and culture in landscapes. Understanding land use and land cover changes is crucial from a socio-ecological systems approach applied in productive landscape studies because they represent larger socio-economic and socio-demographic dynamics that impacts space in addition to societal responses to those dynamics. Land use land cover can also give insight to how cultures use, manage, and protect their ecosystems for productivity, giving vital insights regarding resource exploitation, ecological preservation, and the balance or imbalance between the two. This chapter examines how land use and land cover change affect socio-ecological productive landscapes in Northwestern Ankara.

The present study adopts multiple data sources to analyse LULC change in the region under study. As explained in the Methodology chapter, the analysis is dominantly based on the CORINE data and supported with the other spatial data collected from public institutions. Apart from CORINE data, the analysis of land use and land cover for the region incorporates different land use data gathered from different sources.

Table 18 provides a comparison of different agricultural land use data. These data include 1/25.000 National Soil Database (1985), activity reports of the District Directorates of Agriculture and Forestry of three districts under study (2017), and land use data provided by the Ankara Provincial Directorate of Agriculture and Forestry. While the CORINE data and Soil Database are spatial data, the data from the District and Provincial Directorates of Agriculture and Forestry are tabular data.

Among all other agricultural data sources, CORINE data presents a structured dataset that enables comparison between years. The study of Demir (2021) on the land use land cover change of Kars province of Turkey compares the aerial images from different national and international data sources. The result of the study shows that CORINE data provides geometrical and thematical accuracy over 90%.
Table 18. Comparison of agricultural and natural land use categories among different data sources (in hectares)

<table>
<thead>
<tr>
<th>Date</th>
<th>Data Source</th>
<th>1985</th>
<th>2017</th>
<th>2018</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil Database</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultivated land (arable land)</td>
<td>District Directorate of Agriculture and Forestry</td>
<td>123138</td>
<td>86998</td>
<td>107884</td>
<td>96233</td>
</tr>
<tr>
<td>Irrigated Agriculture</td>
<td>District Directorate of Agriculture and Forestry</td>
<td>7967</td>
<td>NA</td>
<td>17866</td>
<td>NA</td>
</tr>
<tr>
<td>Permanent Crops (orchard and vineyard)</td>
<td>District Directorate of Agriculture and Forestry</td>
<td>5781</td>
<td>3153</td>
<td>770</td>
<td>845,5</td>
</tr>
<tr>
<td>Pasture</td>
<td>District Directorate of Agriculture and Forestry</td>
<td>130318</td>
<td>NA</td>
<td>1668</td>
<td>172326</td>
</tr>
<tr>
<td>Grassland+ Pastures</td>
<td>District Directorate of Agriculture and Forestry</td>
<td>130536</td>
<td>42425</td>
<td>67161</td>
<td>NA</td>
</tr>
<tr>
<td>Rice Fields</td>
<td>District Directorate of Agriculture and Forestry</td>
<td>NA</td>
<td>NA</td>
<td>22</td>
<td>79</td>
</tr>
<tr>
<td>Forest</td>
<td>District Directorate of Agriculture and Forestry</td>
<td>33166</td>
<td>52331</td>
<td>28256</td>
<td>NA</td>
</tr>
</tbody>
</table>

Yet, the comparative table presented below shows conflicting data categories among certain land use and land cover categories between data sources. These categories emerge from categories that are similar in different datasets and are relevant to the present research.

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13 Data production data is not available. The project that produced the data (Arazi Parsel Tanimma Sistemi) dates to 2015 and the data for this study received in 2021.
14 The online reports of the District Directorate of Agriculture and Forestry were used for the analysis. However, the most recent report dates back to 2017.
15 Data is only available for vineyards and unavailable for orchards.
16 District Directorate of Agriculture and Forestry used the pasture and grassland coverage aggregated.
17 The data provided by the Provincial Directorate of Agriculture and Forestry did not include grasslands as a separate land cover category.
Table 19. CORINE Land Cover (CLC) Nomenclature (Büttner et al., 2021)

<table>
<thead>
<tr>
<th>LEVEL 1 Code</th>
<th>LEVEL1 Definition</th>
<th>LEVEL2 Code</th>
<th>LEVEL2 Definition</th>
<th>LEVEL 3 Code</th>
<th>LEVEL3 Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Artificial surfaces</td>
<td></td>
<td>11</td>
<td>Urban fabric</td>
<td>111</td>
<td>Continuous urban fabric</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112</td>
<td>Discontinuous urban fabric</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>Industrial, commercial and transport units</td>
<td>121</td>
<td>Industrial or commercial units</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>122</td>
<td>Road and rail networks and associated land</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>123</td>
<td>Port areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>124</td>
<td>Airports</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13</td>
<td>Mine, dump and construction sites</td>
<td>131</td>
<td>Mineral extraction sites</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>132</td>
<td>Dump sites</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>133</td>
<td>Construction sites</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14</td>
<td>Artificial, non-agricultural vegetated areas</td>
<td>141</td>
<td>Green urban areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>142</td>
<td>Sport and leisure facilities</td>
</tr>
<tr>
<td>2. Agricultural areas</td>
<td></td>
<td>21</td>
<td>Arable land</td>
<td>211</td>
<td>Non-irrigated arable land</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>212</td>
<td>Permanently irrigated land</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>213</td>
<td>Rice fields</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
<td>Permanent crops</td>
<td>221</td>
<td>Vineyards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>222</td>
<td>Fruit trees and berry plantations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>223</td>
<td>Olive groves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23</td>
<td>Pastures</td>
<td>231</td>
<td>Pastures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24</td>
<td>Heterogeneous agricultural areas</td>
<td>241</td>
<td>Annual crops associated with permanent crops</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>242</td>
<td>Complex cultivation patterns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>243</td>
<td>Land principally occupied by agriculture, with significant areas of natural vegetation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>244</td>
<td>Agro-forestry areas</td>
</tr>
<tr>
<td>3. Forest and semi natural areas</td>
<td></td>
<td>31</td>
<td>Forests</td>
<td>311</td>
<td>Broad-leaved forest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>312</td>
<td>Coniferous forest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>313</td>
<td>Mixed forest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32</td>
<td>Scrub and/or herbaceous vegetation associations</td>
<td>321</td>
<td>Natural grasslands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>322</td>
<td>Moors and heathland</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>323</td>
<td>Sclerophyllous vegetation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>324</td>
<td>Transitional woodland-shrub</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33</td>
<td>Open spaces with little or no vegetation</td>
<td>331</td>
<td>Beaches, dunes, sands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>332</td>
<td>Bare rocks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>333</td>
<td>Sparsely vegetated areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>334</td>
<td>Burnt areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>335</td>
<td>Glaciers and perpetual snow</td>
</tr>
<tr>
<td>4. Wetlands</td>
<td></td>
<td>41</td>
<td>Inland wetlands</td>
<td>411</td>
<td>Inland marshes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>412</td>
<td>Peat bogs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>42</td>
<td>Maritime wetlands</td>
<td>421</td>
<td>Salt marshes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>422</td>
<td>Salines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>423</td>
<td>Intertidal flats</td>
</tr>
<tr>
<td>5. Water bodies</td>
<td></td>
<td>51</td>
<td>Inland waters</td>
<td>511</td>
<td>Water courses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>512</td>
<td>Water bodies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>52</td>
<td>Marine waters</td>
<td>521</td>
<td>Coastal lagoons</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>522</td>
<td>Estuaries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>523</td>
<td>Sea and ocean</td>
</tr>
</tbody>
</table>
The analysis of the CORINE LULC data covers assessment of the change among land use categories at different levels for the region. Table 19 illustrates CORINE Land Use Land Cover data classification. The table shows three classification levels for land cover data: Level 1, Level 2, and Level 3. Turkey follows the European Environment Agency (EEA) levels and subgroups through the studies of the Ministry of Agriculture and Forestry. The EEA classification defines 5 Level 1 categories, 15 Level 2 categories, and 44 Level 3 categories. Each level had a land cover "code" to help identify values as illustrated in Table 19. The EEA classifies Level 1 land cover as 1. Artificial Surfaces, 2. Agricultural Areas, 3. Forest and Seminatural Areas, 4. Wetlands, and 5 Water Bodies (Bütten et al., 2021).

Based on these three level classifications, the study area under research contains all five Level 1 land cover classes defined by CORINE data. Whereas the region reveals different types of land use categories under Level 2 and Level 3 classes. Therefore, the analysis of the CORINE data for this study has multiple levels concerning the changes among classes. To assess the below described dynamics in the landcover, CORINE data was processed with the ArcGIS 10.8 through applying spatial overlay method, and the land use transitions in the data between 1990 and 2018 were calculated. Hata! Başvuru kaynağı bulunamadı. presents the matrix that shows the change among land use categories.

Five main categories of land use and land cover categories exist in the region. Table 20 presents five main land use and land cover categories and their change during the intervals of CORINE data between 1990 and 2018. While the artificial surfaces that cover human-made land uses related to urban related activities. According to CORINE classification, the artificial areas land uses that exist in the region are discontinuous urban fabric, industrial or commercial units and mineral extraction sites. The artificial areas only cover 0,9 % of the whole region with 3000 hectares of land. These areas form towns and villages in the region which are scattered across the region mainly over agricultural areas. The largest of these agglomerations are Beypazarı with its size and population, which is followed by Ayaş and Gündül, as described in the previous subchapter.
Table 20. Land use Changes among Level 1 Corine Land Cover Classes for Güdül, Beypazarı and Ayaş Region between 1990 and 2018 (in hectare)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Artificial surfaces</td>
<td>2712</td>
<td>2919</td>
<td>2990</td>
<td>3057</td>
<td>3015</td>
<td>303</td>
<td>0.9</td>
</tr>
<tr>
<td>2. Agricultural areas</td>
<td>154191</td>
<td>154502</td>
<td>153533</td>
<td>153451</td>
<td>153877</td>
<td>-314</td>
<td>46.9</td>
</tr>
<tr>
<td>3. Forest and semi natural areas</td>
<td>169695</td>
<td>169177</td>
<td>170156</td>
<td>170052</td>
<td>169589</td>
<td>-106</td>
<td>51.7</td>
</tr>
<tr>
<td>4. Wetlands</td>
<td>95</td>
<td>95</td>
<td>41</td>
<td>41</td>
<td>121</td>
<td>26</td>
<td>0.01</td>
</tr>
<tr>
<td>5. Water bodies</td>
<td>1089</td>
<td>1090</td>
<td>1062</td>
<td>1181</td>
<td>1180</td>
<td>91</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Water and arable land have been the major determinant of the settlements at different size. While the majority of the villages and towns, almost 90%, are located in the basin of Kirmir Creek and its tributaries. CORINE data defines these settlements as discontinuous urban fabric.

Overall, the prevalence of artificial surfaces experienced a marginal rise from 0.8% in 1990 to 0.9 % in 2018 in the region. This means an overall increase of 303 hectares of land which is transformed into artificial surfaces from other land uses. The increase in the artificial surfaces occurs in the form of discontinuous urban fabric around the town centers. In the given period, the artificial surfaces in Beypazarı increased with the largest proportion in the region with 280 ha area converted mainly from agricultural areas. The development occurred in the agricultural areas in the periphery of the central Beypazarı.
<table>
<thead>
<tr>
<th>Changes in Corine LULC for Güdül, Beypazarı and Ayaş Region between 1990-2018 (in hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corine Level 1</strong></td>
</tr>
<tr>
<td>1. Artificial surfaces</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2. Agricultural areas</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>3. Forest and semi natural areas</td>
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<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>4. Wetlands</td>
</tr>
<tr>
<td>5. Water bodies</td>
</tr>
<tr>
<td><strong>total</strong></td>
</tr>
</tbody>
</table>
Figure 5.11. The change of artificial areas in the regions between 1990 and 2018

In addition, mineral extraction areas (1.3.1.) under mine, dump and constructions sites have a visible increase in the region, especially in Beypazarı and Ayaş districts. While mineral extraction sites did not exist in Ayaş in 1990, these areas increased by 335 hectares between 1990 and 2018. Mainly, 180 hectares of this land transformed from forest and semi-natural areas and 132 hectares transformed from agricultural areas. A similar trend of transformation of agricultural and forest and semi-natural areas occurred in Beypazarı. While there were 2 hectares of mineral extraction sites in Beypazarı in 1990, these areas were increased to 153 hectares in 2018. Güdül has the lowest rate of transformation in the same manner with an increase from 19 to 25 hectares of land for mineral extraction sites. The transformation of agricultural and natural areas into mineral extraction sites has consequences on agricultural production. The section on change in climatic conditions and natural resources describes the changes, impacts and responses on natural resources and agricultural products. Following mine areas, industrial, commercial and transport areas (1.2), which were 56 ha in 1990, increased to 299 ha in 2018.
The proportion of agricultural areas remained relatively stable, accounting for approximately 47% of the overall land area. Between 1990 and 2018, agricultural areas decreased by 314 hectares. Agricultural areas form the second land cover class that covers almost half of the region after the forest and semi-natural areas (52%). The proportion of agricultural areas experienced an increase from 33.0% in 1990 to 36.4% in 2018 in Güdül. In Beypazarı, the agricultural lands experienced minor fluctuations but remained relatively stable, including approximately 39.5-39.9% of the overall land area. During the same time frame, there was a slight decrease in the percentage of agricultural areas, which decreased from 67.4% to 64.5% of the total land area in Ayaş.

The agricultural areas are in the middle and southern parts of the region. The transition from high altitude forest and natural areas to low altitude regions along the Kirmir Creek valley and its tributaries form fertile agricultural grounds in the middle parts of the region. In the southern parts of the region, mid-altitude lands in the form of hilly areas where nonirrigated agriculture and husbandry exists. Such a pattern of landcover forms the southern border of the region. The agricultural land uses are clustered under four subcategories which are arable lands, permanent crops, pastures, and heterogeneous agricultural areas which all exist in the region. Specifically, arable lands (non-irrigated arable lands, permanently irrigated lands, rice fields), permanent crops (vineyards, fruit trees and berry plantations), pastures, and heterogeneous agricultural areas (complex cultivation patterns and land principally occupied by agriculture) are the classifications of agricultural landcover defined by the CORINE project that exist in the region. The variety of agricultural land use represents the diversity of agricultural practices in the region.

In terms of arable lands, the land use slightly increased from 91175 hectares in 1990 to 107884 hectares in 2018. Notably, most arable land remained as such (82997 ha), but a substantial portion was converted into heterogeneous agricultural areas (5681 ha), shrub and/or herbaceous vegetation (796 ha) and open spaces with little or no
vegetation (862 ha). 4500 hectares of land transformed from forest and semi-natural areas to arable land in the given period.

![Figure 5.12. The change of agricultural areas in the regions between 1990 and 2018](image)

As mentioned, arable lands include irrigated, non-irrigated areas and rice fields. Overall, permanently irrigated areas increased from 5000 hectares to 18000 hectares between the given period. Whereas nonirrigated areas increased only by 4000 hectares. The transformation of non-irrigated agricultural areas into artificial uses is observed especially around the center of Beypazarı. Arable land in Güdül mostly preserved their character. Whereas the transformation of non-irrigated agricultural areas to irrigated areas took place in Ayaş and in the southern parts of Beypazarı. In Beypazarı, unirrigated arable land that remained unchanged between 1990 and 2018 in the Kirmir Creek flowing into the Sarıyar lake.

Erol (1958) stated that the inner parts of the Western Blacksea region have been one of the central regions for rice cultivation, especially on the river basins of the steep valleys. The author state the Kirmir Creek is a border between Western Black Sea and Central Anatolia where rice cultivation ends further in the southern parts of the
The author highlights that the southern and northern sections of Kirmir Creek has different agricultural economic practices as grain production is dominant in the southern regions of Kirmir Creek. The author stresses that the increasing importance of rice cultivation during the 1950s stems from the morphological conditions in the northern parts of the Kirmir Creek that results in specific microclimatic conditions for rice cultivation. However, author state the topographical conditions do not allow cultivation in wide valleys. A study from 1990s states that the rice cultivation specifically occurs in the water basin that Kirmir and its tributaries form (Gürgen, 1993). According to Gürgen (1993), although paddy farming is very laborious, it was carried out in every area suitable for this activity, since the income obtained from the unit area is incomparably higher than other products. For this reason, there were many villages around the Kirmir Creek that only deal with paddy farming. In addition to the Kirmir Basin, Gürgen (1993) adds that rice cultivation was more prevalent in the river beds in the northern parts of the region. The CORINE data of 2018 also shows similarity with this statement as the only change in the areal size of the rice fields occurred along the Koca Stream, which is a tributary of Sakarya River that forms the northwestern border of the study area in Beypazarı.

Although the region has a long history with rice cultivation, the topography limits the expansion of rice cultivation to larger areas and limited and scattered rice fields were not cost effective when upgrading to newer irrigation technologies as stated in the interviews. Rice fields had been a common agricultural land use type in the region which started decreasing through the generations of farmers. The landscape of the riverbeds to create terraces for rice cultivation by local communities.

Farmers responded that their older relatives have cultivated rice in Beypazarı and Güdül. Rice cultivation in Kirmir and Süveri Creek basin was a traditional agricultural practice in the agricultural history of the region as mentioned in the interviews. However, rice production has been decreasing and this decrease is also represented in the land use change. While there were 81 hectares of rice fields in 1990 in the region, these areas decreased to 22 hectares by 2018.
One of the producers stated that rice cultivation is no longer profitable, and they stopped production due to risk and costs of production.

"We used to plant cotton and rice; now they are gone. Every villager used to plant chickpeas, but now only about ten families, maybe three to five families, plant them. Not many people plant them anymore. For rice, for instance, people are hesitant to plant because of the wild boars. Politics also played a role in these changes... Fuel prices are high. People can’t recover the money they spend on what they plant. These are also reasons of why people don’t plant anymore." (G1)

Permanent crops that include vineyards and fruit trees and berry plantations, are traditional crop patterns in the region. Between 1990 and 2018, the areas size of permanent crops increased from 150 hectares to 770 hectares. The districts under study are among the largest fruit producer districts in Ankara (TurkStat, 2021). In all districts, the area of permanent crops increased in the same period with Beypazarı experienced the highest increase among all districts from 20 to 500 hectares. In Güdül, the area dedicated to permanent crops tripled reaching 180 hectares. This overall increase in permanent crops in the region most usually stems from the conversion heterogeneous agricultural areas.

Pastures, as the fourth subclass of agricultural land use in CORINE classification, forms a part of the agricultural land use that formally locates on the sidehills in the southern Beypazarı and foothills of Ayaş mountains on the east. Yet, pasture areas have experienced the most significant change in the region with a decrease from 7940 hectares to 1,668 hectares between 1990 and 2018. A significant portion of the pastures was converted into shrub and/or herbaceous vegetation (6231 ha). 700 hectares of pastures converted to other forms of agricultural areas. 289 hectares of pasture transformed to land principally occupied by agriculture which are scattered in Ayaş and Beypazarı districts.

The data shows that there is an overall decrease in pasture areas in all three districts under study. However, Ayaş has experienced the most drastic decrease in pasture
areas from 4200 hectares in 1990 to nearly 300 hectares in 2018. Whereas natural meadow areas increased by 6000 hectares and reached approximately 18% of Ayaş' on land use. Similarly, Beypazarı lost almost two third of its pasture area in the given time period.

Figure 5.13. The agricultural areas in the region by 2018 located on the DEM

When all data sources reviewed as given in Table 18, the most significant area of land use in the table is the 'Cultivated land (arable land)', which has seen notable fluctuations over the period based on the Soil Database and more recent data sources as defined. The data from the 'Soil Database' in 1985 indicates 123138 hectares of cultivated land. The recent data shows a drop ranging from 86998 hectares as per the 2017 data from the 'District Directorate of Agriculture and Forestry' to 107884 hectares in 2018 according to 'CORINE Data'. The cultivated land (arable land) category presents lower fluctuations among different data sources. The changes in cultivated land highlight the dynamic nature of land use and could reflect varying
agricultural practices, environmental factors, or even changes in data collection methods over time.

'Irrigated Agriculture' has shown an increasing trend over the years based on two sources of data: Soil Database and CORINE. While the former data source presents that irrigated agricultural areas were 7967 hectares in 1985, it jumps to 17866 hectares by 2018 according to CORINE data. However, it should be noted a more recent data is not available. The increase in irrigated agriculture is in line with the extending irrigation systems in the region within the given period.

Both data sources present area of 'Permanent Crops' including orchards and vineyards. Soil Database offers an area for permanent crops as 5781 hectares in 1985. The CORINE data of 1990 gives quite a different number for permanent crops which is 150 hectares. However, the recent data provides different numbers. Provincial Directorate of Agriculture and Forestry (data after 2015) and CORINE data presents numbers respectively as 845.5 hectares and 770 hectares that can be considered in the similar range. Whereas the data from the District Directorate of Agriculture and Forestry presents more than 3000 hectares of land for permanent crops which is quite higher than other data sources. The difference between data sources might stem from fact that agricultural practice is a dynamic field that data collection at the local level might give different results. In addition, data classification methods for permanent crops might vary between institutions.

The assessment of pastures is based on three data sources. The Soil Database presents almost 130000 hectares for 1984 (7940 hectares in 1990 data of CORINE). Provincial Directorate data shows an increase reaching a substantial 172326 hectares. However, CORINE data shows a decrease to from 1668 hectares. As mentioned, the comparison among CORINE data shows a decrease; yet data from different national data sources shows an increase. The reason behind this difference might stem from the different classification methods. To overcome classification problem that might stem from the classification of natural grasslands and pastures which are defined by two separate categories both in Soil Database and CORINE,
these two categories added together. In this case, CORINE data of 1990 shows 71376 hectares of pasture area which decreased to 67000 hectares according to CORINE 2018 data and 42000 according to District Directorate’s data. Development of such category for grasslands and pastures gives a more coherent understanding that this land use category decreased between 1985-1990 to 2017-2018. Lastly, the data of MoAaF, Department of Plant Production, shows that three districts hold total of 40551 hectares of pastures. However, comparing the data of different sources shows that there is a definitional problem concerning the pastures and rangelands. While District Directorate of Agriculture and Forestry includes both land uses into same category, Provincial Directorate of Agriculture and Forestry provide data for pastures. It is also important to mention that only CORINE data provides detailed definition related to land classification whereas local and national data providers did not provide definitions for land use categories. As a result, there is a complication in differentiating the land use types from different sources. The same problem exists in the cultivated land and permanent crop types. A more detailed and synchronized classification is required among different levels of public actors for better monitoring of the changes among the land use and land cover classes.

'Rice Fields’ land use category is limited, yet a characteristic land use type for the region. Two data sources provide data for the coverage of this land use category which are CORINE and Provincial Directorate’s data. The CORINE data presents 20 hectares of land for rice fields, which is one fourth of the Provincial Directorate’s data.

According to CORINE data, heterogenous agricultural areas (2.4) are the fourth agricultural land use category in the region that includes two subclasses complex cultivation patterns and land principally occupied by agriculture. heterogenous agricultural areas had a notable decrease from 54920 hectares in 1990 to 43562 hectares in 2018. Notable conversions were into arable land (nearly 20000 ha), shrub and/or herbaceous vegetation (2772 ha) and open spaces with little or no vegetation (3065 ha). In addition, 8500 hectares of land converted from forests and semi-natural areas to heterogenous agricultural areas.
Figure 5.14. The change of forest and semi-natural areas in the regions between 1990 and 2018

The third land cover category in CORINE classification is forests and seminatural areas. This landcover type is the most prevalent landcover in the region. This landcover includes forest, shrub and/or herbaceous vegetation, and open spaces with little or no vegetation. Broad-leaved forest, coniferous forest, mixed forest, natural grasslands, and transitional woodland-shrubs are the components of this landcover.

The proportion of forests and semi-natural areas underwent a slight decrease, declining from 51.8% in 1990 to 51.7% in 2018, reaching nearly 170,000 hectares of land. While the proportion of forest and semi-natural areas underwent a slight decline in Beypazarı and Güdül, the proportion of this land cover stabilized in the region with the increase in Ayaş. Nearly 14000 hectares of land transformed into agricultural areas from forests and seminatural areas between 1990 and 2018. The largest proportion of land with nearly 8500 hectares transformed into heterogenous agricultural areas.

Forests compromise only 8% of the region and form the northern border of Güdül and Beypazarı districts, the northernmost part of the region. The most dominant
forest form is coniferous forest with 27000 hectares. The northern part of the region consists of coniferous forest and natural grasslands. This part of the region forms the foothills of the Köroğlu Mountains. Forests saw a decrease from 32722 hectares in 1990 to 28256 hectares in 2018.

Towards the southern parts of the region, natural grasslands become the prevalent land cover. Shrub and/or herbaceous vegetation (including natural grasslands and transitional woodland-shrub) covers almost 30% of the total landcover in the region, as the most dominant landcover category under forests and semi-natural areas. This category increased from 84855 hectares in 1990 to 97496 hectares in 2018. Open spaces with little or no vegetation follow it with 13%. Between natural grasslands and agricultural areas, in the central parts of the region consists of the third most dominant landcover in the region which is open spaces with little or no vegetation with 13.5% of the total area. This landcover decreased slightly from 52118 hectares in 1990 to 51389 hectares in 2018. The presence of this landcover is the most dominant in Beypazarı with more than half of the total area in this category.

The comparison of the 'Forest' areas among different datasets shows both an increase and decrease in coverage based on the end year data as Table 18 shows. This problem in data accuracy reflects that more localized and continuous agricultural land use data is required to reach a more coherent understanding of change in the land use. Overall, it's clear that different data sources may present different patterns, potentially due to variations in data collection and classification methodologies.

The fourth Level 1 land use land cover classification is wetlands. The region understand includes inland wetlands (4.1). This category remained relatively stable, increasing from 95 hectares in 1990 to 121 hectares in 2018. Wetlands exist only in Beypazarı, along the Kirmir Creek basin and where the creek meets with Sariyar Dam, on the western border of the region.
The water bodies (inland waters) are the last major land use category which remained relatively stable, comprising approximately 0.1-0.2% of the overall land area. At
total, approximately 90 ha of increase occurred in the region between 1990 and 2018. Most of the increase occurred in Beypazarı with increase of 77 ha of increase in water bodies especially where Kirmir Creek flows into Sarıyar Dam, yet the proportion of water bodies remained almost consistent at approximately 0.6% of all land cover in the district. The increase occurred where Kirmir Creek meets with Sakarya Dam.

Overall, The CORINE data reveals that the main land use categories did not experience major changes since 1990. In brief, the time span between 1990 and 2018 exhibited marginal growth in artificial surfaces and forest and semi-natural areas, a decline or stability in agricultural areas, and a persistent presence of water bodies throughout the various regions.

Overall, the major land use and land cover changes in the landscape clusters in five locations as represented in Figure 5.17.
Figure 5.17. CORINE Land use land cover change in the region between 1990 and 2018
5.1.1.5 Land Use Capability for Agriculture

Land use capability classes are a crucial tool for examining the various elements of productive landscapes in rural regions. A systematic classification is provided, which considers various factors including soil characteristics, topography, climate, and potential for erosion. These factors play a crucial role in assessing the appropriateness of land for various purposes, with a particular focus on agricultural activities.

In terms of basic soil characteristics, the region is formed by different soil types including brown forest soils, alluvial soil, colluvial soils, reddish brown soils, non-calcareous brown soils, brown forest soils, non-calcareous brown forest soils.

Figure 5.18. Spatial distribution of large soil groups in the region

Brown Soils are the predominant soil group, covering approximately 57.8% of the total area. Their significant coverage indicates a profound influence on the agricultural practices and landscape of these regions. Typically, brown soils are well-
drained and have moderate to high fertility levels, making them suitable for a variety of crops because of having organic and calcium components (MoARA, 2008).

![Pie chart showing the percentage distribution of large soil groups in the region]

**Figure 5.19.** The percentage distribution of large soil groups in the region

Non-calcareous Brown Forest Soils and Brown Forest Soils constitute 12.9% and 11.2% of the area respectively. Covering the northern parts of the region, these soils are generally well-drained and are often associated with deciduous woodland, suggesting that they could support a variety of crops and possibly some forestry operations.

Non-calcareous Brown Soils cover 6.2% of the area. They are typically less fertile than Brown Soils due to the lack of calcium carbonate, which can limit their agricultural potential. Thus, the natural vegetation is mixed forest or heathland with shrubs and grasses (MoARA, 2008). These groups of soil can be found along the Kirmir Stream in Güdül and Ilhan Stream in Ayaş.

Alluvial Soils, known for their high fertility and excellent water holding capacity, cover a smaller area (3.1%). They are usually located in river valleys and deltas and are highly valued for agricultural use. Alluvial Soils forms the river valleys along the Kirmir, Ilhan and Süvari Streams.
The variations in soil type across these regions are likely to have a significant impact on agricultural practices, including the types of crops that can be grown, irrigation needs, and the type and quantity of soil amendments required to optimize productivity. The significant presence of Brown Soils and Brown Forest Soils suggests that these regions might support a range of agricultural activities, given their generally favorable characteristics for farming. The areas with lesser fertile soil types, such as Non-calcareous Brown Soils, may need more substantial soil management practices or might be better suited to non-agricultural land uses.

The land use capability map was visualized using a geographic data layer prepared within the scope of the Soil Database (1985) obtained from the Ministry of Agriculture and Forestry (see Figure 5.20). Land use capability maps can be utilized to show the land suitability for agriculture. The spatial data for land use capability, then, compared with the land use and land cover structure to develop an understanding on the purposeful use of agricultural lands according to capability classification.

The letters I through VIII stand for the Land Use Capability Classes. Classes I, II, III and IV are suitable for agriculture. While I, II and III classes show the most suitable land classes for agriculture, IV shows areas that can be used for agriculture with various applications, but generally suitable for animal husbandry. Whereas several previous studies conducted in Turkey consider classes V, VI, VII and VIII unsuitable for agriculture (Atalay, 2016; Doygun et al., 2008; Özşahin & Eroğlu, 2018).

The presented data offers a significant depiction of the land use capability within the study area (see Figure 5.19). The data shows the prevalence of land with lower agricultural suitability, specifically falling within classes IV, VI, and VII, while also acknowledging the comparatively lower occurrence of more favorable farming lands, falling within classes I, II, and III. The assessment of the land use capabilities in the arable land of the study region shows that the largest portion of arable lands are among the (class IV) which is somewhat limited for farming.
In the study area, the most suitable areas for agriculture exist in the river basins of Kirmir Creek and its tributaries. These lands are composed of alluvial soils with low slopes. Although Kirmir Creek passes through Güdül, the reason for the lack of Class 1 areas in terms of capability is topographical obstacles. In addition, the soil structure in Güdül districts is dominated by sandy-loamy and stony structure which also create production problems in agricultural areas (MoAF, 2017c).

It is seen that the plain regions of Ayaş and Beypazarı are the most suitable areas for agricultural production. The data shows that land with Class V capability does not exist in the region. The basin of the Kirmir Creek towards Güdül forms the less suitable lands with steep slopes and valleys.

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18 As the map shows, the northern part of the region has missing data which is provided by the Ministry of Agriculture and Forestry.
The land use capability data shows that most land, approximately 47.3% or 147,446 hectares, is classified as class VII. This class often signifies land that is largely unsuitable for conventional agricultural practices, generally due to significant limitations such as poor soil, drainage, steep slopes, or a combination of such conditions. This classification typically suggests that the land is more suited for other uses, such as grazing or forestry.

Land classes IV, which typically indicate land suitable for grazing or certain farming practices with careful management, represent a significant proportion of the total land area at approximately 13.3% (41,296 hectares).

Table 22. The areal size and percentage distribution of land capability classes in the region

<table>
<thead>
<tr>
<th>Land Use Capability Class</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
<th>Undefined class</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (in hectare)</td>
<td>17032</td>
<td>24978</td>
<td>27251</td>
<td>41296</td>
<td>45478</td>
<td>147446</td>
<td>4490</td>
<td>3526</td>
<td>307971</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>5.5</td>
<td>8.0</td>
<td>8.7</td>
<td>13.3</td>
<td>14.6</td>
<td>47.3</td>
<td>1.4</td>
<td>1.1</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The more agriculturally desirable classes (I, II, and III), which are best suited for a variety of agricultural practices due to good soil quality and manageable slopes, comprise smaller proportions of the land. Class I covers about 5.5% (17,032 hectares), class II roughly 8.0% (24,978 hectares), and class III around 8.7% (27,251 hectares) of the total land. 8255 hectares of Class I land is used for non-irrigated agriculture. The class 1 lands are clustered around basins of Kirmir Creek in Beyazari and its tributary, İlhan Creek, towards the settlement center of Ayaş, and in the southern parts of Ayaş and Beypazarı. In the northern parts of the region, the region between Kirmir Creek and Süveri Creek is the most agriculturally suitable region with limited Class I lands. The study area encompasses 185 hectares of land that is distinguished by its first-class soil capability and being used for as discontinuous urban fabric (with the terms of CORINE data classification).
Approximately 1.4% (4,490 hectares) of the land falls into class VIII. This class typically represents land with extreme limitations that render it largely unsuitable for agricultural use. Finally, a relatively small percentage of the land, roughly 1.1% (3,526 hectares of total area), is classified as 'undefined'. This classification compromises settlement centers, water bodies and missing parts in the data, such as the data missing for the northern parts of the region.

Table 23. The areal size and percentage distribution of land capability classes for the arable lands in the region

<table>
<thead>
<tr>
<th>Land Use Capability Class</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
<th>Undefined class</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Arable Lands in CORINE (in hectare)</td>
<td>13473</td>
<td>20380</td>
<td>18321</td>
<td>25442</td>
<td>16415</td>
<td>12943</td>
<td>312</td>
<td>393</td>
<td>107679</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>12.5</td>
<td>18.9</td>
<td>17.0</td>
<td>23.6</td>
<td>15.2</td>
<td>12.0</td>
<td>0.3</td>
<td>0.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The table above shows the assessment of the land use capability for arable lands defined by CORINE classification. The table categorizes arable land across various classes of land use capability and provides their percentage contributions towards a total of 107,679 hectares.

Looking at the most favorable class for farming, class I, it accounts for 12.5% (13473 hectares) of the total arable land. Class II holds a slightly larger portion, comprising 18.9% (20380 hectares) of arable land. Class III represents about 17.0% (18,321 hectares) of the total arable land. However, the largest portion of arable land falls under class IV, which makes up 23.6% (25,442 hectares) of the total. Classes VI and VII also make up a significant proportion of the land, with 15.2% (16,415 hectares) and 12.0% (12,943 hectares) respectively. A relatively small portion of the arable land, 0.3% (312 hectares), is classified under class VIII. Land in this class usually has severe limitations, rendering it largely unsuitable for farming.

To summarize, the arable land in this region is predominantly found in class IV, followed by II, III, I, VI, VII, and class VIII. This suggests a wide range of land use
capabilities in the arable land of the study region, with the largest portion being somewhat limited to farming (class IV).

5.1.1.6 Hydrological System

Kirmir Creek, an important tributary situated in the Sakarya River Basin in Turkey, exemplifies a multifaceted and dynamic hydrological system that is molded by a diverse range of geological and topographical factors. The Sakarya River, which accounts for 3.4% of Turkey's river potential, has its source in the Çifteler district of Eskişehir. The river flows through multiple bodies of water and reservoirs, namely Sarıyar, Gökçekaya, and Yenice, spanning a total distance of 687 kilometers. The river then bends north, defining the boundary between Ankara and Eskişehir. The river merges with Porsuk Stream and later with Ankara Stream and forms Kirmir River flowing west to Sarıyar Dam. The river ultimately discharges into the Black Sea through the Karasu district of Sakarya. It is a major waterway fed by several tributaries, enhancing its flow (MoAAF, 2018). Porsuk Stream that passes through Eskişehir, is the main tributary with 448 km long. The second stream in terms of length is Kirmir Creek with 160 km, followed by Ankara Stream with 140 km long. The system not only governs the distribution and availability of water in the region, but it also exerts a significant influence on the local climate and patterns of vegetation.

The geographical features of the area are primarily characterized by the valley system of streams of Kirmir Creek. These valleys differ in scale, marked by geological features significant for the region. The diverse topographical features significantly influence the path of water flow, consequently shaping the stream network of Kirmir Creek. The hydrological system is significantly influenced by geomorphology, and it influences climate and vegetation, through a feedback mechanism, The hydrological cycle is influenced by the presence of vegetation, primarily through the process of evapotranspiration, which in turn affects local microclimate.
Figure 5.21. Stream network and water bodies in the region

CORINE data reveals that the water bodies (inland waters) remained relatively stable, comprising approximately 0.1-0.2% of the overall land area. Kirmir Creek plays a substantial role in contributing to the surface water supply especially in Beypazarı, which is replenished through both direct precipitation and surface runoff.

Sarıyar Dam is the main water body in the region. The streams feeding the Sarıyar dam lake are the Sakarya River and its tributaries Aladağ, Kirmir and Gürleyik Creeks. Kirmir and Aladağ Creeks form seasonal wetlands where they join the dam lake. The dam and the hilly area surrounding the dam is a wildlife protection area and a key biodiversity area (Eken et al., 2006). Sarıyar Dam forms the western edge of the study area selected as case study area. Kirmir Creek flows toward Sarıyar Dam and has two tributaries, Süveri Creek and İlhan Creek, which are the central water resource in the study area region. While Kirmir Creek stems from the Northern Kızılcahamam mountains, the stream passes from Güdül towards Beypazarı collecting Süvari and İlhan Streams.
Table 24. Irrigation Water Resources in the region

<table>
<thead>
<tr>
<th>Water Body</th>
<th>Type</th>
<th>Location</th>
<th>Purpose</th>
<th>Irrigation Area(ha)</th>
<th>Operation Since</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asartepe</td>
<td>Dam</td>
<td>Ayaş</td>
<td>Irrigation</td>
<td>1500</td>
<td>1984</td>
</tr>
<tr>
<td>Başayaş</td>
<td>Pond</td>
<td>Ayaş</td>
<td>Irrigation</td>
<td>113</td>
<td>2016</td>
</tr>
<tr>
<td>Çanlılı</td>
<td>Pond</td>
<td>Ayaş</td>
<td>Irrigation</td>
<td>120</td>
<td>1993</td>
</tr>
<tr>
<td>Gökler</td>
<td>Pond</td>
<td>Ayaş</td>
<td>Irrigation</td>
<td>56</td>
<td>2017</td>
</tr>
<tr>
<td>Tekke</td>
<td>Pond</td>
<td>Ayaş</td>
<td>Irrigation</td>
<td>65</td>
<td>2017</td>
</tr>
<tr>
<td>Bayram</td>
<td>Pond</td>
<td>Ayaş</td>
<td>Irrigation</td>
<td>138</td>
<td>2019</td>
</tr>
<tr>
<td>Doğanözü</td>
<td>Pond</td>
<td>Beypazarı</td>
<td>Irrigation</td>
<td>975</td>
<td>2015</td>
</tr>
<tr>
<td>Karakaya</td>
<td>Pond</td>
<td>Beypazarı</td>
<td>Irrigation</td>
<td>283</td>
<td>2017</td>
</tr>
<tr>
<td>Çukurören</td>
<td>Pond</td>
<td>Güdül</td>
<td>Irrigation</td>
<td>306</td>
<td>2019</td>
</tr>
</tbody>
</table>

Source: (MoEUCC, 2022; DSİ, 2023)

Underground water resources are particularly important as being an indispensable part of agricultural production in the region that is in the northwestern of Ankara that holds the substantial portion of underground water resources for Ankara. The sources of irrigation water predominantly rely on both surface and underground water sources. The water bodies for irrigation are artificially created for irrigation purposes. Overall, there are nine water resources established for irrigation in the region. While Ayaş holds two-thirds of the surface water resources for irrigation, Beypazarı and Güdül has the other one-third. Water availability and type of agricultural production in the region determine the need for additional irrigation infrastructure. While Beypazarı is rich with alluvial soils and agricultural fields along the Kirmir Stream which enables accessible irrigation water, Güdül’s topography and production capacity limits the possibility of irrigated agriculture. In Güdül, irrigated agriculture predominantly continues in the riverbeds, especially along Kirmir Stream and Süvari Stream. Apart from rivers, surface water is utilized for irrigation purposes, while underground water sources, accessed via wells and drillholes.
The condition and change in water resources for irrigation, the evaluation of the impacts experienced by the producers and their responses are given in the next subsection under the title of change in climatic and environmental conditions.

5.1.1.7  Flora and Fauna

The objective of this subchapter is to examine the ecological diversity found in the Güdül, Beypazarı, and Ayaş regions of Ankara, with a particular emphasis on the unique array of plant and animal species that inhabit these regions. A thorough understanding of these components is not only crucial from an ecological point of view but is also essential for understanding the socio-ecological interactions within the productive landscape. This section will discuss the prominent species, their ecological interactions, and their potential impact on agricultural practices within these regions. This section utilizes secondary studies including previous research and reports of governmental and non-governmental institutions to explore the flora and fauna in the region.

The vegetation in Güdül, Beypazarı, and Ayaş exhibits a diverse array of flora, consisting primarily of shrubs, trees, and a wide range of both wild and cultivated plants. The floral biodiversity within different regions exhibits notable variations, which can be attributed to factors such as climate, topography, and soil conditions. The Ankara region is renowned for its steppe vegetation due to semi-arid climatic conditions. The flora found in the regions also encompasses indigenous herbs and wildflowers, which contribute to the enhancement of the ecosystem by providing support to pollinators and offering advantages in soil conservation.

Aydogdu & Turker (1992) conducted a study to explore the flora of the region between Ayaş, Güdül, Beypazarı and Polatlı. The authors found 173 genera and 311 taxa belonging to 41 families. Fabaceae, Asteraceae, Poaceae, Lamiaceae are the families with the most taxa. The genera with the highest number of taxa are Astragalus, Centaurea, Anthemis, Euphorbia and Salvia.
Ergin & Vural (2021) conducted a study on the flora of Beypazarı that identifies 328 species and subspecies taxa belonging to 4 families and 198 genera were identified. A total of 55 taxa (17 %) are endemic for Turkey. Authors state that considering that the endemism rate of Turkey is approximately 31.82%, it can be said that it is rich in terms of endemics and that the dominance of gypsum soil is also effective in this richness.

Cultivated biodiversity includes the primary cultivated crops in these regions that consist of grains, legumes, and vegetables. Additionally, permanent crop types such as fruit trees including cherries, apples, and pears flourish in the orchards. The vineyards in the vicinity of Gündül and Ayaş are home to grape varieties. These plant species fulfill a dual function as they not only contribute to the economy but also play a role in shaping the landscape and providing habitats for a wide range of fauna.

Simsek et al. (2004) studied the ethnobotanical usage of the wild plant species in the villages of Gündül, Beypazarı and Ayaş districts. The researchers documented a comprehensive range of 192 distinct use for indigenous flora, originating from an array of 85 plant species spanning 31 plant families. This extensive inventory highlights the remarkable biodiversity and traditional knowledge present within these specific geographic areas. The recorded applications of these plants were especially noteworthy in terms of their medicinal usage.

The fauna present in these regions encompasses a diverse array of mammals, avian species, reptiles, insects. The study of Eken et al. (2006) shows three key biodiversity areas (KBA) that is relevant with the case study area. The dam lake the Kirmir Creek...
falls creates a key biodiversity area in the banks of Sarıyar Dam. In the delta where Kirmir stream meets Sarıyar dam lake on the western border of the case study area, seasonal lake surface and marshes form. Sarıyar Dam KBA is a significant habitat for birds throughout migration, winter, and breeding seasons. Additionally, although not falling within the borders of the case study area, there is a wildlife development zone and bird sanctuary within the Sarıyar Dam region.

Figure 5.22. Protection areas in the region (illustrated by the author)

Kirmir Valley is the second key biodiversity area, which completely falls under the study area of the present thesis, defined by the study of Eken et. al. (2006). According to the assessment of the key biodiversity in Kirmir Valley, the study of Eken at. al. shows significant numbers of black stork (Ciconia nigra), small vulture (Neophron percnopterus), whiskered falcon (Falco biarmicus), eagle owl (Bubo bubo) and red-billed mountain crow (Pyrrhocorax pyrrhocorax) breed on the rocks along the Kirmir and İnözü valleys. In addition, raven (Corvus corax), ruddy shelduck (Tadorna...
ferruginea), tortoise (Testudo graeca) and the otter (Lutra lutra) are other species registered in the region.

The study of Mengüllüoğlu (2010) presents the findings of a camera trap study conducted over the course of one year in a 148 km$^2$ pine woodland area in Beypazarı. The results of the study indicate the presence of a diverse range of medium and large mammals, despite the occurrence of human activities such as livestock grazing, logging, and hunting. The study documented a total of 13 mammal species, namely the brown bear, wolf, Eurasian lynx, golden jackal, jungle cat, red fox, Eurasian badger, stone marten, red deer, wild boar, brown hare, Caucasian squirrel, and southern white-breasted hedgehog. The significant variety of mammalian species can be attributed to several factors, including the presence of a relatively undisturbed ecosystem, a wide range of altitudes and habitats, and the favorable attitudes of the local population.

The third key biodiversity area that partially falls within the study area and forms the eastern border of the study region. The region of Ayaş Mountains is characterized by its exceptional preservation of mountain steppes, making it a notable habitat for a diverse array of bird species as well as plant species. The Ayaş Mountains are considered as key biodiversity area for six plant taxa, five of which exhibit endemism solely within the country of Turkey. Several examples of plant species include Aethionema dumanii, Aethionema turcicum, Astragalus turcicus, and Astragalus densifolius subsp. Ayashensis (Ayaş Gümüşü) and Campanula damboldtiana (Ayaş Çançığı). The latter is currently found in the region, has approached the threshold of extinction (Eken et. al., 2006). The region also holds regional significance with regards to bird species. Within the region, various species can be observed breeding, including the Tawny Pipit (Anthus campestris), Long-legged Buzzard (Buteo rufinus), Syrian Woodpecker (Dendrocopos syriacus), Ortolan Bunting (Emberiza hortulana), Lesser Grey Shrike (Lanius minor), and Egyptian Vulture (Neophron percnopterus) (Eken et. al., 2006). In addition, the region harbors a variety of uncommon butterfly species, such as Glaucopsyche alexis (commonly known as
Azure-winged Blue), Polyommatus poseidon (referred to as Poseidon Blue), Pseudophilotes vicrama (known as Vicrama Blue), and Tomares nogelli (recognized as Anatolian Marbled White) butterflies (Eken et. al., 2006).

In addition to these three areas, Köroğlu Mountains KBA\(^{19}\) partially intersects with the northern part of the case study area. The area covers the wildlife development zone in Northern Beypazarı, on the border of Bolu The wildlife development zone (Kapaklı) gained this status for the protection of red deer and other mammals in the region\(^{20}\). Finally, Nallıhan Hills KBA\(^{21}\) whose borders intersect with the western border of the region location in the north of Sariyar Dam in mainly in Nallıhan and partially in Beypazarı districts.

It is important to note that the fauna in this region also encompasses livestock and poultry, which have been domesticated and play a significant role in the agrarian culture of the area. The significance of their contribution to landscape formation includes direct grazing activities and indirect provision of manure for agricultural fields, should not be underestimated. The region is known for its Angora Goats. For instance, in Güdül, out of the 16,500 goats in the district, approximately 12,000 of them are Angora goats. Güdül is the district where Angora goats are produced the most in Ankara (Güdül Municipality, 2019). These Angora goats have been a part of the productive landscape and the rural livelihood in the region, as well as playing a significant role in the region's livestock. Currently, there are efforts to increase the number of angora goats in villages of Güdül from Güdül Municipality and Ankara Metropolitan Municipality.

Apart from the Key Biodiversity Areas, which are not official areas for protection and biodiversity conservation, there are several protection areas in the region (see Figure sss). These areas cover wildlife development zone in the northern part of the

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\(^{19}\) [https://www.dogadernegi.org/koroglu-daglari/](https://www.dogadernegi.org/koroglu-daglari/)


\(^{21}\) [https://www.dogadernegi.org/nallihan-tepeleri/](https://www.dogadernegi.org/nallihan-tepeleri/)
region, Kirmir Creek Valley Protection Zone in Güdül, İnözü Valley Protection Zone in Beypazarı, Sorgun Lake Nature Park in Güdül, Kelebekler Valley and Tekkedağı Nature Parks in Beypazarı. Apart from natural protection efforts, there are two large plain protection zones, namely Sarıyar and İlhanköy Plains announced by decree on Large Plain Protection Zone decided by the Ministry of Agriculture, Food and Livestock in 2016. Sarıyar Plain is located where the slope is low, and the soil structure is suitable for agricultural production where Kirmir Creek meets with Sarıyar Dam Lake. İlhanköy Plain is located on the fertile lands formed by the tributary of Kirmir Creek, İhan Creek. The decree aims to protect the integrity of the plain and agricultural lands by not allowing non-agricultural developments in these areas with the decision that puts the plains under protection in regions with high agricultural production potential and experiencing soil loss and land degradation for various reasons. Therefore, the region is located in the Kirmir Creek basin, where the slope is low, and the soil structure is suitable for agricultural production. In addition, with the Presidential Decree announced in 2020, the protection status of the Kirmir Creek Basin Natural Protected Area was registered as a Sensitive Area to be Strictly Protected.

The presence of a wide range of wildlife in the region plays a significant role in maintaining the ecological well-being of the area through activities such as pollination of plants, regulation of pest populations, and participation in nutrient cycling processes. One example of a location that harbors a diverse array of bird species in the region as explained. Among these avifauna, certain species assume pivotal functions in the control of pests within agricultural landscapes in addition to pollination and seed dispersal (Sekercioglu, 2012). The interplay between plant life and animal life is crucial for sustaining a productive socio-ecological system. The interaction in question encompasses various ecological processes such as pollination,

seed dispersal, nutrient cycling, and pest control, all of which exert a significant impact on agricultural productivity. These systems illustrate a complex network of interdependencies and interactions, wherein crops and their animal pollinators coexist and engage in a mutually advantageous symbiotic association. The case study conducted in Anolaima, Colombia, along with the utilization of the integrated socio-ecological model, highlights the pivotal importance of pollinators, such as bees, in both agricultural productivity and the preservation of nutritional quality in food production (Cely-Santos & Lu, 2019). Nevertheless, this complex balance of these processes may be disturbed by various factors, including anthropogenic activities, climate change, and the destruction of habitats.

Although the region encompasses both unique and endangered flora and fauna within officially declared and based on research, it is disconcerting to note the inadequate conservation efforts currently in place. Notwithstanding the considerable ecological diversity present in this region, it is evident that the ongoing conservation endeavors are inadequate. The region is characterized by the presence of multiple key biodiversity areas (KBAs), wildlife development zones, and protection zones that have been designated to safeguard natural habitats and species. However, it appears that these measures are insufficient in effectively preserving the ecological integrity and ensuring agricultural sustainability within the area. The persistence of the threat of extinction faced by certain distinctive and endangered species in the region is a cause for concern, underscoring the necessity for the implementation of more comprehensive conservation strategies rather than piecemeal efforts experienced in the region.

5.1.1.8 Vegetation

As summarized in the previous section, the region that includes the Güdül, Beypazarı, and Ayaş districts are characterized by an array of diverse flora and fauna, exhibiting a broad spectrum of plant and animal species that significantly contribute to the socio-ecological productive landscape of the region. The vegetation in these
regions primarily consists of shrubs, trees, and a wide variety of both wild and cultivated plants, influenced by factors such as climate, topography, soil conditions and as well as human activities.

There are several indices used to evaluate and monitor vegetation. As agriculture is part of the vegetation, using a spatialized index to assess the change in vegetation in a productive landscape is found applicable. One of these indices is the Normalized Difference Vegetation Index (NDVI), which is frequently used for agricultural purposes. NDVI measures the quality of vegetation by determining the chlorophyll density in plants. Healthy green areas absorb visible light strongly, while leaves reflect near-infrared light. As explained in the methodology chapter, two NDVI images were prepared and processed to assess change among two satellite images taken in July of 2017 and 2021. While Figure 5.23 shows the NDVI image for July 2017, Figure 5.24 shows for 2021.

Figure 5.23. Normalized Difference Vegetation Index (NDVI) for July 2017
The analysis of change of NDVI pattern in the study region between 2017 and 2021, as data processing for this analysis explained in the methodology chapter, employs two Sentinel 2 satellite images from respective time periods. To assess the change, two images were processed to represent change in the vegetation between the given period.

Table 25. Classification of NDVI change and areal change in vegetation between 2017-2021

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>Range</th>
<th>Areal hectares</th>
<th>Change (in hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Loss</td>
<td>-1.544553 – 0.001</td>
<td>136889</td>
<td></td>
</tr>
<tr>
<td>(2) No Change</td>
<td>-0.001 – 0.001</td>
<td>5225</td>
<td></td>
</tr>
<tr>
<td>(3) Gain</td>
<td>0.001 – 1.376398</td>
<td>185515</td>
<td></td>
</tr>
</tbody>
</table>

Table 25 displays the changes in vegetation coverage in the districts of Güdül, Ayaş, and Beypazarı, as analyzed using NDVI (Normalized Difference Vegetation Index) images from 2017 and 2021.
The range of -1.544553 to 0.001 represents the relative change in NDVI values, indicating a reduction in vegetation coverage. The negative value indicates that vegetation has declined. The total area that experienced this loss in vegetation is 136,889 hectares. The range (-0.001 to 0.001) represents areas where NDVI values remained relatively stable between the two time points, suggesting that there was little to no change in vegetation coverage. This corresponds to an area of 5,225 hectares. The range of 0.001 to 1.376398 indicates an increase in NDVI values, suggesting an increase or growth in vegetation coverage. This corresponds to a substantial area of 185,515 hectares.

When the NDVI images of the study region were analyzed in detail, it is seen that the highest density vegetation exists in the northern parts of the region where forest coverage is the most. However, the vegetation density decreases towards the southern parts of the region where steppe vegetation dominates. These areas are represented as sparsely vegetated areas in CORINE land cover data.

Figure 5.25. Classified Normalized Difference Vegetation Index for July 2017
Figure 5.26. The change in NDVI between 2017 and 2021 over agricultural land use of CORINE 2018

Situated within the northwestern part of Ankara, these districts are marked by a distinctive semi-arid climate, significant for the rest of Ankara, the area's vegetation is predominantly of the steppe type. The distinctive topography and geology created specific vegetation zones from steppe regions to river valleys and high-elevation mountainous places. Examination of the NDVI images of the study region shows that the highest density vegetation exists in the northern parts of the region. This region is a forested area at the foothills of the Köroğlu mountains. While the northern part of both Beypazarı and Güdül has the highest density vegetation, dominantly covered by coniferous and mixed forests. While the northern parts of the region have a more arid climate, semi-arid climate dominates the central and southern parts. The change of climatic conditions impacts on the vegetation when combined with the geological and topographical features of the area.
The vegetation density decreases towards the southern parts of the region from forests to natural grasslands and to steppe vegetation until the basin of Kirmir Creek. Transition from forests and natural grasslands, sclerophyllous vegetations and transitional woodland shrubs represent transition from high density to moderate density vegetation. Overall, the region is dominated by low vegetation apart from stream basins and forest areas in the northern part of the region.

Figure 5.27. Vegetation and geomorphology in central parts of the study region

While the Kirmir Creek basin represents medium to high vegetation of cultivated plants, the basin is surrounded with geological and topographical formations called facies (See Figure 5.27). These sparsely vegetated areas surround the non-irrigated agricultural areas creating a layer between the agricultural areas on the Kirmir Creek basin part of Beypazarı and non-irrigated areas lying on the northern and southern of the valley. Kirmir Creek passes through the center of Beypazarı and Güdül districts. The vegetation along the river valley is a mixture of dense and moderate vegetation dominated by cultivated plants and trees. The green trace in the middle of the region in NDVI images shows water way of Kirmir Creek and represents dense vegetation (See Figure 5.23 and Figure 5.23)

In the southern parts of Beypazarı, elevation rises, forming Kırbaşı Plateau. This plateau is eroded by the Sakarya river and its Kirmir and Ankara tributaries(Türkan, 2013). This area is composed of moderate to low vegetation areas where irrigated and non-irrigated agriculture continues in this section of the region. In terms of
change of vegetation in these agricultural areas, the analysis presents that southern of Kirmir creek is more rich in terms of vegetation compared to the agricultural areas on the northern part of the basin that is limited with geological formations that show low density. Figure 5.25 represents the areas that show gain and loss in vegetation.

The parts of Kirmir Creek valley that falls into the borders of Güdül are surrounded by cultivated and natural vegetation. In the southern part of Kirmir Creek of Güdül, the elevation rises forming natural grasslands available for animal breeding. Similarly, northern parts of Ayaş, part of Ayaş mountains, hold natural grasslands in moderate and low vegetation areas.

İlhan Creek, the tributary of Kirmir Creek that passes through Ayaş, represents the densest vegetation along the river basin in the region. The region where the İlhan Creek and Süveri Creek connects to Kirmir Creek in the central part of the region is where three districts intersect. This region along the İlhan Creek compromises permanently irrigated areas, as one of the most fertile lands in the region. These cultivated lands extend towards the settlement center of Ayaş in the east forming one of the vegetation rich areas in the region located in Ayaş bordered with rising elevations of Ayaş Mountains. This region consists of permanently irrigated area accompanied by non-irrigated agricultural crops and land principally occupied by agriculture with transition to natural areas as elevation increases. However, The most significant decrease in vegetation occurred in this terrain. While the river basins show moderate to high vegetation, the topographical thresholds surrounding the river basin represent low vegetation and marked by decrease in vegetation when the NDVI images of 2017 and 2021 compared.

The most significant decrease in vegetation occurred in the terrain where Kirmir, Süveri and İlhan Creek intersect in Beypazarı district. While the river basins show moderate to high vegetation, the topographical thresholds surrounding the river basin represent low vegetation and marked by decrease in vegetation in given time period.

Karadaş & İmamoğlu (2019) presents the NDVI analysis for the Süvari Stream, a stream that is a tributary of Kirmir and that has a basin spanning Beypazarı and Güdül
districts. Authors conclude that the basin prominently exhibits moderate vegetation density that has an increasing trend from south to north of the basin.

According to Karadaş & İmamoğlu (2019), the terrain where Süveri Stream connects to Kirmir Creek presents the lowest rate of vegetation. While Kirmir Creek basin has limited high vegetated area that is suitable for agricultural production surrounded by the unoccupied, rocky land formations. The landscape surrounding the river basin falls into the category of low vegetation density. The villages of Beypazarı such as Akçakavak and Kızılcasöğüt (from where farmers were interviewed) are in this part of the region. The present study also reaches to similar conclusions concerning the low vegetation areas but adds that there is a loss of vegetation that might stem from diverse factors such as change in climatic conditions, soil characteristics, water availability, and biodiversity.

In addition, Karadaş & İmamoğlu (2019) state that higher vegetation density exists especially on the north-facing slopes, likely resulting from climatic influences. These findings are relevant with the findings of the present study that also includes the Süveri Stream basin. NDVI analysis when assessed together with the aspect map of the region presents a similar conclusion that the surfaces facing north are rich in terms of vegetation. In addition, as mentioned, climatic conditions have a considerable impact on the vegetation.

In conclusion, between 2017 and 2021, there was a substantial gain in vegetation cover across these districts, with an increase of 185,515 hectares. Overall, there is a gain in vegetation in the central and northern part of the region where forests and seminatural areas exist. Specifically, natural grasslands in Northern parts of Ayaş district and Güdül district has experienced gain in vegetation according to comparison of two NDVI images from 2017 and 2021. A significant amount of area, 136,889 hectares, however, experienced a loss in vegetation. A relatively small area (5,225 hectares) remained unchanged in terms of vegetation cover.
5.1.2 Context of Agricultural Production and Producers Characteristics in the Region

This section aims to explore the context of agricultural production in the region. For this aim, this chapter focuses on the type of agricultural production, crop and product type, land ownership and land size, and agricultural organization in the region. Moreover, this chapter explores and analysis the characteristics of the farmers such as farmers’ time in agricultural practice, the labor type adopted for agricultural production and, income patterns of the farmers based on the qualitative interviews conducted. As a result, this section utilizes different data sources which are not limited to interviews with the farmers, but also secondary statistical data.

Based on the analysis, the productive landscape of the districts of Güdül, Beypazarı, and Ayaş presents a diverse array of agricultural practices. Conventional agriculture remains a dominant practice, especially in Beypazarı, where over half of its producers prefer this method. Farmers in Güdül, on the other hand, mention a notable inclination towards ecological farming. This method, based on traditional agricultural practices and local indigenous knowledge, is predominant in Güdül, with nearly 39% of its producers referring to this method. Interestingly, this method of farming is entirely absent in Ayaş and Beypazarı, underscoring Güdül's distinct agricultural identity. Ayaş displays more diversified agricultural methods including both conventional and organic farming. In addition to the prevailing approaches, certain farmers adopt a combination of conventional, ecological, and organic farming techniques, thereby practicing mixed agricultural methods. The mixture implies that farmers possess adaptability, potentially in response to experienced impacts stemming from changing climatic conditions and steps in agricultural production. The data further highlights the presence of organic farming and good farming practices in the region, albeit to a limited extent.

In terms of crop and product types, the region demonstrates diverse production patterns across its districts. The agricultural patterns of crop production in the districts of Ayaş, Beypazar, and Güdül are individually examined, focusing on three
primary crop types: grains, vegetables, and fruits. Beypazarı stands out as a primary agricultural center in the region, a leading lettuce producer in Turkey, and is also a substantial producer of crops such as spinach, radish, green onions, and zucchini. Ayaş, on the other hand, is renowned for fruits and vegetables. Key crops include tomatoes, melons, watermelons, peppers, and cherries. Güdül’s hilly terrain predicates a predominantly non-irrigated agricultural practice, except the irrigated agricultural production adjacent to riverbeds. However, rising input costs in agriculture has caused some hesitation among farmers, mirroring a shift towards husbandry.

Interviews highlight varying **landsizes** across different districts. Interview data reveals diverse landholding patterns across districts. Approximately 18% of farmers have 100-500 decares, with a consistent 12% each for the 25-50 and 50-100 decares categories. Güdül is dominated by smaller plots of 0-5 decares at 17%, while no such holdings were reported in Beypazarı and Ayaş. Beypazarı stands out for larger holdings, with 37% between 100-500 decares and 27% exceeding 500 decares. Land consolidation is particularly emphasized in Beypazarı. **Landownership** practices differ: 26% of farmers utilize a mix of renting and owning, while 40% of Ayaş farmers solely rent, compared to a mere 9% in Beypazarı. In contrast, Beypazarı boasts a higher rate of exclusive land ownership at 15%. From 2001 to 2020, the number of registered farmers fluctuated. Among the districts, Beypazarı experienced 13% decline, whereas Güdül faced a significant drop of 22%. In stark contrast, Ayaş experienced 27% growth in its number of farmers. However, there is a problematic of statistical data regarding actual farmers as mentioned in the interviews.

The practices and decisions of farmers are crucial in shaping agricultural landscapes. Three key variables—**time in agriculture, income sources, and labor preferences**—offer insights into this dynamic. Concerning income, Beypazarı stands out with 58% of its income from plant production, emphasizing its dominance in this field. Güdül, on the other hand, displays a diversified agricultural income, with plant production (32%), viticulture (23%), and orcharding (23%). Husbandry is
also significant, especially in Güdül, where it contributes to 14% of the agricultural income, suggesting the region's ecological fit for this activity.

The interview results on the farmer's time in agriculture shows that 32% of farmers have been in agriculture for over 30 years, with Beypazarı having the highest proportion at 64%. However, Güdül has a mixed distribution: 17% with up to 10 years, 22% between 11-20 years, and 11% each in the 21-30 years and 30+ years categories.

In the region of Ayaş, family farming emerges as the prevailing agricultural practice, comprising approximately 60% of the reported responses. Beypazarı exhibits a diverse labor composition, with 45% of individuals engaging in a combination of family-based and external labor, while 18% pursue individual work with external workers. Güdül is highly dependent on familial labor, which constitutes 50% of the workforce. When doing a comparative analysis of the districts, it becomes evident that Güdül distinguishes itself through its emphasis on a family-based approach, while Beypazarı adopts a combination of family and external labor use for agricultural practices.

Finally, Ayaş appears community and market driven with cooperative tendencies, Beypazarı leans towards individualism with membership to formalized structures such as cooperatives and chambers, and Güdül whereas, points to community-initiative based collaboration practices without official memberships.

Overall, the analysis of the agricultural production characteristics of the region and the producers, there occurs distinctions of the producers in each district.

Based on an analysis of land ownership in the region, farming can be broadly categorized into three distinct scales: small, mid, and large. The **Small-Scale** farms encompass those with an area ranging from 0 to 100 decare, and there are 14 producers operating within this category, dominantly from farmers in Güdül and Ayaş. The **Mid-Scale** farms are those that span an area between 100 to 500 decare, with a total of 8 producers identified within this category which is formed by farmers
in Ayaş and Beypazarı. Lastly, the Large-Scale farms, covering land areas exceeding 500 decares are managed by 3 producers from Beypazarı in the region. They are a minority but contribute significantly to understanding differences among producers of different land sizes and agricultural techniques.

Types of agricultural production method and labor type add layers two more layers to this categorization. The agricultural production method compromises of four categories: conventional, ecological, organic, and mixed methods. Agricultural labor categories that emerged from the interviews cluster around four categories: family, individual, external and their mixture. Adding these layers to the agricultural profiling of the producers results in 10 distinct categories of producers that exist in the region.

Table 26. Producer profiles emerged in the region

<table>
<thead>
<tr>
<th>Producer Profile</th>
<th>District / Number of Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small-Scale Family-Based Ecological Producers</td>
<td>Güdül (5)</td>
</tr>
<tr>
<td>Small-Scale Family-Based Organic Producers</td>
<td>Ayaş (1)</td>
</tr>
<tr>
<td>Small-Scale Mixed Labor Conventional Producers</td>
<td>Beypazarı (1) &amp; Güdül (1)</td>
</tr>
<tr>
<td>Small-Scale Family-Based Conventional Producers</td>
<td>Güdül (1)</td>
</tr>
<tr>
<td>Small-Scale Individual Conventional Producers</td>
<td>Güdül (2)</td>
</tr>
<tr>
<td>Mid-Scale Mixed Labor Conventional Producers</td>
<td>Beypazarı (3)</td>
</tr>
<tr>
<td>Mid-Scale Family-Based Organic Producers</td>
<td>Ayaş (1)</td>
</tr>
<tr>
<td>Mid-Scale Family-Based Conventional Producers</td>
<td>Beypazarı, Ayaş, Güdül (4)</td>
</tr>
<tr>
<td>Large-Scale Mixed Labor Mixed Farming Producers</td>
<td>Beypazarı (2)</td>
</tr>
<tr>
<td>Large-Scale Labor-Based Conventional Producers</td>
<td>Beypazarı (1)</td>
</tr>
</tbody>
</table>

i. **Small-Scale Family-Based Ecological Producers:** These producers are primarily found in Güdül (G1, G2, G3, G5, G6). These producers follow traditional practices with emphasis on ecological farming and rely predominantly on family labor.
ii. **Small-Scale Family-Based Organic Producers:** Single farmer in Ayaş (A1) forms this category that blends organic farming with family-driven labor.

iii. **Small-Scale Mixed Labor Conventional Producers:** Only one farmer each from Güdül (G4) and Beypazarı (B9) forms this category. These farmers adopts family and external labor that adopt conventional practices.

iv. **Small-Scale Family-Based Conventional Producers:** Only a single farmer exists in this category from Güdül (G8), especially in its central parts of the district. Conventional farming practices are followed on a small operatable scale, with family members being the primary workforce.

v. **Small-Scale Individual Conventional Producers:** Again, farmers in Güdül (G7, G9) form this category where individual production in farming is more evident in an individually operatable scale.

vi. **Mid-Scale Mixed Labor Conventional Producers:** These farmers predominantly based in Beypazarı (B2, B7, B8) and rely on conventional farming techniques with mix of family and hired labor.

vii. **Mid-Scale Family-Based Organic Producers:** This category holds only one farmer from Ayaş (A4). There is a mixture of organic farming and family-driven labor adopted as a production method.

viii. **Mid-Scale Family-Based Conventional Producers:** Mid-scale family-based producers manage farms between 100 to 500 decare of land farms predominantly with family labor, sticking to conventional farming practices. This category is composed of farmers from Beypazarı (B3), Ayaş (A2), and Güdül (G11).

ix. **Large-Scale Mixed Labor Mixed Farming Producers:** These are found in Beypazarı (B4, B5) operating lands larger than 500 decare. The district has a significant portion of farmers with larger plots, and there's a mix of both family and external labor involved in farming practices.

x. **Large-Scale Labor-Based Conventional Producers:** Only one farmer located in Beypazarı (B6) with land size more than 500 decare. This profile
aligns with the dominant farming method of the district which leans toward conventional agricultural practices, with larger plots and a labor-focused approach.

Figure 5.28 presents the typologies of producers which is based on the districts under study.

![Figure 5.28. Distribution of producer profiles among districts under study](image)

Figure 5.29. Geographical distribution of the producers under profile categories
5.1.2.1 Type of Agricultural Practices

The rich tapestry of agriculture in the districts of Güdül, Beypazarı, and Ayaş is characterized by a multitude of agricultural practices, each with its own distinct methods. The type of agricultural production in these districts is varied, ranging from conventional techniques to environmentally conscious organic and ecological farming. Moreover, the prevalence of good agricultural practices demonstrates the efforts towards more sustainable production methods. Adapting to the shifting environment and demands, some producers combine diverse methods, resulting in an integration of practices. This section examines the prevalence of these agricultural practices, the support given to such practices in the region and producers’ by utilizing different data sources such as in-depth interviews and secondary data collected.

Table 27 presents the number of farmers practicing good farming and the total area (in decare) allocated to these practices in Güdül, Beypazarı, Ayaş, and Ankara over the years 2012 to 2019. Ankara PDoAF Ankara provided provincial level and district level data on the good farming support given to producers in the case study region.

The provided data from Ankara PDoAF sheds light on the varying degrees of 'good farming' practices across different regions in Ankara, from 2012 to 2019. While regions like Güdül displayed minimal participation, notably Beypazarı, reflected an encouraging rise in both the number of farmers and the land area dedicated to good farming practices. Ayaş, although demonstrating a relatively lower engagement, showed persistent involvement over the years.

In Güdül, good farming practices are minimal with only a limited registration observed in 2014. Both the number of participating farmers and the area allocated for good farming decreased to zero in the subsequent years. In Ayaş, the adoption of good farming practices started with 9 farmers in 2016 and decreased to 5 in 2019. Though the number of farmers is low, there’s a continuation of good farming practices. Beypazarı, on the other hand, shows a significant increase in both the number of farmers and areas dedicated to good farming practices from 2012
onwards. The peak is reached in 2018 with 97 farmers working on approximately 1373 hectares of land. However, there's a noticeable decline in 2019. Ayaş has relatively lower engagement compared to Beypazarı.

Table 27. The number of farmers practicing good farming and the total area (in decare) allocated to these practices in Güdül, Beypazarı, Ayaş, and Ankara

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Güdül</td>
<td># Farmers</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Area (da)</td>
<td>0</td>
<td>0</td>
<td>127</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Beypazarı</td>
<td># Farmers</td>
<td>5</td>
<td>5</td>
<td>28</td>
<td>27</td>
<td>41</td>
<td>76</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Area (da)</td>
<td>293</td>
<td>2705</td>
<td>3908</td>
<td>2593</td>
<td>4820</td>
<td>7881</td>
<td>13733</td>
</tr>
<tr>
<td>Ayaş</td>
<td># Farmers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Area (da)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>281</td>
<td>146</td>
<td>0</td>
<td>62</td>
</tr>
<tr>
<td>Ankara</td>
<td># Farmers</td>
<td>10</td>
<td>15</td>
<td>64</td>
<td>55</td>
<td>400</td>
<td>356</td>
<td>709</td>
</tr>
<tr>
<td></td>
<td>Area (da)</td>
<td>1848</td>
<td>9633</td>
<td>9094</td>
<td>5698</td>
<td>43504</td>
<td>34591</td>
<td>84256</td>
</tr>
</tbody>
</table>

PDoAF has developed four projects on disseminating good farming practices between 2018 and 2020 in Ankara. These projects cover dissemination and support for farmers to adopt good farming practices. Specifically, conducted in the Ayaş district, a project initiative under this scheme sponsored the certification fees for 10 tomato producers. Although the most recent data dates to 2019, this might explain the modest increase in the number of participating farmers from 2018 to 2019 in Ayaş.

The data obtained from GDoPP of the MoAF presents governmental supports to good farming practices at Turkey level. The support to good farming has experienced transformation in supporting scheme third times between 2007 and 2018. When good farming practices started in 2007, there was no support given based on the size of the area. In 2008, the unit price of support was determined as 18 TL per decare. In 2009, the support scheme diversified in terms of the plant type cultivated on the land. This has led to differentiation of vegetable and fruit production, greenhouse agriculture and cultivation of medical herbs. By 2017, individual and group
certificated production was differentiated in terms of support and rice cultivation was integrated into the support scheme.

Another important finding from the data on good farming practices, the data shows that from 2013 onwards, the unit price support given to both vegetables and fruits (50 TL/da), greenhouse farming (150 TL/da) and cultivation of medical herbs (100 TL/da) became stagnated and did not experience change between 2014 and 2018.

Despite these initiatives, the uptake of good farming remained limited in the region. This discrepancy could stem from variations in state support across districts, farmers’ perceptions, and sustainability concerns. Different levels of engagement towards good farming practices might stems from different level of states supports to districts, sustainability of the supports and take-up of the practice by farmers, and perception of farmers towards good farming applications which can be the subject of further research on the topic. This situation might stem from the different amount and dedication to support in good farming applications.

The development of organic farming in Turkey is intricately linked with a sequence of significant legislative initiatives that have aimed to establish standardization, promote and enhance organic agricultural methodologies. One notable landmark in this path was the enactment of the Organic Farming Law No. 5262, on 2004. The legislation represents an important achievement in the context of organic farming in Turkey. This legislative framework serves as the basis upon which the entire organic farming sector in the country.

Data from GDoPP underscores the growth trajectory of organic farming from 2006 to 2019. While support for organic farming has consistently increased, it's essential to analyze this against broader economic indicators in agriculture for a comprehensive understanding.

Starting in 2006 with 1042 supported entrepreneurs working on an area of 43758 decare, the numbers have steadily risen to 55849 entrepreneurs working on an area of 3951737 decare by 2019. Support unit prices have also seen a steady increase,
starting from 3 TL/da in 2006 and reaching 100 TL/da for the first product category by 2017. Notably, the support unit prices have become more differentiated by product category since 2013, with different prices being set for fruit and vegetable farming, field crops, and different product categories. It is also important to note that the amount of the support has been almost stabilized since 2014, fixed to the range of 70 to 100 TL in the primary crops. The total amount of support provided has also grown substantially. Starting from 131275 TL in 2006, it has increased to 162974573 TL in 2019, making the total support provided over these years amount to 831343955 TL. However, this increase in the number of supports should be analyzed with the economic indicators of the agricultural sector to assess the adequacy, quality, and success of the supports. Yet, the data shows a significant expansion of organic farming practices in Turkey between 2006 and 2019, accompanied by a dramatic increase in the amount of support provided for these practices by the government.

Ankara PDoAF provided data on the number of organic farmers and area allocated for organic farming in decare, within the districts of Güdül, Beypazarı, Ayaş, and the entirety of Ankara, spanning the years 2012 to 2019. The number of organic farmers in Ankara and in districts of study shows a similar pattern of change between 2012 and 2019. It should be noted that there were no organic farmers in Güdül, Beypazarı and Ayaş districts in 2012. In Ankara, there were 71 organic farmers who produced on 26436 decare of area in 2012. In 2013, there is a increase in all districts and in Ankara.

Table 28. Number of Organic Farmers and Total Area Allocated to Organic Farming

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Güdül</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Farmers</td>
<td>0</td>
<td>14</td>
<td>13</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area (da)</td>
<td>0</td>
<td>90</td>
<td>90</td>
<td>23</td>
<td>23</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Beypazarı</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Farmers</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Area (da)</td>
<td>0</td>
<td>238</td>
<td>285</td>
<td>583</td>
<td>583</td>
<td>481</td>
<td>679</td>
<td>670</td>
</tr>
<tr>
<td>Ayaş</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Farmers</td>
<td>0</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Area (da)</td>
<td>0</td>
<td>105</td>
<td>67</td>
<td>140</td>
<td>140</td>
<td>60</td>
<td>78</td>
<td>26</td>
</tr>
<tr>
<td>Ankara</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Farmers</td>
<td>71</td>
<td>105</td>
<td>85</td>
<td>78</td>
<td>78</td>
<td>77</td>
<td>81</td>
<td>50</td>
</tr>
<tr>
<td>Area (da)</td>
<td>26426</td>
<td>41762</td>
<td>35887</td>
<td>33843</td>
<td>33843</td>
<td>31032</td>
<td>50766</td>
<td>33250</td>
</tr>
</tbody>
</table>
In Güdül, the number of organic farmers reached its highest point in 2013, with a total of 14 individuals. However, in subsequent years, this figure experienced a gradual decline, ultimately reaching zero in both 2018 and 2019. The area allocated for organic farming exhibited a similar pattern, peaking at 90 decare in 2013 and subsequently declining to zero by 2018. Beypazarı has consistently maintained a relatively stable number of organic farmers, ranging from 1 to 3 individuals. By 2019, there were total of 3 farmers in the district. In contrast, the area of organic farming has exhibited a slight rise, expanding from 238 decare in 2013 to 670 decare in 2019. The number of organic farmers in Ayaş has exhibited variability over time between 2013 to 2018 with number of farmers ranging around 5 to 7, while hitting a lowest point of 1 in 2019. The allocation of land for organic farming displayed fluctuations, reaching a peak of 140 decare in 2015 and declining to the lowest point of 26 decare in 2019.

This decrease in the number of farmers and area supported might be relevant with the financial requirements to sustain organic farming. Input prices of fertilizers and pesticides are higher than conventional farming that farmers are challenging to afford, especially for small-scale farmers.

In addition to organic and good farming practices, the data obtained from the PDoAF includes the number of farmers conducting greenhouse cultivation and the respective land dedicated to greenhouse farming. The data points out that greenhouse farming in certain Güdül, Ayaş and Beypazarı districts are almost stable in 2018, 2019 and 2020, not exceeding 18 farmers at the total. However, the dataset of GDoPP still presents different data in terms of both definition and the number of farmers conducting greenhouse cultivation.

Ecological farming has strong roots in traditional agricultural practices and indigenous knowledge systems that are adapted to the existing conditions. These traditional approaches were established in direct relation to the environment and the specific demands of local populations and were passed down through generations.
The data for ecological farming practices in the region only depends on the in-depth interviews with the farmers. Adoption of ecological farming practices by farmers is not prevalent in the case study area but exists in Güdül district, specifically among the small-scale farmers. Interviews with the farmers reveal a specific motivation and push to switch to ecological farming from other type of practices. For instance, the family of farmers, the interview G1, states that marketing opportunity is the determinant factor for switching to ecological farming.

To represent different agricultural practices in the region to explore the productive landscape, the design of the case study incorporated in-depth interviews with the farmers who adopted different agricultural practices (see Table 29). The type of agricultural practices in the region consists of 5 categories. These categories are conventional, good farming, organic farming, ecological farming, and mixture of different practices.

### Table 29. The type of agricultural practices that farmers pursue

<table>
<thead>
<tr>
<th>Type of agricultural production</th>
<th>Category</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Conventional</td>
<td>11</td>
<td>32</td>
<td>1</td>
<td>20</td>
<td>6</td>
<td>55</td>
<td>4</td>
</tr>
<tr>
<td>(2) Ecological</td>
<td>7</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>(3) Both conventional and organic/ecological</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>(4) Good Farming</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>(5) Only Organic Farming</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(6) Not a Producer</td>
<td>10</td>
<td>29</td>
<td>2</td>
<td>40</td>
<td>2</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>(7) Unknown</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
<td><strong>100</strong></td>
<td><strong>5</strong></td>
<td><strong>100</strong></td>
<td><strong>11</strong></td>
<td><strong>100</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>

Among the three districts, Beypazarı predominantly leans towards conventional farming, with over half of it’s the mentions (55%) indicate this method. Contrastingly, Güdül stands out with a strong inclination towards ecological farming, with nearly 39% of its producers adhering to this method – a practice
absents in the other two regions. Ayaş, despite its smaller count, showcases a diversified pattern including both conventional and organic methods, and only organic farming.

The interview results show that 32% of the farmers mention that they conduct conventional agriculture. Among all mentions on conventional agriculture, almost 55% comes from Beypazarı. Ecological farming follows conventional agricultural by the number of mentions with 21%. Responses from Güdül form all mentions in this category. Good farming has limited representation, with only Beypazarı having a single entity practicing it (9% of Beypazarı).

Adoption of mixed application of conventional, ecological, and organic production received equal mentions in each district with one response each. Similarly, there is only one farmer that adopts solely organic farming practice who is in Ayaş. This farmer was also the only organic farmer in Ayaş when the interview was conducted. The other organic producers interviewed prefer to combine with conventional agricultural practices.

5.1.2.2 Crop Selection and Product Type

Agricultural practices and crop choices varied among districts due to factors such as terrain, soil type, climate, and socioeconomic situations, Güdül, Beypazar, and Ayaş offer insights into the diversity and dynamics of crop selection and types marked by agricultural techniques.

Recognized as a major agricultural production center, Beypazarı leads Turkey in lettuce output and ranks high in spinach and radish production. Crops grown in the region include lettuce, iceberg lettuce, green onions, spinach, radish, and zucchini. Irrigated farmland is less common than nonirrigated farming. A major feature of the region is the presence of organic farmers, with a substantial percentage using good farming methods. Historically, crops such as rice, sesame, and cotton, which were formerly widely grown, have since been phased out. The valley floors, particularly
those produced by the Kirmir Creek and their tributaries, are extremely important for agricultural activity in Beypazarı, providing fertile alluvial plains suited for high-yield farming (MoAF, 2017b; Türkan, 2013).

Known as a fertile location for vegetable and fruit production, the Ayaş district's principal sources of income are tomatoes, melons, watermelons, carrots, peppers, beans, cherries, and other fruits. Ayaş, like Güdül, is seeing an increasing shift away from agriculture and into husbandry, owing primarily to agriculture's deteriorating profitability. The largest settlements in terms of agricultural areas locate most dominantly in the Southern parts of the districts such as Oltan, Tekke and Gençali neighborhoods. While non-irrigated agriculture continues to predominate, irrigated farming methods are concentrated in areas such as İlıca, ilhan, Akkaya, and sections of Sinanlı and Oltan (MoAF, 2017a).

Located in a hillier terrain than both Beypazar and Ayaş, Güdül's agricultural produce is predominantly non-irrigated. Irrigated agriculture does exist in some regions, particularly those near riverbeds. Because of rising input costs, the tendency of shifting from agriculture to husbandry is becoming more prevalent. In terms of production diversity, the head of the Güdül Chamber of Agriculture (G11) indicates that Güdül's climate is favorable for artichoke cultivation, yet the number of farmers farming this crop has declined due to the labor-intensive nature of the production process. Historically, the area was also dominant in carrot and tomato growing, with districts such as Çağ'a and Güneyce producing significantly. Notably, the regions of Garipçe, Adalkuzu, and Karacaören in Güdül form a closed basin with a high concentration of irrigated agriculture.

With its diverse agricultural landscape, the region exhibits varied production trends across its districts. Each of the districts of Ayaş, Beypazar, and Güdül has its own agricultural pattern of crop production which are analyzed under main crop types: grains, vegetables, and fruits.
Grains

Specific grain types mark the agricultural specialization of the region. The most farmed grains in case study region are wheat, barley, sugar beet and chickpea.

Wheat has seen a slight increase between 2004 and 2020. Between 2004 and 2020, wheat production in the Ankara region exhibited fluctuations in both volume and district contribution. Starting in 2004 with a total of 98,340 tons, Ayaş was the primary producer at 48%. However, by 2020, despite the overall production surge to 110,541 tons, Ayaş's contribution declined to 39%. Notably, Beypazarı's contribution increased from 34% in 2004 to 42% in 2020, while Güdül's share rose slightly from 18% to 19% over the same period. Meanwhile, the region's contribution to Ankara's total wheat production witnessed a modest growth, moving from 10% in 2004 to 12.5% in 2020.

For Barley, from 2004 to 2020, the Ankara region experienced a notable shift in barley production dynamics. Initially, in 2004, Beypazarı was the dominant district, contributing 64% of the total barley output. However, by 2020, Ayaş took the lead with a 43% contribution, marking a significant growth from its 25% share in 2004. Conversely, Beypazarı's share declined from 64% in 2004 to 33% in 2020. Güdül also saw a steady increase in its contribution, rising from 11% in 2004 to 24% by 2020. Despite these district-level changes, the region's contribution to the overall barley production in Ankara remained consistent at 10% throughout the period.

In 2004, a total of 28,045 tons Sugar Beet was produced in the region and this number increased to 43,046 in 2020. Over the span of 16 years, Ayaş consistently emerged as the dominant district for sugar beet production in the Ankara region. From 2004 to 2020, Ayaş's contribution to the regional output ranged between 74% to 78%. In comparison, Beypazarı's share hovered around 25% in 2004, slightly dropping to 22% by 2020. Güdül's role remained minimal, with its contribution fluctuating around 2%. Overall, while there was a growth in total sugar beet production in the region, Ayaş maintained its dominant position.
Lastly, Chickpea production underwent significant shifts. In 2004, from a humble total of 2,774 tons, Ayaş contributed 43%, Beypazarı 31%, and Güdül 26%. By 2010, the production rose to 4,650 tons. Ayaş was responsible for 50%, Beypazarı 12%, and a notable 38% from Güdül. The year 2020 recorded a total of 13,534 tons, with Ayaş leading with 63%, followed by Beypazarı at 33% and Güdül with 4%.

In addition, rice cultivation only occurred in Beypazarı with 87 tons in 2004 forming almost 7% of total production in Ankara. Rice cultivation decreased to zero by 2010 and follows the same trend in 2020.

Regarding the change product pattern in Beypazarı, a former farmer and also the head of Mukhtars Association from Beypazarı responds that rice cultivation was more prevalent than vegetable production in 1980s.

"Now, in the 80s, there was normally not much vegetable production. I mean, there were rice fields around here until 1985. We were planting rice, I mean I was planting it too. I was harvesting 70-80 tonnes annually. Later, when this Ankara irrigation was built on the Kirmir Stream, our water supply decreased."
A former study on the agricultural practices in Güdül also reveals decrease in rice cultivation in the Kirmir Creek Basin support the assertion of the interviewee B10. According to Sırakaya (1992), before the Sarıyar Dam was built, the Kirmir Creek frequently overflowed and after the dam was built, the waters of the stream decreased. The construction of dykes on the stream negatively affected rice cultivation. Paddy fields have been replaced by crops such as vegetables and sugar beet.

**Vegetables**

There are five distinct vegetable categories farmed dominantly in the districts of Ayaş, Beypazarı, and Güdül. These crop types cover tomato, carrot, lettuce, onion, and sugarbeet.

In 2004, **Carrot** production in the region totaled 107,400 tons in 2004, where Beypazarı was the predominant contributor with 93%, while Ayaş and Güdül contributed 2% and 5%, respectively. The main trend in carrot production in the region between 2004 and 2020 highlights Beypazarı's continued dominance. The role of Beypazarı in the region slightly increased its share to 93% in 2010 and to 99% in 2020. Overall, while the region's carrot production slightly declined from 2004 to 2010 and then saw a considerable increase by 2020. The contribution of Ayaş and Güdül diminished in the given period as Beypazarı solidified its role as the principal carrot producer. Beypazarı has the same trend for overall carrot production in Ankara between 2004 and 2020, producing 90% of all carrots produced in Ankara.

**Tomato** production in the region saw a declining trend from 2004 to 2020. In 2004, Ayaş was the primary tomato producer, contributing over half of the region's total production. However, its dominance waned over the years, as its contribution dropped from 61% in 2004 to 36% in 2020. Simultaneously, while Beypazarı's share slightly fluctuated, Güdül's contribution remained relatively stable, hovering around 30%. Overall, the region's total tomato output diminished over the 16-year span.
With a similar trend, the place of the region in tomato production in Ankara province decreased from 63% to 43% in the given time period.

![Graph](image)

Figure 5.31. Percentage of vegetable production in the region in 2004, 2010 and 2020

From 2004 to 2020, Beypazarı was the dominant leader in **Lettuce** production in the region. While total lettuce yield increased from 2004 to 2010, it decreased slightly in 2020. Beypazarı's contribution was extremely stable over the years, hovering around 99%. In comparison, Ayaş and Güdül's contributions were minor, each contributing for less than 1% of the region's total lettuce production. Essentially, over the 16-year period, Beypazarı maintained its dominant position in lettuce production. Overall, the region’s contribution to lettuce production in Ankara decreased from 98% to 94% from 2004 to 2020.

The region experienced an upward trend in **Onion** production from 2004 to 2020. Initially, Ayaş was the primary contributor, responsible for about 60% of the region's output. However, by 2020, Beypazarı emerged as the dominant producer, covering over 70% of the regional production, a notable shift from its 40% in 2004. Güdül consistently had a minimal share throughout the years, never exceeding 0.2% of production in the region. Overall, the contribution of the region in the onion production in Ankara decreased from 11% to 7%.
**Spinach** production in the region saw a substantial increase between 2004 and 2020. While the 2004 production was modest, with Beypazarı as the main contributor at 84%, this dominance became more pronounced over the years. By 2020, Beypazarı was responsible for a staggering 98% of the regional spinach production. Ayaş's share remained relatively low, fluctuating around the 1-3% mark throughout this period, while Güdül consistently contributed less than 1%. In contrast to other vegetable types, spinach production drastically raised in Ankara from 5000 tons to nearly 40000 tons. The contribution of the region in this amount also increased from 88% to 98%.

**Fruits**

In addition to grains and vegetables, farmers in these districts mostly cultivate a wide variety of fruits, including grapes, apples, pears, peaches, plums, quinces, cherries, mulberries, and walnuts that have significant contribution to Ankara’s fruit production. This rich agricultural tapestry firmly puts these districts as among Ankara's most fruit-producing districts. The land use in the region also proves the presence of fruit production with vineyards and orchards existing in the mild climatic conditions in the region. According to TurkStat (2021), the districts under study play an important role in Ankara's fruit production.

In 2004, Grape production in the region amounted to 9,650 tons, a significant 67% of Ankara's total grape output of 14,313 tons. Ayaş contributed 7%, Beypazarı led with 52%, and Güdül accounted for 41%. By 2010, regional production increased to 13,977 tons, making up 45% of Ankara's 30,703 tons. Ayaş's contribution slightly increased to 6%, Beypazarı's share decreased to 53%, and Güdül saw a significant rise at 41%. By 2020, grape production in the region was 9,270 tons, which is 37% of Ankara's 25,034 tons. The distribution was Ayaş at 7%, Beypazarı at 78%, and Güdül with 15%. Among other fruit types, the contribution of the region to production of grape lost its prominence as Beypazarı ranks second only to Kalecik in grape production.
Figure 5.32. Percentage of fruit production in the region in 2004, 2010 and 2020

**Apple** production in the region in 2004 was 3,163 tons, accounting for 10.6% of Ankara's 29,891 tons. Ayaş, Beypazarı, and Güdül contributed 27%, 36%, and 37% respectively. By 2010, the region's production slightly increased to 3,574 tons, 11% of Ankara's 31,548 tons. Ayaş took a 54% share, Beypazarı had 14%, and Güdül with 32%. In this sense, Ayaş is Ankara's second-largest apple producer. In 2020, regional production was 3,516 tons or 14% of Ankara's 24,200 tons. Here, Ayaş dominated with 64%, Beypazarı had 13%, and Güdül contributed 23%.

In 2004, the region produced 2,032 tons of **Mulberries**, representing about 54% of Ankara's 3,749 tons. Ayaş accounted for approximately 49%, Beypazarı contributed 44%, and Güdül was at 6%. By 2010, this increased to 2,636 tons, or 66% of Ankara's 4,008 tons. During this time, Ayaş's share was 74%, Beypazarı's was 13%, and Güdül's was 13%. By 2020, mulberry production in the region climbed to 3,014 tons, comprising 75% of Ankara's total 4,014 tons. The contributions by district were: Ayaş at 62%, Beypazarı at 22%, and Güdül at 17%.

In 2004, the region produced 2,000 tons of **Cherries**, making up 40% of Ankara's 5,047 tons. Ayaş contributed 53%, Beypazarı added 36%, and Güdül was at 11%. By 2010, production increased slightly to 2,409 tons, accounting for 39% of Ankara's
6,111 tons. Ayaş's share was 45%, Beypazarı's was 17%, and Güdül's was 37%. By 2020, cherry production in the region reached 2,771 tons, which was 47% of Ankara's 5,918 tons. The district contributions were: Ayaş at 64%, Beypazarı at 10%, and Güdül at 26%. At the Ankara level, Ayaş notably produced around 30% of Ankara's cherries, amounting to 1,700 tons in 2020.

In 2004, regional Pear production was 2,483 tons, which was 12% of Ankara's 20,776 tons. Ayaş contributed 30%, Beypazarı 37%, and Güdül 33%. By 2010, this rose to 3,186 tons, accounting for 18% of Ankara's 17,646 tons, with Ayaş at 34%, Beypazarı 20%, and Güdül leading with 46%. By 2020, the region's pear production was 2,161 tons, which comprised 24% of Ankara's 9,128 tons. Ayaş led with 54%, Beypazarı followed with 35%, and Güdül was at 11%. Despite the region's relatively stable pear production, the overall decrease in Ankara's pear production increased the region's relative contribution to this fruit category.

In conclusion, while each district's agricultural practices and crop choices are distinct, several overarching trends, such as a shift toward husbandry and organic farming, are visible. The richness of the land, climatic circumstances, and socioeconomic developments all contribute to the agricultural narrative of these places.

Crop types reflect a wide range of crop options. In Ayaş, accounting for 77% of mention stated the crop types cultivated in the region. However, when it comes to crop selection procedures, Ayaş has a distinct preference for both irrigated and non-irrigated ways. When it comes to specific crops, there is a balanced representation of vegetables and grains at 30% each, with feed crops are closely at 20% each. In Ayaş, interview results present diversification of crops by farmers.

Beypazarı, on the other hand, follows a balanced context, placing equal focus on crop diversification and irrigation practices, each with a 50% share. Surprisingly, the farmers in the district evenly mention preference across all irrigation practices that
guide the Crop Selection. In terms of crop types, vegetables are the most popular (44 %), but grains (33%) and feed crops (23%) are also mentioned.

Table 30. Crop and product pattern of the farmers interviewed

<table>
<thead>
<tr>
<th>Crop and Product Type</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Crop Selection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Both irrigated and nonirrigated</td>
<td>10</td>
<td>42</td>
<td>3</td>
<td>100</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>(ii) Nonirrigated</td>
<td>8</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>(iii) Irrigated</td>
<td>6</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>(2) Crop Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Vegetables</td>
<td>12</td>
<td>35</td>
<td>3</td>
<td>30</td>
<td>4</td>
<td>44</td>
</tr>
<tr>
<td>(ii) Grains</td>
<td>10</td>
<td>29</td>
<td>3</td>
<td>30</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>(iii) Feed Crop</td>
<td>8</td>
<td>24</td>
<td>2</td>
<td>20</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>(iv) Legume</td>
<td>4</td>
<td>12</td>
<td>2</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
<td>100</td>
<td>13</td>
<td>100</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>

Güdül offers a slightly different scenario. Güdül, shows tendency towards nonirrigated (42%) and mixed irrigation techniques (33%) that rules the crop selection. Vegetables are the most preferred crop, with 33%, while Grains and Feed Crops are close behind, with 27% each. Legumes, while not the first option, account for 13% of the total. It is also important to note that farmers usually diversify the production in Güdül and Ayaş, whereas in Beypazarı, farmers show a tendency to follow single crop cultivation.

The region presents both mixture of irrigated and non-irrigated agriculture that supports diverse crop types. The regional agricultural landscape manifests distinct variances and similarities across Ayaş, Beypazarı, and Güdül, each characterized by similar crop selection and type.
5.1.2.3 Number of Farmers and Pattern of Landownership and Landsize

To comprehend the context of agricultural production in case study districts, it is necessary to investigate two fundamental factors: the fluctuation in the number of registered farmers over the past two decades and the landownership patterns exist in the region based on in-depth interviews and secondary data. The interaction between these elements not only provides insight into the agricultural fabric of the region, but also has broad implications for the socioeconomic and legislative dynamics at play such as the existing inheritance system.

Over the two-decade period, all areas observed a fluctuation in the number of registered farmers in the region. The data of PDoAF provides the number of farmers and its change between 2001 and 2020 in three districts under study. On a broader scale, the number of registered farmers in the entire province of Ankara fell by 7%, from 49,650 in 2001 to 46,339 in 2020. Figure 5.27 presents the change in number of farmers registered to the Farmers Registry System (FRS) from 2001 to 2020 in the districts of Beypazarı, Güdül, and Ayaş, and in the province of Ankara as a whole. Notably, the districts of Beypazarı and Güdül followed this declining trajectory, whereas Ayaş presented a contrasting pattern, experiencing a rise of 27% in registered farmers.

In Beypazarı, the number of registered farmers slightly decreased by 13% overall, from 2,654 in 2001 to 2,304 in 2020. Although the numbers peaked at 3,198 in 2007, they have generally shown a gradual decline since then. Güdül displayed the most significant reduction among the districts, with the number of registered farmers falling by 22%, from 581 in 2001 to 454 in 2020. The highest number of registered farmers was seen in 2004 with 908 farmers. Contrastingly, the district of Ayaş experienced an overall increase in the number of registered farmers. The number rose by 27% from 1,702 in 2001 to 2,169 in 2020. However, the growth was not consistent across the years, with a slight dip in numbers between 2008 and 2012.
In conclusion, the data provided by PDoAF presents the trajectory of change in registered farmers and indicates a general decrease in the number of registered farmers in the province of Ankara and the districts of Beypazarı and Güdül over the past two decades. Ayaş, however, went against this trend and saw a growth in the number of farmers.

The data of GDoAF, the number of registered farmers has the timespan between 2014 to 2020. and it supports the data from the Provincial Directorate of Agriculture and Forestry. There is no conflict among the data of different directorates.

In the interviews with the DDoAF branches in three districts, the representatives provided similar numbers as given by the provincial directorate (PDoAF). For instance, in Güdül, almost half of the registered farmers stopped registering, and by 2020, there were 450 farmers registered in the district. There are also concerns that the registration rate does not represent the real farmer population not only in the case of study districts but also in Turkey. For instance, the interview with the representative of DDoAF in Ayaş critically questions the reliability of the existing number of farmers registered in their records. Overall, there is a problem of

Figure 5.33. Change in registration rates to the FRS in Beypazarı, Güdül and Ayaş

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registration of the correct number of farmers, and this shows that the number of
farmers in the case study area might show different numbers than provided data.

According to the head of Ayaş DDoAF states that farmers register the areas with the
products that are supported by the government. They do not register other products
outside of the support scheme. This creates a problem in statistics.

“The cultivated land, i.e. the land cultivated with a plough, is not the same as
the land applied to the FRS. So, the two numbers are irrelevant. Do you know
what this also affects the statistics? In other words, I am willing to accept 5
per cent in agricultural statistics, but 50 per cent is wrong.... According to our
ÇKS system, you see either 10 decares or 20 decares of tomatoes in Ayaş. Look
how many tomatoes are in reality. Let me tell you the number of seedlings
distributed. At least 5 million seedlings. This is close to 5000 decares, at least
for tomatoes. I don't count peppers, but the FRS shows 10 decares. Don't you
think this is a waste of statistics?” (A3)

According to interviewee A3, one leg of the problem depends on agricultural land
ownership. On the other hand, land sizes and land law influence agricultural land
ownership and impacts the number of farmers registered to the Farmers Registry
System (FRS). Together with an agricultural support system based on land
ownership, these legal complexities further confound the landscape. This situation
stems from the inherent problems with the FRS.

According to the study of the Ministry of Food, Agriculture, and Livestock (MoFAL,
now MoAF), which is aimed at preventing the division of agricultural lands, the
average size of agricultural enterprises in Turkey is 83 decares, including cultivated
areas, fruits, and vineyards (Yüceer et al., 2013). When grazing lands are included,
this average increases to 133 decares. In international comparisons, the average size
of agricultural lands is larger than in Turkey. According to (Eurostat, 2023),
while the average sizes vary by country, the average size of agricultural land in the
European Union was 174 decares in 2020. Additionally, almost two-thirds of the
EU’s farms were smaller than 5 hectares (ha) in size in 2020, considering there are a
total of 9.1 million agricultural holdings. In Poland, a country half the size of Turkey, there are 1.3 million agricultural holdings. In contrast, the data obtained from PDooAF shows that there are more than 36 million agricultural holdings in Turkey. Contrast, the average farm size is 1818 decares, and there are 2076 farms In the USA (Yüceer et al., 2013). Clearly, the average size of land in Turkey shows a fragmented structure.

Like the EU, small parcels also dominate the distribution in Turkey, with 65% of total parcels being in the 0-5 decare category, yet they cover only 14% of the total area. Medium-sized parcels (5-10 da and 10-25 da) account for about 30% of total parcels and cover 37% of the total area. Similarly, parcels larger than 100 decares make up about 0.52% of total parcels but cover 26.76% of the total area.

The study by the Ministry of Food, Agriculture, and Livestock led by Yüceer et al. (2013) conducted field studies with producers all over Turkey to determine the economic advantages and disadvantages caused by the division of agricultural lands. The results of the study show that the highest number of producers who see the division and fragmentation of land as a problem are in the Central Anatolia Region, which is also covered in this study.

According to the research findings of Yüceer et al. (2013), the most significant economic problems caused by the division of enterprises are increased investment and production costs (22%), decreased agricultural income due to low production and yield (21%), increased input usage and labor loss (17%), limitations on the use of mechanization and technology (13%), inability to produce for the market (9%), difficulties in using agricultural credit (7%), and losses due to unclear land boundaries (8%). In similar vein, Yaslioglu et. al. (2009) assert that fragmented agricultural plots are one of the biggest issues hindering productivity in agriculture in Turkey. Authors reveal a modest trend toward land consolidation after the 1980s, but agricultural lands remain significantly fragmented for the longer timeframe of 1950 to 2001.
On the other hand, the study of Yüceer et al. (2013) also found economic advantages of the current property division. These advantages include supporting family livelihoods (27%), family labor working in agriculture and preventing unemployment (19%), pursuit of high yield per unit area (13%), preservation of biological diversity and local knowledge (6%), and ease of organic farming (5%). 31% of farmers stated that there are no economic advantages to fragmentation.

In order to determine the minimum sizes of agricultural lands and prevent their further division and also to ensure the protection and improvement of the soil, classify agricultural lands, the Law on Amending the Law on Soil Protection And Land Use No. 5403 has been updated with amendments made by Law No. 6537 in 2014\(^2\). The law defines methods and rules that encourage the planning and use of agricultural lands, as well as those agricultural lands generating sufficient income, in accordance with sustainable development principles. The law does not allow the division of agricultural lands under certain size. In order not to allow the decrease of land size below productive size, the law on the Protection of Agricultural Areas has been enacted to ban the division of agricultural lands by heritage. According to the law, agricultural areas cannot be divided under a limit that is defined as "Agricultural Land Sizes with Sufficient Income".

The legislation sets out the minimum area requirements for various categories of agricultural land in Turkey. For general farming land, marginal agricultural land, and special crop lands, the smallest acceptable area is defined as 2 hectares. For agricultural land with existing plantings, the minimum is 0.5 hectares, and for land used for sheltered agriculture such as greenhouses, it is 0.3 hectares. These minimum area limits cannot be decreased by splitting to shareholders. Nevertheless, for areas with unique climate and soil conditions, such as those suitable for cultivating tea, hazelnuts, or olives, MoAF can approve the formation of smaller plots if required by the characteristics of the land. The objective of these rules is to uphold productive

\(^{24}\) https://www.resmigazete.gov.tr/eskiler/2014/05/20140515-1.htm
farming operations by ensuring a certain size of agricultural land is maintained. The land sizes with sufficient income are determined according to peculiarities of provinces and their characteristics.

Land consolidation has become a tool for achieving land size that has adequate income and infrastructure to increase productivity. To establish farm holdings with adequate income, MoAF, in necessary cases, has the authority to consolidate or even expropriate agricultural lands that are smaller than the minimum agricultural land size based on Law No. 5403. During land consolidation processes, smaller lands can be combined with assigned lands to form new agricultural lands that meet the adequate income agricultural land size. This essentially allows for the creation of viable farming plots from smaller, potentially less productive pieces of land.

Under the framework of Law No. 3083 on Agricultural Reform Law on Land Arrangement in Irrigation Areas, several neighborhoods underwent land consolidation in Beypazarı, including Kızılcasöğüt, İncepelit, Uruş, and Yoğunpelit. In addition, a more extensive set of land consolidation activities took place within the scope of Law No. 5403. The neighborhoods involved in this initiative were Tahir, Oymaağaç, Tacettin, Dikmen, Mahmutlar, Kırşeyhler, Kapullu, Kirbaşı, Gürsoğüt, Kayabükü, Fasil, Köşebükü, Kuyucak, Çantarlı, and Akçakavak (MoAF, 2017b). The available data includes the qualitative interviews with farmers and secondary data point to land consolidation projects in Beypazarı.

Although the law aimed at increasing the productivity of the farming parcels, the application in the field yielded other problems. The first one of these problems that emerged in the interviews is that when the shareholders do not divide the land and register the land on one stakeholder and the other continue to use based on their internal agreement. In this case, the whole farm belongs to one stakeholder and unofficially, the other stakeholders continue to produce. This situation in return results in unofficial cultivators cannot be registered to FRS and not being able to benefit from the state supports. Thus, the number of farmers registered to the system is one, but more than one person cultivates the land with their own means.
The representative from the Beypazarı Chamber of Agriculture (B2) describes the practice of land consolidation in the local area and highlights the fact that consolidation can only be applicable with the revision of the land inheritance law.

"We had a consolidation project, but we stopped it. Despite being named 'consolidation,' it's not done properly. All they do is construct roads within the lands and collect money from the government. In recent years, this is what I've observed. There were 13 villages around us. The project was done in one of them, but it has problems. In the other 10-12, it's halted and it's uncertain what will happen next. They don't pay attention to anything, like infrastructure, or changing the land share ratios. For instance, if someone has land in 10 or 15 places, the logic of consolidation should be to reduce that to 3-4 places. But it wasn't like that here. Nothing changed. They just divided certain sections and built roads in between. The number of shares remained the same. Even if they say you can't sell or split it, the inner distributions remain the same. In fact, without changes in inheritance laws, consolidation doesn't make sense. One of Turkey's biggest problems is the inheritance law; it needs to be revised. Without changing it, consolidation is meaningless. This kind of consolidation won't work. To prevent fragmentation, inheritance laws need to change. Otherwise, no matter how you divide it on paper or restrict sales, the internal distribution remains the same. Inheritance law needs revision. There are many examples in Europe. It could be implemented by taking those as examples, but unfortunately..." (B2)

The data obtained from PDoAF (2020) presents the pattern of land fragmentation in both Ankara and Turkey, where many small and medium-sized parcels exist. However, a significant portion of the agricultural area is held by relatively few but larger holdings. The range of Figure 5.34 represents the distribution of agricultural holding size among the ranges of 0-5da, 5-10da, 10-25da, 25-50da, 50-100da, 100-500da, more than 500da.
As seen in above Figure 5.33, the majority of parcels in both Ankara and Turkey are of smaller size. In Ankara, about 58% of total parcels fall within the 0-5 decare range, accounting for 8.5% of the total area. Medium-sized parcels (5-10 da and 10-25 da) form a significant percentage in both regions. In Ankara, they account for about 32% of total parcels and cover roughly 33% of the total area.

Figure 5.34. The percentage breakdown of agricultural land sizes (in decares) Ankara and Turkey

Larger holdings, although fewer in number, occupy a considerable portion of the total area. For instance, in Ankara, parcels larger than 100 decares make up less than 1% of total parcels but cover around 23% of the total area.

The Law on Amending the Law on Soil Protection And Land Use No. 5403\(^{25}\) defines sufficient agricultural land size for Ayaş, Beypazarı and Güdül as respectively, 200 decare, 150 decare, and 200 decare. Yet, the study of Yüceer et al. (2013) classified the province of Ankara among the provinces with the highest average parcel size (19 da).

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25 https://www.resmigazete.gov.tr/eskiler/2014/05/20140515-1.htm
In-depth interviews reveal seven clusters concerning land sizes. Table 29 shows the distribution of mentions in total and among districts. The category frequencies show that almost 18% of farmers mention having land between 100 and 500 decare. Equally, farmers mention having land between 25 and 50 decare (12%) and 50 and 100 decare (12%). Farmers with 0 to 5 decares of land comprise almost 9% of all mentions. Specifically, farmers in Güdül have the largest share in 0–5 decare (17%), whereas no farmers in Beypazarı and Ayaş responded in this category. A similar share of farmers mentions having 50 to 100 decare of land (17%) in Güdül. Farmers in Güdül do not mention having land larger than 100 decare.

Table 31. Distribution of landsize among interviewed farmers

<table>
<thead>
<tr>
<th>Landsize</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) 0-5 da</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>(2) 5-10 da</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(3) 10-25 da</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(4) 25-50 da</td>
<td>4</td>
<td>12</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>(5) 50-100 da</td>
<td>4</td>
<td>12</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>(6) 100-500 da</td>
<td>6</td>
<td>18</td>
<td>1</td>
<td>20</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>(7) 500+</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>(8) Not a Producer</td>
<td>10</td>
<td>29</td>
<td>2</td>
<td>40</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>(9) Unknown</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
<td><strong>100</strong></td>
<td><strong>5</strong></td>
<td><strong>100</strong></td>
<td><strong>11</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Although there are limited interviews in Ayaş, the results show a high prevalence of renting (40%). One farmer was interviewed from each of the land size categories of 25–50 decare, 50–100 decare, and 100–500 decare. Almost 37% of farmers in Beypazarı mention having land between 100 and 500 decare, and 27% have land larger than 500 decare. Overall, Beypazarı farmers mention having the largest land size, while the farmers in Güdül have the smallest.
Finally, three categories emerged from the interviews with agricultural producers concerning landownership. The interview with the producers shows that 22 farmers responded to landownership. While each region has its own landownership patterns, there is a clear tendency of people diversifying their landholding practices, particularly by combining renting and owning. 26 % of all mentions refer that farmers continue production both on rented and own land. Farmers across the region, especially in Beypazarı and Güdül, use a combination of renting and owning.

Table 32. Landownership pattern of the farmers interviewed

<table>
<thead>
<tr>
<th>Landownership</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Rent and Own</td>
<td>9</td>
<td>26</td>
<td>1</td>
<td>20</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>(2) Rent</td>
<td>8</td>
<td>24</td>
<td>2</td>
<td>40</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>(3) Own</td>
<td>5</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>(4) Not a Producer</td>
<td>10</td>
<td>29</td>
<td>2</td>
<td>40</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>(5) Unknown</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>100</td>
<td>5</td>
<td>100</td>
<td>11</td>
<td>100</td>
</tr>
</tbody>
</table>

Production on rented land receives 24% of mentions and includes production on land of family and relatives who migrated to or live in other cities and towns.

40% of respondents from Ayaş solely rent land, making it the dominant landholding pattern in this region. Whereas in Beypazarı, only 9% rent land, making this the least common method of landholding in Beypazarı. Locals use the term "icara vermek" for the conditions they rent agricultural land. Almost a quarter of the mentions refer to the use of rented land which is above the share of use of only owned land.

Only 15% of the respondents solely own their lands. In comparison to other regions, Beypazar has a considerably greater rate of sole ownership. Additionally, a significant proportion, 29%, are not agricultural producers. This suggests that nearly a third of the sample is not actively involved in farming, yet they might still have stakes in the agricultural landscape through other means.
5.1.2.4 Agricultural Production Characteristics of Farmers

A comprehensive evaluation of the productive environment involves a thorough investigation of the farmers. Their characteristics, which are the result of individual decisions, traditions, and adaptabilities, impact the agricultural ecosystem's resilience, productivity, and evolutionary direction. This study considers three variables central: time in agricultural occupation, income categorization, and form of agricultural labor.

**Time in Agriculture**

The time dimension of a farmer's being present in agriculture might indicate accumulated skill, dedication to traditional techniques, and flexibility to the ever-changing agricultural context. Concurrently, income diversity, whether from varied farming activities or additional sources of income, provides insights into the farmer's economic resilience, risk-mitigation methods, and ability for creativity in an uncertain socio-economic and socio-ecological landscape. Finally, the agricultural labor structure—whether a farmer prefers family-based farming, operates as an individual producer, or uses external workers—provides insight into the socioeconomic dynamics, family engagement, and possible scalability of farming operations in the region.

Table 33. Time in agriculture of the farmers interviewed

<table>
<thead>
<tr>
<th>Time in agriculture (year)</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) 0-10</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>(2) 11-20</td>
<td>6</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>(3) 21-30</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(4) 30+</td>
<td>11</td>
<td>32</td>
<td>2</td>
<td>40</td>
<td>7</td>
<td>64</td>
</tr>
<tr>
<td>(5) Not a Producer</td>
<td>10</td>
<td>29</td>
<td>2</td>
<td>40</td>
<td>2</td>
<td>18</td>
</tr>
</tbody>
</table>
In-depth interviews present farmers are engaged in agricultural activities for the time periods of 10, 20, 30 or more than 30 years (Table 32). More than third of all farmers indicate that they have continued agricultural production for more than 30 years while almost one fifth (18%) have practiced for the years between 11 and 20. While more than half of all famers in Beypazarı (60%) and almost half in Ayaş (40%) represent the most experienced famers with over 30 years of practice, in Güdül, farmers present a more diverse scale of experience in terms the years that they have spent in practicing agriculture with 17% for up to 10 years, 22% for up to 20 years, and equally 11% for up to 30 and more than 30 years. One third of all farmers interviewed claim not being a producer, which falls under almost similar ratios in Ayaş and in Güdül.

**Income**

Income diversity is an important aspect when researching productive landscape and its productive actors. The responses gathered from producers who stated multiple income options. Overall, 76 responses identified four categories of primary income sources: (i) income from agricultural production, (ii) income from non-agricultural activities, (iii) diverse income sources, and (iv) agribusiness/trade. Additionally, there are two respondents whose income option was not available.

The results indicate that the primary source of income for all three regions is from agricultural production, which constitutes over 50% of all income resources (Table 33). Specifically, while plant production constitutes almost half of all production activities (41%), there appears diverse production types including Viticulture (8%), orchard (6%), husbandry (5%), beekeeping (3%), and poultry (1%). Consistently, in all case districts, almost or more than half of production (Ayaş: 46%; Beypazarı and Güdül: 52%) takes place in agriculture and the most significant subcategory of
agricultural production is plant production, which represents over 40% of the income from agricultural production in all three districts.

In Beypazarı, plant production represents over 58% of the income from agricultural production, while in Ayaş and Güdül, it accounts for approximately 40% and 32%, respectively. Following plant production, orcharding, and viticulture are the dominant income sources from agriculture in Güdül. Similarly, preferred husbandry and beekeeping are income sources in Güdül.

Table 34. Income sources of the farmers interviewed

<table>
<thead>
<tr>
<th>Income</th>
<th>Category</th>
<th>% in Total</th>
<th>Ayaş</th>
<th>% in Ayaş</th>
<th>Beypazarı</th>
<th>% in Beypazarı</th>
<th>Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Income from Agricultural Production</td>
<td>39</td>
<td>51</td>
<td>5</td>
<td>45</td>
<td>12</td>
<td>22</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>(i) Plant Production</td>
<td>16</td>
<td>41</td>
<td>2</td>
<td>40</td>
<td>7</td>
<td>58</td>
<td>7</td>
<td>32</td>
</tr>
<tr>
<td>(ii) Viticulture</td>
<td>8</td>
<td>21</td>
<td>1</td>
<td>20</td>
<td>2</td>
<td>17</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>(iii) Orchard</td>
<td>6</td>
<td>15</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>(iv) Husbandry</td>
<td>5</td>
<td>13</td>
<td>0</td>
<td>2</td>
<td>17</td>
<td>3</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>(v) Beekeeping</td>
<td>3</td>
<td>8</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>(vi) Poultry</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(2) Income from Non-Agricultural Activities</td>
<td>20</td>
<td>26</td>
<td>3</td>
<td>27</td>
<td>7</td>
<td>30</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>(i) Income outside Agriculture</td>
<td>14</td>
<td>70</td>
<td>2</td>
<td>67</td>
<td>5</td>
<td>71</td>
<td>7</td>
<td>70</td>
</tr>
<tr>
<td>(ii) Retirement pension</td>
<td>6</td>
<td>30</td>
<td>1</td>
<td>33</td>
<td>2</td>
<td>29</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>(3) Diverse Income</td>
<td>12</td>
<td>16</td>
<td>1</td>
<td>9</td>
<td>3</td>
<td>13</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>(4) Agribusiness/Trade</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(5) Unknown</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>76</td>
<td>100</td>
<td>11</td>
<td>100</td>
<td>23</td>
<td>100</td>
<td>42</td>
<td>100</td>
</tr>
</tbody>
</table>

Income from non-agricultural activities covers income sources of non-agricultural producers such as mukhtars and other institutional representatives and retirement pensions and accounts for 26% of the total income sources in the region. However, there are differences in the subcategories of non-agricultural activities among the districts. One third of income comes from non-agricultural activities in Ayaş (27%) and Beypazarı (30%).
Diverse income sources cover a combination of agricultural and non-agricultural income sources. For instance, as respondent profile subsection also explains, some institutional representatives continue agricultural production with institutional jobs or self-employment. This income type constitutes 16% of the total income sources in all three districts. Finally, agribusiness/trade and unknown sources of income represent minor sources of income across all three regions, with agribusiness/trade accounting for only 4% with equal responses from each district.

Relevant to income opportunities, the interviewers also mention that agricultural production loses prominence as a source of income, especially for the younger generation. A respondent replies as follows:

«Young people do not prefer jobs in agriculture. Women do not prefer man working in agriculture to marry. They want to migrate outside of Güdül to Ankara and other cities and find a job with minimum wage. » (G11)

Labor

Agricultural labor constitutes another component which helps explain the agricultural productive landscape of the region. It does not only describe the economic composition of the region, but it also provides clues about its resilience capacity to changing conditions. In-depth interviews reveal three types of labor in agriculture (Table 34). These include (i) the share of family farming, (ii) individual farming, and (iii) the use of labor during agricultural production among interviewers. Almost half of all mentions (40%) refer to family farming in the regions.

Table 35. Agricultural labor preferences of the farmers interviewed

<table>
<thead>
<tr>
<th>Labor</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Family</td>
<td>13</td>
<td>38</td>
<td>3</td>
<td>60</td>
<td>1</td>
</tr>
<tr>
<td>(2) Family and Workers</td>
<td>6</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

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Following this, 18% of farmers’ mentions indicate the use of workers additional to family labor during agricultural production. Individual production and using workers additional to individual labor have equal share of mentions (6%).

All producers in Ayaş use family labor whereas this is only half of the farmers in Güdül. In Beypazarı, almost half of the farmers use workers in addition to family labor. Overall, while family farming is most frequently mentioned, individual production has the smallest share. Both families and individuals prefer using workers depending on the land size, crop type and technology available.

5.1.2.5 Agricultural Organization and Support

Agriculture, generally seen as fields and products, is a complex web of institutions, procedures, and initiatives that guide the sector. This system relies on agricultural organization, which integrates numerous components including not only farmers as individual producers but also cooperatives, NGOs, and grassroots initiatives. This section examines the context of agricultural organization in the region through focusing on the current and changed state of agricultural organization with the help of the data obtained and the interviews conducted with the farmers and institutions in the region. It is important to note that the present study does not aim to explore and analyze the organizational process behind these actors of agricultural production in the region. In addition, the data obtained from the relevant institutions does not include data and information on the organizational aspects but provides statistical data on the number of cooperatives in the region. As a result, this section utilizes secondary data from different sources.
The data from GDoAR presents the types and numbers of cooperatives found in three districts. Overall, there are two types of cooperatives in general: agricultural production and irrigation cooperatives. According to the data, there are six Agricultural Development Cooperatives and two Irrigation Cooperatives in Güdül. Beypazarı has fewer Agricultural Development Cooperatives (four in total) compared to Güdül. The district has a slightly higher number of Irrigation Cooperatives with five. This implies a strong focus on agriculture and a particular emphasis on irrigation and water management in this district. Whereas this data source does not provide data on Ayaş district.

The data from PDoAF provides information about the number of agricultural cooperatives in Güdül, Beypazarı, and Ayaş districts as well as in Ankara between the years 2012 to 2020 (see Table 36). In Güdül, the number of cooperatives remained constant at 10 from 2012 until 2014, after which it decreased to 7, and maintained this number until 2019. A slight increase is noticed in 2020, when the number rises to 8.

Beypazarı initially had 15 cooperatives in 2012, but the number started to decline from 2014 and stabilized at 8 from 2015 to 2018. Like Güdül, Beypazarı also saw an increase in 2020, reaching 10 cooperatives. This shows a similar pattern to Güdül with a more pronounced decrease in the middle years. In Ayaş, the number of cooperatives initially decreased from 19 in 2012 to 13 in 2015 and then remained constant until 2018. However, in 2020, the number increased slightly to 14, indicating a slight recovery after a period of decline.

Table 36. Number of agricultural purpose cooperatives in Güdül, Beypazarı and Ayaş districts for 2012-2020

<table>
<thead>
<tr>
<th>Year/District</th>
<th>Güdül</th>
<th>Beypazarı</th>
<th>Ayaş</th>
<th>Ankara</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>10</td>
<td>15</td>
<td>19</td>
<td>214</td>
</tr>
<tr>
<td>2013</td>
<td>10</td>
<td>15</td>
<td>17</td>
<td>200</td>
</tr>
<tr>
<td>2014</td>
<td>7</td>
<td>9</td>
<td>14</td>
<td>170</td>
</tr>
<tr>
<td>2015</td>
<td>7</td>
<td>8</td>
<td>13</td>
<td>163</td>
</tr>
<tr>
<td>2016</td>
<td>7</td>
<td>8</td>
<td>13</td>
<td>157</td>
</tr>
</tbody>
</table>
In addition, there are 6 Agricultural Credit Cooperatives in the region with 3 in Beypazarı, 2 in Güdül, and 1 in Ayaş. Agricultural Credit Cooperatives in Turkey are organizations formed with the goal of enhancing agricultural production and improving producers’ socioeconomic conditions by giving financial assistance to small and medium-sized agricultural producers.

In conclusion, the general pattern of agricultural cooperatives in these districts and in Ankara overall decreased but a resurgence was noticed in 2020. This could potentially be due to changing agricultural policies or economic conditions that influenced the cooperatives’ formation and dissolution. The exact reasons, however, would require a more detailed analysis and additional data on the cooperative processes. To compare the datasets obtained on the number of cooperatives from PDoAF and GDoAR, two datasets show similar patterns.

The data of the DDoAFs in the supports the number of existing cooperatives with minor differences. The region of Güdül has a notable focus on the advancement of agriculture, as seen by the presence of numerous Agricultural Development Cooperatives. There exists a total of eight cooperatives, each with the ability to serve distinct localities or address special agricultural requirements. Significantly, the Karacaören Irrigation Cooperative plays an important role in expanding the irrigation systems in the district (MoAF, 2017c).

The Beypazarı district exhibits a well-organized arrangement of its agricultural establishments. Large areas of irrigated land are under the control of two important irrigation cooperatives, Krbaş and Başören, with Kırbaşi controlling an astonishing 1,500–2,000 decare. Moreover, the existence of 103 wells inside the Kırbaşi Irrigation Cooperative serves as evidence of dependence of agricultural production on underground water resources. In addition, Beypazarı is host to various
cooperatives with the purpose of agricultural development. The existence of four Agricultural Credit Cooperatives and four Agricultural Development Cooperatives demonstrates that there are limited and stagnated participation to the cooperatives concerning the almost stabilized number of cooperatives in recent years (MoAF, 2017b).

Even though Ayaş has fewer cooperatives than Güdül and Beypazarı, it maintains a balance between development and irrigation. Eight Agricultural Development Cooperatives and one Irrigation Cooperative are in this district. In addition, the existence of an irrigation union suggests a coordinated effort to manage and distribute water resources equitably among cultivators.

Table 37. Membership to Cooperative and Unions

<table>
<thead>
<tr>
<th>Membership to Cooperative and Union</th>
<th>Category</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Not a Member to a Cooperative</td>
<td>11</td>
<td>52</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>89</td>
</tr>
<tr>
<td>(2) Member to Cooperative(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[agriculture, husbandry, irrigation, rural development, Agricultural Credit Cooperative, Beet Cooperative]</td>
<td>9</td>
<td>43</td>
<td>1</td>
<td>75</td>
<td>5</td>
</tr>
<tr>
<td>(3) Member of a Union</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>21</td>
<td>100</td>
<td>4</td>
<td>100</td>
<td>8</td>
<td>100</td>
</tr>
</tbody>
</table>

In-depth interviews show that not all farmers tend to self-organize to facilitate their production processes (Table 37). While half of farmers do not engage in memberships of any kind of organization (52%), the other half states two significant membership status (48%): (i) a member of a cooperative, and (ii) a member of a union. The Agricultural Credit Cooperative and Beet Cooperative are given as examples to these organizations.
Güdül has the highest percentage with almost all farmers being non-member of any organization (89%). On the contrary, Ayaş has the highest percentage of cooperative members with 75% and followed by Beypazarı with 63%. Furthermore, only 5% of the total mentions refer to union membership, with Ayaş having the highest percentage of union members at 25%.

Concerning the NGO membership as a form of agricultural organization, Table 38 presents farmers’ membership status across three NGO categories including agriculture, rural development, and non-agriculture in the case districts. Almost half of all mentions (41%) refer to an association membership. More than one third (35%) stated being members of the Chamber of Agriculture. This distribution varies according to the districts. While all farmers in Ayaş claim their association membership, this is valid for almost half of Güdül farmers (45%). This shows that Güdül tends to be in a part of agricultural organizations. This tendency is also visible considering the activities of civil society organizations working on rural development and agricultural production.

Table 38. Membership to Non-Governmental Organizations (NGOs)

<table>
<thead>
<tr>
<th>NGO Membership</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Association Membership (agriculture, rural development, non-agriculture)</td>
<td>7</td>
<td>41</td>
<td>100</td>
<td>29</td>
<td>4</td>
</tr>
<tr>
<td>(2) Membership of Chamber of Agriculture</td>
<td>6</td>
<td>35</td>
<td>0</td>
<td>0</td>
<td>57</td>
</tr>
<tr>
<td>(3) No NGO Membership</td>
<td>4</td>
<td>24</td>
<td>0</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>TOTAL</td>
<td>17</td>
<td>100</td>
<td>100</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

The second most referred membership among farmers in Güdül (22%) also belongs to the Chamber of Agriculture. Whereas, nearly a quarter of the responses (23%) state as not being a member of any kind of non-governmental organization. Güdül has interesting results while two thirds of the mentions point to membership, one
third refers to no NGO membership. In Beypazarı, on the other hand, more than half of all farmers (57%) state their membership to the Chamber of Agriculture.

In-depth interviews also show the significance of farmers’ engagements in collaborative activities. Table 39 presents three types of collaboration: (1) Collaboration with Local Initiatives and Organizations, (2) No Collaboration, and (3) Collaboration with Governmental Institutions and International Platforms.

Equal share of mentions from farmers points to a collaboration with local initiatives and organizations (42%) and no collaboration (42%). The rest (%17) claims collaboration with governmental institutions and international platforms, both public institutional and international.

Table 39. Current state of collaboration among farmers

<table>
<thead>
<tr>
<th>Collaboration</th>
<th>Category</th>
<th>Frequency</th>
<th>% in Total</th>
<th>Ayaş</th>
<th>% in Ayaş</th>
<th>Beypazarı</th>
<th>% in Beypazarı</th>
<th>Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(1) Collaboration w/ Local Initiatives and Organizations</strong> [local initiatives and networks, NGOs]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Collaborating with Local Network</td>
<td>10</td>
<td>42</td>
<td>2</td>
<td>67</td>
<td>2</td>
<td>25</td>
<td>6</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>(ii) Collaborating with NGO</td>
<td>10</td>
<td>42</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>75</td>
<td>4</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td><strong>(2) No Collaboration</strong></td>
<td>10</td>
<td>42</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>75</td>
<td>4</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td><strong>(3) Collaboration w/ Governmental Institutions and International Platforms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Collaborating with Public Institutions</td>
<td>4</td>
<td>17</td>
<td>1</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>(ii) International Collaboration</td>
<td>2</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>24</td>
<td>100</td>
<td>3</td>
<td>100</td>
<td>8</td>
<td>100</td>
<td>13</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

In Ayaş, 67% of all interviewed farmers claim that they collaborate with local initiatives and organizations and 33% state a collaboration with governmental institutions and international platforms. This makes Ayaş the most active district in
collaboration with other bodies in agriculture. With the least membership to an organization, Güdül appears one of the second most active district in collaborative activities. Almost half of the farmers in Güdül indicate that they collaborate with local initiatives and organizations. Moreover, one third of all farmers in Güdül (33%) refer to a collaboration with governmental and international institutions. Whereas farmers in Beypazarı refer to very limited collaboration both with local, governmental, and international networks. Interestingly, with the highest membership of the professional chamber in the sector, three fourths of all farmers in Beypazarı (75%) claim no collaboration. The rest who states no collaboration are from Güdül constituting one third of all mentions (30%).

Based on the data provided from the institutions and responses for the interviews, the rest of this subsection focuses on the specific agricultural support programs and their background that aims for the sustainability of the productive landscape.

To improve the land capability of agricultural areas, The ÇATAK Program is a government initiative designed to safeguard the quality of soil and water, promote the sustainability of natural resources, prevent erosion, and mitigate the negative impacts of agriculture. The "Environmentally Purpose Agricultural Land Protection (ÇATAK) Program" which initiated in first in 2006, is a key part of Turkey's strategy to establish agro-environmental policies tailored to its unique conditions (Delikkaya & Atasever, 2021). The program originates from the Agricultural Reform Implementation Project (ARIP) which was published in 2001 with the monetary support from the World Bank for the financing of the ARIP activities. ÇATAK Program is one of the activities under ARIP in which the support is provided in the form of payments for designated areas over a period of three years. These payments are targeted towards three separate categories of practices that supports practices including minimum soil tillage farming practices, conserving the structure of soil and water and preventing erosion and environmentally friendly farming techniques.
and cultural practices\textsuperscript{26}. The province of Ankara has been under the ÇATAK (Environmentally Purpose Agricultural Land Protection) Program since 2011. According to the data obtained from GDoPP, under the Program, 3310 producers have received support payments amounting to 19706317 TL for an area of 272942 decares between the years of 2011 and 2019. In Ankara, the number of producers benefiting from the program has generally increased over the years, from just 25 in 2011 to a peak of 975 in 2018. However, there was a significant drop in 2019, with the number decreasing to 637. The program started applications in Beypazarı in 2016. The implementation of the ÇATAK Program was terminated as of the end of 2020.

The representative from Ayaş DDoAF (A3) mentions the ÇATAK program and its benefits, also adding that landownership problems hindered better operation of the program.

“\textit{The significant decrease in organic matter is largely due to this: farmers not taking ownership of their fields. For instance, there was a project by our Ministry of Agriculture called ÇATAK, which stands for the protection of agricultural lands for environmental purposes. It was a great project. It said, 'Collect the stones, apply animal manure, and we'll give you money.' It was a wonderful project. But the farmer would say, 'Okan Bey, the money you offer only covers a portion of our costs. I've cleared the stones from this land. You're going to give me 50 lira per decare. It's good money. I'll also apply manure. That's a 100-lira expense; 50 lira will come out of my pocket. Why would I do this for someone else's land?' We need to resolve the ownership issue as soon as possible”} (A3)

\textsuperscript{26} https://www.tarimorman.gov.tr/Konular/Bitkisel-Uretim/Tarla-Ve-Bahce-Bitkileri/CATAK
In addition to the support provided above, there are rural development projects implemented in the region under the activities of the Ankara PDoAF. The data obtained from the PDoAF presents various rural development projects that were implemented in the districts of Ayaş, Güdül, and Beypazarı between 2006 and 2020. The content analysis of the past and existing projects points to the tendency of the supports for agricultural production. These tendencies are clustered under four main dimensions.

The first one is the increasing attention towards integration of renewable energy in agricultural production. Across the districts, there's a visible shift towards renewable energy, particularly solar energy, as of 2014, showcasing a general trend in both districts through integrating sustainable energy solutions to farming operations.

The second trend concerns the grain-related projects which points to the dominant pattern of agricultural production. While there's a consistent interest in grain-related projects, with three significant undertakings between 2006 to 2019 in Ayaş, the highest grant allocated for a project was in 2019 for "Flour Factory Capacity Enhancement and Technology Renewal", which was 622500 TL.

Thirdly, farming and agricultural operations, from equipment upgrades to storage facilities, remain a consistent focus among the project themes. Beypazarı exhibits a strong emphasis on agricultural inputs, packing and post-harvest technologies like cold storage facilities. The highest grant allocation in Beypazarı was for a fertilizer processing and packaging facility in 2015, amounting to TL 627,016.04. Apart from that the allocation of rural development projects on the cold storage facilities and related technology improvements are a recurring theme and supports the vegetable production capacity of Beypazarı. The representative from the Gardeners Cooperative of Beypazarı (B1) points to the continuing need for increasing the capacity and the number of facilities for cold storage of vegetables and fruits for better marketing.

Thirdly, investment scales have grown over time. The projects towards the latter part of the period (post-2015) generally see higher financial support than the earlier years.
Güdül rather received support in animal breeding operations that shows the tendency of the agricultural production in the region in the given time period, marked with the highest amount of support given to the region. Finally, rural development efforts in the mentioned districts of Ankara over the period 2006-2020 display a diverse yet evolving approach. While the initial years were more about foundational infrastructures like storage and basic processing, the latter years marked a shift towards technological advancements, sustainability, and enhancement of existing operations.

5.2 Change in Man-made and Climatic Conditions, Resulting Impact and Response of Farmers on the Dimensions of Water, Soil and Plant

This section presents farmers’ responses in the case districts of the Northwestern Ankara to the impacts of manmade conditions and climatic conditions and their impact and response in three major dimensions: water, soil and plants. This also constitutes the analytical response to the 2nd sub-research question, which is: “How have changing conditions impacted natural resources and agricultural products within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?”

In-depth interviews reveal that farmers are affected by both man-made and climatic conditions. Man-made conditions mainly refer to infrastructural, agricultural, and economic interventions. Whereas climatic conditions consist of changes in seasons, temperature, rainfall, and snowfall patterns. In addition, this chapter delves into the impacts and responses by farmers against the changes experienced.

In the Northwestern regions of Ankara, encompassing Ayaş, Beypazarı, and Güdül, an array of shifting man-made and climatic conditions have instigated significant transformations in the socio-ecological landscape, markedly affecting natural resources such as water, soil, and plant life. A significant portion of respondents have underscored the overwhelming influences of infrastructural developments,
particularly thermal power plants and mining operations, which have threatened water quality and quantity. Water scarcity, pollution, salinity, and depleting underground water levels have surfaced as prime concerns. These water challenges have manifested differently across the districts: Ayaş is grappling with water scarcity, Beypazarı faces potential groundwater contamination, and Güdül is concerned about surface water reductions and Kirmir Creek pollution.

The soil, another vital resource, has not been spared either. Farmers across the districts have observed alterations in soil fertility and health, pinpointing both increases and declines in fertility. Concerns over heightened soil temperatures, pollution, and salinity have been especially pronounced in Beypazarı, whereas Ayaş has been battling with polluted and less fertile soils. Conversely, Güdül reported improved soil fertility, perhaps a reflection of its ecological farming practices.

Altered climatic patterns, especially inconsistent rainfall, combined with the adoption of hybrid seeds (as referred by the farmers), have manifested in almost 50% of farmers observing damages to plants. The onset of diseases, exacerbated by changing climatic conditions and possibly hybrid seeds, presents another significant challenge. Yields have been impacted, with Beypazarı farmers particularly feeling the financial repercussions.

For water challenges, while 42% remained traditional in their water usage, 27% ventured into new irrigation techniques. Beypazarı, notably, diversified its water sources. In confronting impacts related to soil, 60% of farmers turned to animal manure to bolster fertility, and Ayaş witnessed a unique transition from conventional to organic farming. To counter plant health and yield disruptions, farmers have demonstrated a combination of adaptive strategies. A considerable proportion of farmers, namely 62%, have made modifications to their production processes, which include changes in product patterns, pesticide utilization, and in certain instances, a transition towards organic farming. The adoption of a proactive position is particularly evident in Güdül, where 69% of farmers have chosen to pursue this method. However, it is noteworthy that a significant proportion of farmers,
particularly those located in Ayaş, have not implemented any significant measures in response to the mentioned climatic issues.

5.2.1 Man-made Conditions

Human interventions alter the productive landscape, particularly affecting water, soil, and plants. As urbanization and advanced agricultural practices gain momentum, they bring about significant changes to these core components. This subchapter delves into the manmade conditions that impact the natural resources farmers use for production including water and soil as well as the plants that they produce.

The respondents referred to man-made conditions clustered under three main groups of interventions: (i) infrastructural constructions (63%), (ii) agricultural system (%31), and (iii) hybrid seeds (6%) (see Table 40).

Infrastructure, including thermal power plants, mines, and water treatment plants represent the most repeatedly cases as a source of main environmental problems, which, in turn, impact farmers’ agricultural activities. Some of these facilities are Çayırhan Thermal Powerplant located in Nallıhan district on the border of the case study area, Eti Soda Mine in Beypazari and other type of mines exists in Ayaş and Beypazari. This category represents a substantial proportion of 63% in relation to the overall number of mentions. The district of Güdül demonstrates a significant focus on the impacts of infrastructures, as indicated by 78% of all mentions. Ayaş and Beypazari exhibit notable percentages of mentions, with 50% and 59% respectively (see Table 40).

Among these, Güdül farmers demonstrate the highest level of mentions within this category. Although Güdül stays relatively remote from infrastructural and industrial land use developments as represented in Figure 5.17, the infrastructural development plans in the region including cancelled hydroelectric power plant on Süveri Creek in mid-2010s and recent mine development proposal in the region might be the reasons
for high number of mentions as farmers has a collective action practice against the detrimental impacts of development on the environment. In addition, interviewed farmers in Güdül has developed more awareness to the sustainability discussions due to relatively high level of civil society organization might resulted in more awareness towards the impacts of infrastructural developments on agriculture.

Among the several aspects encompassed by the domain of infrastructure, thermal power plants emerged as the most cited subject, constituting a significant majority of 59% in relation to mentions pertaining to infrastructure. The impact of thermal powerplants received the highest number of mentions from the regions of Beypazarı and Güdül, constituting 62% and 57% of references, respectively.

The Çayırhan Thermal Power Plant, located in Nallıhan district which is adjacent district to the case study area on the west, started its operations in the year 1978 (IDPAD, 2022). The power generating facility is strategically situated near the borders of the Sariyar Dam of Sakarya River, which acts as a demarcation between the Beypazarı and Nallıhan districts. The lignite is supplied from Beypazarı District of Ankara Province, which is one of the most important and largest lignite coal mining fields in Turkey.

Currently, there is not any research particularly directed at the impacts of thermal powerplant on agricultural production in the region. However, there are limited number of studies that focus on the impacts of thermal powerplants on the soils in surrounding region of powerplant.

Karaca et al. (2009) analyzed the impact of Çayırhan Thermal Power Plant's emissions on nearby soils, considering prevailing winds from the northwest to southeast and a locally observed wind from the northeast towards Beypazarı. Soil samples revealed higher contamination in areas aligned with the prevailing wind direction. Notably, these soils had decreased pH values, suggesting SO₂ interaction (Karaca et al., 2009). The study identified significant sulfur pollution, especially in the Beypazarı northeast region, and elevated cadmium levels exceeding regulatory
limits. The high sulfur content in the soil increases its acidity, raises the pH value of the water in contact with the ground, and restricts plant nutrition. Cadmium in the soil creates a toxic effect (IDPAD, 2022).

Table 40. Man-made conditions that impact agricultural production

<table>
<thead>
<tr>
<th>Man-made Conditions</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdüllı</th>
<th>% in Güdüllı</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(1) Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Thermal powerplant, water treatment plant, lime mine, soda mine]</td>
<td>22</td>
<td>63</td>
<td>2</td>
<td>50</td>
<td>13</td>
<td>59</td>
</tr>
<tr>
<td>(i) Thermal Powerplant</td>
<td>13</td>
<td>59</td>
<td>1</td>
<td>50</td>
<td>8</td>
<td>62</td>
</tr>
<tr>
<td>(ii) Mine [Etisoda, Stone, Lime]</td>
<td>8</td>
<td>36</td>
<td>1</td>
<td>50</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>(iii) Water Treatment Plant</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>(2) Impacts of Agricultural System</strong></td>
<td>11</td>
<td>31</td>
<td>1</td>
<td>25</td>
<td>9</td>
<td>41</td>
</tr>
<tr>
<td>(i) Conventional Agriculture</td>
<td>6</td>
<td>16</td>
<td>1</td>
<td>25</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>(ii) Hybrid Seeds</td>
<td>5</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td><strong>(3) Human Disturbance to Natural Environment</strong></td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>35</td>
<td>100</td>
<td>4</td>
<td>100</td>
<td>22</td>
<td>100</td>
</tr>
</tbody>
</table>

In line with this, although not located close to the power plant, the farmers in Güdüllı mention the impacts of the powerplant. This situation supports the assertion of Karaca et al. (2009) that wind direction is more relevant indicator than proximity to the power plant considering the experienced wind-direction from Kirmir Creek Basin in the northeast might also cause transfer of polluters to the Güdüllı district. However, this assumption needs further scientific studies in the region to assess the actual impacts of the thermal powerplant on the socio-ecological system, including understanding of the impact across subsystems of SES. The existing studies are not
sufficient to understand the actual impact on SES. Yet, these power plants has hidden costs and the impacts of thermal powerplants on the SES is absolute.

A recent study conducted by a non-governmental organization, IDPAM (2022), indicate that, at different measurement intervals and for a range of pollutants (including PM10, PM2.5, NO2, and SO2), the documented measurements consistently surpassed the prescribed daily and annual thresholds or recommendations established by regional environmental regulations, the World Health Organization (WHO), and the European Union (EU). This observation suggests that the air quality within the designated region routinely violates both local and international benchmarks, hence presenting potential hazards to human health and the environment. Yet, more studies are needed to understand and find interrelations on the impacts of thermal power plants not only on singular dimensions of the SES such as soil, air or health alone but in a more interrelated way.

An expert from Güdül DDoAF narrates the impacts on thermal powerplant on their agricultural production, specifically plants as such:

“Viticulture without using chemicals was possible in Güdül before. The impact of powerplant is that the particules clog the stomas of the plants. The thermal power plant damages the environment in this way. “(G15)

While 60% of the farmers interviewed consider that the thermal power plant has impacted the agricultural production negatively and increased plant diseases, the expert from Beypazarı DDoAF explains the problem from a different perspective. The interviewee considers that the increased use of inputs and increased yield creates vulnerability to plant diseases and insects as hybrid types are more vulnerable.

“I'm not sure if it [thermal power plant] causes [plant] disease. Thermal power plant started operation in 1984... In 1984 they [farmers] were still using

27 https://ekolojikolektifi.org/portfolio/termik-santrallerin-maliyeti-alternatif-bir-degerlendirme/
heirloom seeds, their fields were strong because they used animal manure. Since then, chemical fertilizers have been heavily used, and resistance has dropped, as new hybrid strains and chemical fertilizers have been used and resistance to disease and pests has dropped. There is such a thing in agriculture. The higher the yield, the more open to diseases. Since new hybrid strains are grown instead of plants that used to adapt here, they are not that resistant to diseases and pests here. The yield does not decrease, it is much more than before, but the [plant] disease is increasing." (B3)

The second infrastructural condition that is dominantly mentioned by the farmers are the establishment of mines such as those pertaining to Eti Soda Mines in Beypazarı and other stone and lime mines in the region. As discussed in the subsection on Land Use and Land Cover (LULC), mine development were notably prevalent, particularly in the regions of Ayaş and Beypazarı.

Eti Soda mine is one of the facilities that were mentioned by the farmers in Beypazarı. Eti Soda San. ve Tic. A.Ş., also referred to as Eti Soda, was established in 1998 with the primary objective of extracting and processing trona mineral reserves. These reserves were initially identified in 1979 as a byproduct of coal drilling activities in the Beypazarı area of Ankara. The major objective was to provide these significant reserves to the national economy. In 2007, Eti Soda initiated the process of establishing its mining operations along with a thermal power plant. The start of production in these facilities took place in 2009. There is not any scientific study found related to the impacts of mine and its associated thermal power plant on the local communities, agricultural production and overall SES interrelation.

Relevant to the impacts of Eti Soda Mine, the head of Chamber of Agriculture in Beypazarı (B2) responds as follows:

“There's Eti Soda mine. It extracts the ore with water. It gives hot water to the underground. For this reason, hot water dissolves some minerals, so we think that soda mines are mixed into our water in my region. Most people in my
region could not use their water. In this sense, we do not know what to do.” (B2)

“There's an Eti Soda mine here. The underground is not used for drilling at the moment. It [pollution] has penetrated 80 meters of drilling here. When you irrigate from there, carrots, lettuce, spinach, all the plants dry up.” (B5)

Apart from Eti Soda Mine, as the largest mining establishment in the region, there are lime and stone mines at different scales already existing or planned in the region. One of the mining projects which drew the reaction of the local people and non-governmental organizations and was sued with the participation of the public is a proposed mine project in the Uruş Neighborhood in Beypazarı District and close to other villages in Güdül District. The mine project involves open-pit extraction and crushing-screening of sepiolite, a form of clay. Residents of Uruş, Tahtacıörençik, and nearby neighborhoods on the border of Beypazarı and Güdül districts, along with village leaders, NGOs, and institutions, oppose mining in this location due to its natural and agricultural significance. Local NGOs have filed a lawsuit against the Ankara Provincial Directorate of Environment and Urbanization’s decision to not require an Environmental Impact Assessment (EIA) for the proposed project to halt execution of the project as the proposal threatens the local community’s right to a healthy environment and the area’s eco-friendly agriculture and livestock activities. The expert report of the lawsuit stated that the EIS report is necessary as mining could lead to the loss of agricultural lands in Uruş Village, depriving villagers of their agricultural income. Dust from mining activities may contaminate agricultural lands in both Uruş Village and neighboring Güdül areas, leading to

potential crop yield and quality losses for cultivated fruits, vegetables, and vineyards\textsuperscript{30}.

Another mine based environmental struggle is the planned lime mine in Doğanyurt village of Beypazarı that suggests establishment over pastures. The land use analysis presented under the subsection ccc also provides spatial insight on the location of the proposed mine in Beypazarı where there has been a transition from natural and agricultural areas to mining areas for industrial purposes between 1990 and 2000. Yaşar (2020) evaluates the spatial and ecological impacts of proposed mine on the region. According to the author, the proposed limestone quarry, located near vital agricultural and pastoral lands, poses significant threats to the region's primary economic activities: farming and livestock rearing. Despite the Ankara 2038 plan emphasizing land preservation, the quarry's operations may produce dust that can harm nearby farmlands, forests, and grazing areas essential for local livestock, including the renowned Tiftik goats. Moreover, the quarry's water usage, sourced from the local drinking water supply, could worsen the already pressing water scarcity issues and the region's desertification risks. Consequently, the quarry could profoundly disrupt and degrade the local environment, affecting the livelihoods of over 1,500 residents who rely on these resources. These impacts were also highlighted by several other NGOs from local, provincial and national level produced reports to assess the current situation for the same mining area. For instance, Nature Association produced a report that assess the impact of mine on the natural environment\textsuperscript{31} and the Association for the Research of Rural Environment and Forestry\textsuperscript{32} on the impacts on rural environment. Notwithstanding the presence of abundant biodiversity in the project region, it was granted an exemption from undergoing the Environmental Impact Assessment (EIA) process. The judgment was

\textsuperscript{30}https://www.birgun.net/haber/madene-direnen-yurttas-kazandi-386470
legally contested by a coalition of concerned locals and civil society organizations. Based on a comprehensive expert assessment, the legal proceedings ended in the termination of the project. In the expert view, the Ankara Metropolitan Municipality Water and Sewerage Authority (ASKİ) has raised concerns regarding the project, citing alterations in the direction of groundwater flow caused by explosive mining operations and emphasizing the necessity of safeguarding possible water sources within the vicinity. As a result, the project was determined to be in violation of rules, leading to the termination of the Environmental Impact Assessment (EIA) procedure by the EIA Permit and Supervision Directorate.33

Farmer A4 describes the impacts of mining activities in Ayaş as below:

“There are quarries close to our village. Our old values are going away. They set up 3 quarries and at least half of the 500-year-old mountain is gone. Aside from their dust and soil, they dried half of the 300-year-old pear trees. We have this. They don’t take any precautions. They always spoil our roads. They explode dynamite, chaning underground water ways. There is also dust, dust on the grapes, dust on the crops.” (A4)

The last subcategory under the infrastructural conditions is related to water treatment issues. The district of Güdül distinguishes itself by its notable inclusion of a water treatment facility, hence emphasizing a distinct concern within the area. Similar to the findings, there is a study that find out the organic pollution in Kirmir Creek, especially in Güdül sections (Kucuk & Alpbaz, 2008). However, recently, a water treatment plant started operation in 2018 in Kızılcahamam where Kirmir Creek origins.

The second most referred dimension mentioned by the farmers as man-made condition that impact on the natural resources and plants in productive system is the

existing **agricultural system** operations. The discussion around the impacts of agricultural systems, particularly conventional agriculture, and the utilization of hybrid seeds, accounted for 31% of the overall mentions. Beypazarı district referred to notable level of impact and responsiveness towards the evolving agricultural dynamics, as seen by its representation of 41% of the total mentions. The subject of conventional agriculture continues to be a matter of discourse in Ayaş and Beypazarı; nevertheless, it is noteworthy that it is not mentioned in Güdül. These results are aligned with the agricultural profile of the region where Beypazarı is characterized by conventional agriculture and Güdül by ecological practices that farmers mentioned accumulated impacts of the system as discussed in the section on Number of Farmers and Pattern of Landownership and Landsize.

Lastly dimension, **environmental disturbances**, refer to events or processes that disrupt the natural balance and functioning of ecosystems. These disturbances can be caused by human impact on the natural environment such as river pollution, pollution by the visitors of natural areas. These disturbances cited less frequently, account for 6% of the total mentions. Both Ayaş and Güdül have a similar number of mentions under this category. Interestingly, the farmers in Beypazarı did not express this as a significant issue, suggesting that there may be either limited disruptions in the area or other more prominent concerns.

### 5.2.2 Change in Climatic Conditions and Disasters Experienced

Agriculture in the region is undergoing significant changes due to climatic changes. Clear trends emerge from discussions with local farmers from several districts. These changes, which include changes in seasons, rainfall, temperature, and snowfall, pose both problems and implications for the agricultural industry. This section examines these climatic changes in depth, focusing on how they manifest differently in different districts.
Farmers highlighted the impact driven from the **change in climatic conditions**. Accordingly, they referred to four types of change: (i) change in seasons, (ii) change in rainfall, (iii) change in temperature, and (iv) change in snowfall. As shown in Table 40, the case districts almost equally experience change in seasons (33%), change in rainfall (30%), and change in temperature (27%).

Table 41. Changed climatic conditions based on interviews

<table>
<thead>
<tr>
<th>Changed Climatic Conditions</th>
<th>Frequency</th>
<th>% in Total</th>
<th>Ayaş</th>
<th>% in Ayaş</th>
<th>Beyazari</th>
<th>% in Beyazari</th>
<th>Güdül</th>
<th>% in Güdül</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td>(1) Change of Seasons</td>
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<td>33</td>
<td>2</td>
<td>29</td>
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<td>13</td>
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<tr>
<td>(2) Change in Rainfall</td>
<td>20</td>
<td>30</td>
<td>3</td>
<td>43</td>
<td>25</td>
<td>12</td>
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<tr>
<td>(i) Decrease in Rainfall</td>
<td>8</td>
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<tr>
<td>(ii) Fluctuation in Pattern</td>
<td>6</td>
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<td>0</td>
<td>1</td>
<td>20</td>
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<td></td>
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<tr>
<td>(iii) Increase in Rainfall</td>
<td>6</td>
<td>30</td>
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<td>1</td>
<td>20</td>
<td>2</td>
<td></td>
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<tr>
<td>(3) Change in Temperature</td>
<td>18</td>
<td>27</td>
<td>2</td>
<td>29</td>
<td>5</td>
<td>25</td>
<td>11</td>
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<td></td>
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<tr>
<td>(i) Increase in Temperature</td>
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<td>80</td>
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<tr>
<td>(ii) Temperature Gap</td>
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<td>28</td>
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<td>0</td>
<td>1</td>
<td>20</td>
<td>4</td>
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<tr>
<td>(4) Change in Snowfall</td>
<td>6</td>
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<td>0</td>
<td>3</td>
<td>15</td>
<td>3</td>
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</tr>
</tbody>
</table>

The region as a whole has experienced noticeable climatic shifts, with the most prevalent being the **Change of Seasons**, accounting for 33% of all climatic alterations.

“The climate has changed. A lot. For example, it came a month late this year. Our tomatoes should have turned red by now. But it won’t be red for another 15 days. It came a month later. Our bees were also surprised. Until recently, we used to cover the bees to prevent them from getting cold. So, it has changed a lot.” (G7)

Based on the interviews, this category appears to be relevant with both change in rainfall and change in temperature. Farmer A1 narrates the interrelatedness of the
climatic conditions on the agricultural production, that sets a direct relationship between experienced climatic impacts of the accumulated human actions on agricultural production.

“Of course, climate change has affected us a lot. Well, a lot. We are the ones who did it, with these pesticides, fertilizers, everything. It has affected us. It definitely leaves damage to every year's crop from somewhere. There are either hail disasters, floods, or severe droughts. In other words, it is dry, suddenly there is excessive rainfall, and the crops are flooded. I mean, the effects of this are too many.” (A1)

Farmers mention three types of change in rainfall. These include: (i) decrease in rainfall (40%), (ii) fluctuation in rainfall pattern (30%), and (iii) increase in rainfall (30%). Ayaş, for example, has experienced a significant change in rainfall, with a sharp 100% rise (with the mentions by all farmers). Beypazarı, on the other hand, experiences 60% loss in rainfall despite a 35% shift in the season pattern, the most among the districts. Almost half of all mentions by the farmers in Güdül (42%) equally indicate both decreases in rainfall and fluctuations in rainfall patterns.

“Now, the main source of our groundwater is snow. rainwater flows away, the region does not receive snow due to climate change and rains do not fall.” (B3)

“Rainfall has decreased. For example, April rains fall in May and early June. In our childhood, April rains used to fall in April, and everything would be green in May. Now it rains at the end of May and beginning of June. Our crops, barley and wheat are damaged.” (G6)

Farmers refer to two types of change in temperature. While three forth of all mention (72%) claim an increase in temperature, one fourth (28%) stresses the temperature gap between day and night. Temperature changes are uniform throughout districts, but their intensity varies. Temperatures in Ayaş and Beypazarı have risen by 100% and 80%, respectively. Güdül follows the trend, albeit at a
comparatively lower 64%. On the one hand, 80% of all mentions about the temperature gap between day and night come from Güdül. On the other hand, 80% of the mentions from the farmers in Beypazarı refer to an increase in temperature.

“There's a big difference in temperature between this year and last year. It's 38 [Celsius] degrees now, even though it's the end of August. Before, it used to get colder after the 15th of August. Now, on the contrary, summer is coming after August. The weather is hot until November... As a result, this year our tomatoes ripened 15 days later than last year. In other words, they turned red. Last year we delivered them to the market 15 days earlier.” (G6)

“There is a big difference between day and night temperatures. Summer started to come later; winter started to come later. So, the seasons are changing. Therefore, it stresses the fruits and vegetables and reduces the yield.” (B4)

The producers' observations can be correlated with the temperature and precipitation data that have been recorded. For instance, the analysis reveals varying district temperatures with a notable increase in certain years. There is a correlation between these recorded fluctuations and the experiences of farmers, particularly in terms of how variable seasons impact agricultural practices. However, further research with more detailed and accurate data collection would be needed to conclude.

Almost one tenth (9%) associate the experienced impact with change in snowfall. But in Ayaş, while almost half of all mentions (43%) state the significance of changed rainfalls, change in snowfall is not experienced at all in this district. Change in snowfall is experienced the most in Beypazarı among all districts with 15%. The obtained meteorological data for Beypazarı reveals a fluctuating trend between 2000 and 2013. However, between 2013 and 2020, there were no days with snowfall recorded. A significant decline in snowfall could have profound effects on agriculture, particularly in terms of crop water availability. Farmers' accounts of reduced water availability and challenges in irrigation could be direct outcomes of these decreased snowfall and drought conditions.
A farmer in Beypazarı (B3) narrates the change in snowfall which is also relevant to the change of seasons.

“We're not living in winter. No, we don't live in winter. It used to snow seven meters in Beypazarı. Now it snows about a finger. And what's falling is melting. When I was a child, we used to go to the village in summer. In winter, my brothers were in primary school. We used to come to Beypazarı center. The neighbors used to make a road to the bazaar with shovels. Men and women, people removed the snow the front of their houses so that we could come to the center... Now it's not snowing at all, but the snow is melting.” (B3)

” It’s not snowing anymore. Snow doesn't feed the water like it used to. Snow feeds the water at the bottom. It's not snowing, my dear. You can see. Winter is like summer and summer is like winter.” (B9)

“In the past, it used to snow and rain on 10th November or so, we couldn't enter the fields. We couldn't do anything. Now we plant until the end of November. We are sowing cereals. So now you can think about it. The climate has gone a month ahead or months... We didn't know what happened.” (G11)

In-depth interviews also revealed the types of **disasters** that farmers experience during their agricultural activities and that negatively impact their productivity. These include (i) hail, (ii) drought, (iii) flood, and (iv) frost (see Table 42).

The most frequently mentioned experienced disaster is hail, with 53% of the total mentions. This is followed by drought with 28% and flood with 13%. While Beypazarı and Güdül represent the general trend of the region with similar distribution of impacts, Ayaş equally experience hail (33%), drought (33%), and flood (33%). Frost represents a disaster category that receives the fewest references, with only 6% of all mentions, and it seems to constitute a problem equally in Beypazarı (7%) and in Güdül (7%).
Table 42. Experienced disaster according to interviews

<table>
<thead>
<tr>
<th>Experienced Disasters</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Hail</td>
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<td>1</td>
<td>33</td>
<td>50</td>
<td>9</td>
<td>60</td>
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<tr>
<td>(2) Drought</td>
<td>9</td>
<td>28</td>
<td>1</td>
<td>33</td>
<td>29</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>(3) Flood</td>
<td>4</td>
<td>13</td>
<td>1</td>
<td>33</td>
<td>14</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>(4) Frost</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>100</td>
<td>3</td>
<td>100</td>
<td>14</td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>

Across the region, hail stands out as the dominant climatic disaster, affecting each district substantially but being most pronounced in Güdül. Yet, this disaster type is the most predominant category among farmers in both Beypazarı and Güdül.

“Of course, I think the climate has changed. There was no fear of hail disaster before. Now we live in fear of hail. 3 years ago, a hailstorm destroyed our land. We couldn't harvest anything; it was harvesting time. We didn't get a harvest.” (B7)

“We get hail almost every year. Hail happens in our village every year. It was not like this in the past. It used to happen once every 3-5 years, once every 10 years. I don't know why now. It hits one side of the village every year.” (B10)

"In the past, our grandparents used to say that hail wouldn't fall at night, but now it does. In the morning, when you go to harvest the lettuce, hail has ruined it. They used to say hail doesn't fall at night. I've seen this before, roughly before the 2000s; we were going to harvest the lettuce, and it had hailed. We had never heard of hail at night before." (B6)

“For example, you're planting seedlings and hail comes. It starts to hail, and the seedlings are gone. The fruit is gone. This year there were two families planted, the next day it was completely gone...In this village, for example,
seedlings were planted two or three times because of hail. Farmers planted two or three times.” (G1)

While the data from GDoM (2021) suggests no days with hail between 2013 and 2020 in Güdül and Ayaş, and Beypazarı only recorded hail in 2011, farmers' testimonies contrast these findings. They claim to have experienced hail during this period, emphasizing a disparity between ground experiences and official meteorological records. This underscores the localized nature of climatic events like hail, which can sometimes evade regional meteorological stations' records. It also highlights the importance of collecting and integrating localized and experiential knowledge to offer a complete understanding.

The second most frequent disaster is drought, making up 28% of climatic disasters. Some of the mentions related to the issue of "drought" or "decreasing water levels," and its adverse impact on farming and agriculture are below:

“There is also drought this year. In other words, in most places here, in our chickpea fields, drought up to 100 per cent, in partial places. As a farmer, I planted about 250 acres of chickpeas. 100 acres of chickpeas I won't take a combine harvester, I won't go for plowing, I won't go for anything. Now the animals there will spread.” (G11)

"It's been very dry; the waters have decreased. We didn't have many problems in the past, the waters didn't decrease much. For the past 3-4 years, there's been a significant reduction in water. The stream from which I fetch water is also drying up, and my water supply is dwindling. Water that used to flow as thick as a wrist now flows at this much. It's been decreasing for years. Because when there's no winter..." (G3)

Less common than the above two, farmers also experience flood and frost as climatic disasters. The dominancy of the hail as a climatic disaster that flood was also put forward by farmer B4 as he compares the impact of two disasters:
“We have had hail for a few years. When there is a flood, it does not do much, it chooses a place for itself because it leaves a certain nest, it affects that area. Hail is not like that, once it comes, it takes everything away.” (B4)

Frosts, being the least frequent disaster (6%) in the region, are comparably rare in all districts. Frost can damage or kill crops when temperatures drop abruptly. Local producers might experience decreased yields and income because of frost damage as narrated by Farmer B5.

“This year [2020] we had frost in May. In May. It froze hard in May. Wheat yielded 150kg, for example.” (B5)

5.2.3 Impact and Response to Changing Climatic Condition in Farmers’ Use of Water and Soil and their Cultivation of Plants

In-depth interviews reveal that farmers experience change in their use of water and soil during their agricultural production activities as well as in their cultivation of plants in the face of changing climatic conditions. The impact of climatic conditions on these natural resources also forces farmers to seek adaptive responses to enhance their agricultural production. This section presents the impacts emerging due to uncontrollable conditions and farmers’ responses to the emerging circumstances.

The dynamic nature of climatic conditions presents a range of complex issues in the dimensions of water, plant, and soil health. The region is currently decreasing in water level in all three districts, particularly the declining levels of groundwater and water bodies, resulting in concerns such as water scarcity, pollution, and salinity. Farmers in all districts respond to this problem by continuing their habitual water use, adopting new methods, and taking initiatives in water management.

The issue of plant health is of utmost importance, as it is adversely affected by a range of climatic extremes. These adverse conditions lead to the development of diseases, a decline in crop output, and significant financial loss. Certain farmers are addressing these difficulties by modifying their agricultural techniques, actively
pursuing information, and making use of incentives. However, certain locations, such as Beypazarı, demonstrate a deficiency in their proactive response. In Ayaş and Güdül, farmers change the production phases and the season of production, they gain knowledge, and use available incentives.

The soil's condition has also experienced negative effects, leading to observable deterioration in soil fertility, namely in the regions of Beypazarı and Ayaş due to using the chemicals and switching to certified seeds. In contrast, the region of Güdül has observed an improvement in soil health as Güdül, the most natural and locally organized district. Various adaptive solutions, such as the utilization of animal manure, adoption of methods to increase soil carbon and the alteration of production methods, have been implemented. However, it is important to note that the degree of urgency and intensity in these responses differs among locations.

5.2.3.1 Water

Farmers identified six categories of impacts related to water, including (i) water scarcity, (ii) pollution and water salinity, (iii) decrease in subterranean water levels, (iv) decrease in groundwater levels and dams, (v) increase in irrigation costs, and (vi) water availability. Water scarcity, pollution, and water salinity stand as the most frequently reported issues among all. To deal with these impacts, farmers claim that they developed five ways of response. They include (i) habitual water use, (ii) adoption of new methods for water use, (iii) initiative in water management, (iv) no action, and (v) not irrigating. Farmers in Ayaş and Beypazarı reported a decline in groundwater levels, while those in Güdül reported a decline not only in groundwater levels but also in rivers, and dams as well as the primary irrigation water sources.

Table 43 presents the impacts of changing climatic conditions on water dimensions as experienced by farmers and their responses to these impacts. In terms of impacts, one third of all mentions highlight water scarcity (32%). Almost half equally point out pollution and water salinity (22%) and decrease in underground water (20%).
Following these, farmers also mention decrease in ground water levels in general and in dams (12%), increase irrigation costs (8%) and impacts on water availability (6%). The significance of each impact varies across the case districts. In reaction to the observed impacts, the farmers we interviewed outlined five strategies they've adopted. Nearly half of the responses pertained to the introduction of new irrigation techniques and accessing different water sources (27%). Additionally, individual, and collective measures for water management made up 18% of the strategies. Notably, a significant proportion of farmers either maintained their conventional water usage practices (42%) or chose not to adopt any changes at all (12%).

**Water scarcity** is identified as the predominant and urgent concern within the region, constituting around 32% of all mentions pertaining to the effects on water resources. Water scarcity is a concern in all three of the districts, as almost half of all mentions both in Ayaş (40%) and in Güdül (40%) refer to water scarcity. While Beypazarı faces it slightly less at 24% of all mentions in the district. Water scarcity is an overarching topic and amplifies the effects of other water related experienced impacts. This scarcity further intensifies the over-extraction of underground sources, escalating irrigation costs and further limiting water availability for agricultural use.

**Pollution and water salinity** are the second most frequently experienced impacts at 22% as far as water is concerned in agricultural production. 90% of all mentions regarding this topic come from farmers in Beypazarı. 40% mentions from the farmers in Beypazarı displays the highest degree of impact on pollution and water salinity. In contrast, Ayaş does not have any documented concerns in this domain, whilst Güdül has a minimal percentage of 5% of all mentions from the district.

Pollution and water salinity consists of three sub-categories of impact including (i) water salinity, (ii) polluted underground water, and (iii) polluted Kirmir Creek. Water salinity (60% of this category) and polluted underground water (40% of this category) are only expressed by the farmers in Beypazarı. Moreover, the pollution in the Kirmir River was only mentioned in Güdül.
“There’s a water shortage right now. The biggest problem. For example, the places where intensive agriculture, lettuce, etc. are planted in summer, they take water from the drill, which we call dead water, from the pools 40-50 metres below, and collect them in one place. The places intensively cultivated in summer are at an altitude of 1000 metres, boreholes are drilled, it comes from dead water. They collect it in one place and irrigate it with water from 40-50 drills. As the water decreases, the salt content increases and becomes harmful for the plant. If the soil gets too much salt, it dies. It turns into a very harmful form. The man irrigated the field and the field turned white. Not only does it kill the plant, but the soil dies.” (B3)

“We’re pretty much out of water. We use a lot of sprinklers and drip irrigation here. We use the water well, but since our capacity is high, the capacity of the green area increases, the depth of the water increases and the salinity increases.” (B2)

“I give the example of sewage being discharged into rivers as environmental pollution affecting agriculture. It ended the fishery in Kirmir. In the past, you could drink the water in those Kirmir streams. I remember from my childhood, we used to go fishing. Now I am afraid to enter the stream because of the pollution.” (G8)

**Decrease in underground water** constitutes the third most mentioned impact on water as one fifth of all mentions (20%) refer to this problem. 60% of all mentions in Ayaş and almost a quarter of all mentions in Beypazarı (24%) point to a decrease in underground water levels. Whereas only 5% of mentions in Güdül refer to this situation. While almost all mentions (90%) in this category refer to decreasing underground water levels, the other 10%, which represents only a single statement from Ayaş, refers to changing underground water ways.

Overall, interview results show that farmers in Ayaş and Beypazarı experience a decrease in underground water levels, which is the main source of agricultural
irrigation. Farmers in Güdül refer to a decrease in groundwaters such as rivers and dams, which are the main source of water for irrigation.

“... when I was a gardener until 2000, I used to irrigate from 6 meters, my drills were from 5 to 8 meters. 10-meter drills were few. Now there are 100 meters, so there are many.” (B6)

“Water availability has changed, of course. For example, water used to come out at 5-6 meters. Now it's 150-200 meters. One tenth of the previous water is left. What does the person who is engaged in irrigated agriculture do? He hits at least 10 drills. He takes half a flicker of water from each of them and collects it from there again with pumps.” (B5)

Interviewee B1 narrates the further impacts of decreased water levels on carrot production in Beypazarı district. As carrots are one of the signature products of the region, decreased water levels and resulting water salinity impacts carrot production in Beypazarı. The interviewee states that only in high altitude areas in the basin such as Kırbaşi village region whose waters are still not salty produces carrot. As a response, farmers mention transition to alternative products such as beetroot which is resilient in salty and calcic waters.

“[Decrease in underground water levels] it started to be reflected in the cost of production very much. You take more water from deeper depths, and since you do this with electrical energy, the quality of the product is related to the quality of the product, and since the water is decreasing, the deeper waters are more salty and more calcareous. We are also experiencing these. Naturally, it also damages the product. We cannot grow products specific to the region. For example, carrot, the main thing of Beypazarı is carrot. Salty and calcareous underground waters no longer make carrots.” (B1)

Following the decrease of underground water, 12% of farmers' mentions equally indicate a decrease of ground water levels both in general terms and specifically in dams. Decrease in ground water is primarily expressed only by the farmers in Güdül,
whereas this impact receives no mentions from Ayaş and Beypazarı. About one third in Güdül (30%) mention a decrease in ground water as a consequence of climatic conditions. General decrease in ground water and decrease in ground water in dams mentioned equally by the farmers in Güdül.

“I draw water from the Kirmir. Mine is not drip irrigation. Isn’t the water reduced, can water withstand this heat? Did it used to flow like this in the past? Let’s say it's reduced, how are you going to draw water, do you expect drip irrigation? Drip irrigation can’t be used here, drip irrigation is suitable for the land above. Let’s say it's decreased, what can you do? It won't decrease from here, our water comes from the forest.” (G2)

“Our water comes from the Çanıllı dam in Ayaş with a closed system. The state built it in 2015, underground irrigation. But there is no water in the dam due to drought. Now this stream flows, called İlhan stream, İlhan stream. We supply water from there with our own means.” (G9)

**Increase in irrigation costs** is another experienced impact when water is concerned in agricultural production, with only 8% of all mentions. Dominantly, farmers in Beypazarı indicate this situation, with 75% of responses in this category. However, this comprises 12% of all mentions in Beypazarı, followed by 5% in Güdül.

The Gardener’s Cooperative (B1) explains the chain of decreased underground water level and increased costs for irrigation. The interviewee states that the water sources for irrigation are Kirmir river and underground water. Underground water was accessible from 10 to 20 meters in the 1990s, however, currently the water is accessible from 150 to 300 meters. The salinity of the water also increased as the farmers draw water from deeper levels and this situation has impacted the products of irrigated agriculture. When farmers try to get water from shallow parts, they need to collect water from multiple sources in a pond which needs more energy as farmers do not direct water directly to irrigation system but collects at one location and then distributes. This situation leads to an increase in consumed energy and respective prices.
Table 43. The impacts and responses of the changes in water dimension

<table>
<thead>
<tr>
<th>WATER IMPACT</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
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<tbody>
<tr>
<td>(1) Water Scarcity</td>
<td>16</td>
<td>32</td>
<td>2</td>
<td>40</td>
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<td>24</td>
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<tr>
<td>(2) Pollution and Water Salinity</td>
<td>11</td>
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<td>0</td>
<td>10</td>
<td>40</td>
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<td>55</td>
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<td>0</td>
<td>6</td>
<td>60</td>
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<tr>
<td>(ii) Polluted underground water</td>
<td>4</td>
<td>36</td>
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<td>40</td>
</tr>
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<td>(3) Decrease of Underground Water</td>
<td>10</td>
<td>20</td>
<td>3</td>
<td>60</td>
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<td>24</td>
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<td>(i) Decrease in underground water level</td>
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<td>90</td>
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<td>3</td>
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<td>(ii) Decrease in Water levels in Dam</td>
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<td>3</td>
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<td>(5) Increase in Irrigation Costs</td>
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<td>3</td>
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<td>(6) Water Availability</td>
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<tr>
<th>WATER RESPONSE</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Habitual Water Use</td>
<td>14</td>
<td>41</td>
<td>1</td>
<td>20</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>(i) Continue Using Underground Water and Drill</td>
<td>8</td>
<td>57</td>
<td>1</td>
<td>100</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>Deeper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Water from River</td>
<td>6</td>
<td>43</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>(2) New Methods for Water Use</td>
<td>9</td>
<td>26</td>
<td>1</td>
<td>20</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>(i) Transition to Water Efficient Irrigation</td>
<td>3</td>
<td>33</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(ii) Change in Irrigation Period</td>
<td>2</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(iii) Water from Multiple Sources</td>
<td>2</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>67</td>
</tr>
<tr>
<td>(iv) Water from the Dam</td>
<td>2</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>(3) Water Management Initiative</td>
<td>6</td>
<td>18</td>
<td>1</td>
<td>20</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>(i) Water Management Measures</td>
<td>3</td>
<td>50</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(ii) Stopped Using Underground Water</td>
<td>2</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>(iii) Regional Collective Action</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>(4) No Action [concern, wait]</td>
<td>4</td>
<td>12</td>
<td>2</td>
<td>40</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(i) Concerns for future</td>
<td>2</td>
<td>50</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>0</td>
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<tr>
<td>(ii) No Institutional Response</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(iii) Waits Water from the God</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(5) Not irrigating</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>34</td>
<td>100</td>
<td>5</td>
<td>100</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>
The interviewee from Güdül DDoAF (G15) explains that as water scarcity forces farmers to extract water from greater depths, energy consumption doubles, leading not only to increased electricity costs but also to a general rise in input costs for agriculture.

“...there's a difference between extracting water from 50 meters underground and from 120 meters underground. The energy will double, so to speak. The costs of consumed electricity will increase, as well as other related costs. This leads to an increase in input costs.” (G15)

**Water availability** is the least frequently mentioned impact with 6%, referring to increased water availability and pollution being filtered. Only farmers in Güdül refer to this situation in the region, and 15% of mentions in Güdül indicate this situation.

In response to the experienced impacts, interviewed farmers shared the five ways that they sought and adopted (Table 42). Almost half of these include new methods of irrigation and reaching water sources (27%) as well as individual and collective water management initiatives (18%). More than half implies either the continuation of habitual way of using water (42%) or taking no action (12%).

Farmers adopting new methods for water use indicate a change in their choice of irrigation type, period, and water source. Under this category, while transitioning to water-efficient irrigation (%33) practices receives the higher share of frequency, the other three new ways equally refers to changing the irrigation period (22%), adapting to use water from multiple sources (22%), and using water from the dam (22%).

While the transition to water-efficient irrigation and change in irrigation period are most prevalent in Güdül, the use of water from multiple sources is predominantly sought in Beypazarı. Farmers in Beypazarı and Güdül also express their use of water from the dam.

Taking an initiative on water management (18%) is another response type highlighted by farmers in the region. Accordingly, while half of all mentions refer to the adoption of water management measures (50%), the rest half is associated to
stopping the use of underground water (33%) and joining the regional collective action (17%). While in Ayaş, all farmers who are engaged in water management initiatives participated in developing measures for how water resources can be managed best. In Beypazarı, all farmers stopped using underground water as part of such action. In Güdül, farmers were heavily involved in setting up the measures for management, but they also took part in initiating a regional collective action.

“Of course, the water's decreased. It's not like it used to be. As the water decreases, you have to think about how to use the water sparingly. Let me put it this way.” (A2)

Habitual water uses form 41% of all mentions and refers to the continuation of existing habits in water use. In this category, farmers refer to the continued use of underground water (57%) and water from rivers (43%). The farmers refer to their continued use of underground water by drilling deeper to get more water, which forms almost 60% of the mentions in this subcategory. Half of the farmers in Beypazarı refer to habitual water use. While Beypazarı accounts for 75 percent of mentions referring to the use of underground water, all mentions that refer to the continued use of water from the river come from Güdül. Only one farmer each from Ayaş and Güdül continues to use underground water. There are also farmers who mention that they take no action (12%) against the impacts. This category includes concerns for the future (50%), the absence of institutional responses (25%), and waiting for water from God (25%, one mention). While farmers from Ayaş only mention that they have concern for the future, farmers in Güdül wait a solution either from public institutions or from God.

Based on the qualitative data collected from farmers in Ayaş, Beypazarı, and Güdül, it is noticeable that the agricultural practices in these districts are significantly influenced by the issues arising from changing climatic conditions, particularly about water resources. The primary concern that arises is the lack of water, which is closely followed by the problems of pollution and water salinity, particularly focused in the region of Beypazarı. The difficulties at hand encompass not just environmental
concerns, but also have far-reaching socio-economic impacts, as indicated by the increase in irrigation expenses and the switch to conventional agricultural practices. In response, farmers are shown adaptation, with a notable portion adopting novel irrigation systems, while others persist in habitual methods. Nevertheless, the research highlights a concerning percentage of farmers who are either idle or reliant on external aid when confronted with these issues. The narratives highlight a complex relationship between natural limitations and human adaptability.

### 5.2.3.2 Soil

Farmers have identified four principal categories of impacts linked to soil: (i) soil fertility, with a sub-categorization into a decrease in soil fertility and an increase in soil fertility, (ii) soil health, breaking down into decrease in soil health and polluted soil, (iii) soil conditions, further categorized into soil salinity, decrease in soil moisture, decrease in soil organic carbon, and increase in soil temperature. To address these impacts, three primary strategies were discerned: (i) increasing soil fertility through measures like the use of animal manure and enhancement of the soil carbon, (ii) change in production types, and (iii) taking no responsive action.

Table 44 shows the impacts experienced by farmers as a consequence of change in climatic conditions and responses of farmers to these impacts on soil. Categorizing the mentions from the interviews, the table shows a myriad of soil issues raised by farmers, with fertility and health being at the forefront. Regarding impacts, almost three fourths of all mentions stress the soil fertility (29%), health (21%) and conditions (21%) worsened. This is particularly experienced in Beypazarı (88%) and Ayaş (80%) with higher significance. On the contrary, one third also claims an increase in soil fertility (29%), which appears in Güdül with 50% significance. To cope with worsening soil fertility, farmers adopt practices to increase the soil carbon such as using animal manure (60%). Among all farmers, one particularly responds by changing production types from conventional to organic (20%) (A1). While this is equally applied in Ayaş, all adaptive response efforts are given to increase soil
fertility among farmers in Beypazarı. Güdül, being the least negatively impacted district, takes no action. The responses of farmers to these challenges not only provide evidence of their capacity to adapt but also demonstrate the important connection between soil conditions and agricultural practices.

In terms of impacts on soil, there are a total of 24 responses clustered under four major categories. Soil-related impacts and responses share the lowest share of mentions among all categories under impacts and responses to change in climatic conditions and external factors.

The primary impact observed is **bad soil fertility**, accounting for 29% of all instances. The regions of Ayaş and Beypazarı have expressed concern about the decrease in soil fertility, with rates of 20% and 22% respectively. This issue is common in all three districts, with Güdül experiencing the highest level of impact at 40%. For instance, a farmer and the representative of Chamber of Agriculture in Güdül (respectively, G3 and G11) link changing climatic conditions, specifically decrease in snowfall with the bad soil fertility.

> “The fertility of the soil has also changed. Because it used to snow in the past. The snow would stay for months, and the soil would soften with the snow. The nutritional value increased. Now it doesn’t snow. A finger of snow melts the next day. Snow is supposed to nourish the soil. We haven’t seen proper snow for the last 3–4 years; a finger of snow falls and melts. When there is cold in the winter, insects and diseases all die from the cold, but when there is no cold, last year's tomato was infected with a *tuta absoluta*[^34], we said it would die in the winter. There was no cold in the winter, even in the winter butterflies flew away.” (G3)

“In my childhood years, I am now 42 years old. In other words, the most fertile lands before my twenties have now become the most infertile lands. Because of the untimely precipitation... I mean, climate conditions have changed a lot.” (G11)

Table 44. The impact and responses on soil dimension

<table>
<thead>
<tr>
<th>SOIL IMPACT</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Bad Soil Fertility</td>
<td>7</td>
<td>29</td>
<td>1</td>
<td>20</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>[Decrease in Soil Fertility]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Good Soil Fertility</td>
<td>7</td>
<td>29</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>(i) Good Soil Fertility</td>
<td>4</td>
<td>57</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>(ii) Increase in Soil Fertility</td>
<td>3</td>
<td>43</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(3) Bad Soil Health</td>
<td>5</td>
<td>21</td>
<td>2</td>
<td>40</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>(i) Decrease in Soil Health</td>
<td>3</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>(ii) Polluted Soil</td>
<td>2</td>
<td>40</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(4) Bad Soil Conditions</td>
<td>5</td>
<td>21</td>
<td>1</td>
<td>20</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>(i) Soil Salinity</td>
<td>2</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>67</td>
</tr>
<tr>
<td>(ii) Decrease in Soil Moisture</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(iii) Decrease in Soil Organic Carbon</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(iv) Increase in Soil Temperature</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>TOTAL</td>
<td>24</td>
<td>100</td>
<td>5</td>
<td>100</td>
<td>9</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOIL RESPONSE</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Increasing Soil Fertility</td>
<td>3</td>
<td>60</td>
<td>1</td>
<td>50</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>[animal manure, soil carbon]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Change in Production Type</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(3) No Response</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>TOTAL</td>
<td>5</td>
<td>100</td>
<td>2</td>
<td>100</td>
<td>2</td>
<td>100</td>
</tr>
</tbody>
</table>

Good soil fertility makes up another 29% of mentions. Specifically, within this category, two trends emerge: existing good soil fertility and increasing soil fertility. While there is an overall 57% mention of having good soil fertility, the increase in soil fertility stands at 43%. Güdül seems to have benefited the most in terms of increased fertility, indicating 67% of all mentions in this category, followed by Ayaş at 100%.
A farmer in Beypazarı refers to having good soil fertility whereas no farmer mentions increasing soil fertility in Beypazarı.

“I mean, how tired and worn out are our soils now? I was always saying that we should do organic farming. You know if we could sell our products differently in the market. Everyone was saying "no organic farming here, this can't be done organically, it can't be organic".... The yield would be low, you wouldn't make any money, you wouldn't be able to produce, you would be in debt, and so on and so forth. On the contrary, there was an increase in yield. Our soil is recovering. I mean, I can see the difference between this year's soil and last year's soil.” (A2)

Farmer B7, however, considers that good soil fertility is related to the good care of the soil, without linking to changing climatic conditions. In similar vein, Farmer G5 points to the rotational cropping for having good soil fertility.

“If you do not take care of it [soil], there is a change. If you look after it, if you do the fallow and weeding on time, if you pull the goose foot regularly, the yield is good. But if you delay, if you graze, the yield is low, of course.” (B7)

Equal frequency of mentions indicates both bad soil fertility and good soil fertility, with 29% of the mentions. For both categories, farmers in Güdül contribute with a higher number of mentions than Beypazarı and Ayaş.

Bad soil health (21%), and bad soil conditions (21%), share an equal number of mentions, with 5 mentions for each category. Bad soil health is particularly problematic for Ayaş and Beypazarı, with 40% and 33% of all mentions from each district, respectively. This category includes sub-categories of decreased soil health (60%) and polluted soil (40%). Only farmers in Beypazarı and Ayaş refer to bad soil health. While farmers in Beypazarı only point to a decrease in soil health, farmers in Ayaş refer to polluted soil. In stark contrast, farmers in Güdül do not report any bad soil health conditions.
For instance, a farmer in Beypazarı (B5) not only relates the soil health to climatic conditions but also to the increase in fertilizer prices that farmer considers relevant to feed the soil with supplements for more fertility. This presents that soil health are not only related to climatic and environmental impacts but also the human interference with the method of agricultural production.

“The yield was very low this year due to weather conditions... The fertility of the soil has changed as it has been continuously cultivated. Now the soil is not fed. Fertiliser, for example. We used to put 50kg of fertiliser in my childhood, when I started. Now we're down to 10kg [because of the high costs of fertiliser]... Animal manure is also expensive. Before, for example, no one looked at it. Now it costs 2000 liras per lorry. It is enough for 10 decares, so it has also increased.” (B5)

In similar vein, farmer B8 states that use of chemicals tires the soil and relates fertility and yield with the increase of plant diseases.

“Our productivity was very good, now our fields are exhausted. Why? It's tired of using chemicals. The soil exhausts itself over time because of constant watering and pesticide supplementation. And for the last five or six years there have been [plant] diseases. Because of those diseases...” (B8)

Lastly, 21% of mentions relate to overall bad soil conditions, with concerns over soil salinity, decrease in soil moisture, organic carbon reduction, and increased soil temperature. Beypazarı seems to be the most affected district with 33% mentions, particularly with concerns related to salinity and rising soil temperature.

Bad soil conditions (21% of mentions) divide into four sub-categories. Only farmers in Beypazarı refer to soil salinity with two mentions. Only one mention from each district indicates the rest of the subcategories. While a mention in Güdül indicates a decrease in soil moisture, a mention in Ayaş mentions a decrease in soil organic carbon. Additionally, one mention from Beypazarı refers to an increase in soil temperature.
“Those who do not irrigate from Kirmir stream and those who irrigate from drilling have decreased water and the rate of salinisation increases. This causes problems in the soil in the future and the plants growing there cannot grow. For example, lettuce grows at 1.2 salinity, but as this salinity rate increases, lettuce in the water will not be grown. It will have to change crops. As the water decreases, the salt rate increases, it becomes harmful for the plant. If the soil gets too much salt, it dies. It turns into a very harmful form. The man irrigated the field, and it turned white. Not only is it killing the plant, but the soil is dying.” (B3)

Farmers, in response to these challenges, have shown adaptability. The responses are very limited given the experienced impacts on soil, with a total of five mentions. These five mentions fall into three categories. Increasing soil fertility by using animal manure and applying measures to increase soil carbon receives 60% (3 mentions) of all mentions. While two mentions indicate this situation in Beypazarı, only one mention from Ayaş refers to declining soil fertility.

According to an interview with the head of Ayaş DDoAF (A3), decreased soil organic carbon is relevant with the landownership problems. Especially in rented fields, farmers do not take good care of fields in terms of fertilizing and irrigation and due to decreased use of animal manure. According to the interviewee A3, the project of the Ministry of Agriculture, called ÇATAK program (see sub-chapter on Agricultural Organization and Support) applied in Ayaş and served for this aim to increase the soil organic carbon through using animal manure. The protection of agricultural lands for environmental purposes.

Change in production type is only mentioned in one mention from Ayaş. In addition, only one mention in Güdül indicates that he has no response to soil-related problems.

According to farmer A1, change in production type from conventional to organic is an adaptive response of the farmer to increase soil fertility. Below quotation narrates
the experience of the farmer with regards to soil fertility and product yield when
switching to organic agricultural production.

“Of course, it [using chemicals] was polluting the soil. It was becoming like
lime, like stone where it was constantly cultivated. Now, I mean 1 year. We
didn’t use it much anyway, because they are always based on cost, on the
pocket. There is no way to afford them anyway. Now we didn’t use any
chemicals, plus we used microbial fertilizers, fertilizers that break down the
soil and clean it more quickly. Both the yield of vegetables increased, and I
saw the change in the soil. You know, when the soil was ploughed this year,
the soil was falling apart. Every year it was like this with colds and clods. I
hope this will increase from year to year.” (A1)

All in all, the relationship between soil health and climatic changes has become
increasingly evident through the experiences of farmers across the districts of Ayaş,
Beypazarı, and Güdül. This study highlights that a considerable portion of the
farming community, particularly in Beypazarı (88%) and Ayaş (80%), has discerned
detrimental shifts in soil fertility, health, and conditions, which they largely attribute
to changing weather patterns. The farmers’ responses provide a demonstration of
their resilience and ability to adapt. However, it is clear that the challenges they
encounter, resulting from both natural changes and human interventions such as
fertilizer consumption, are intricate and interconnected. The significance placed on
soil conditions serves as a reminder of the fundamental function that soil plays in
agriculture and highlights the pressing need for comprehensive measures to address
its health considering shifting climatic conditions.

5.2.3.3 Plant

Farmers have pinpointed four major categories of impacts related to plant health and
productivity: (i) Plant and Product Damage, detailed further into aspects like damage
to products, metabolic effects on plant growth, and increased plant stress; (ii) Plant
Disease, that includes the subcategories of increase in plant disease, decrease in plant resistance and increase in weed; (iii) Yield/Financial Loss, characterized by a direct decrease in yield, financial loss, and loss of products; and (iv) Seasonal Productive Cycle Change, highlighting changes in the ripening and plantation seasons. In response to these impacts, farmers have adopted four primary response strategies: (i) Change in Production Phases, which encompasses modifications in product patterns, pesticide usage, and even a transition to organic farming; (ii) No Action, a passive approach where some farmers await divine intervention or maintain their regular production; (iii) Gaining Knowledge/Use of Incentives/Action, marked by collective regional actions, consultations, and a shift in attitudes; and (iv) Change in Production Season, adjusting the harvesting and plantation periods. The observed responses reflect the farmers' adaptive measures to counter the aforementioned plant-related challenges, emphasizing their resilience and dynamism in the face of evolving agricultural challenges.

As Table 45 presents, almost half of all mentions (%49) refers to the damage occurring in the form of burnt, frozen, and stress of plants. The other half highlights plant disease (29%), yield deterioration and financial loss (16%). Beypazarı experiences the highest plant damage among all other districts with 54% and Güdül has the second highest with 47%. In both places, one third of all mentions also point out plant disease as another significant impact that farmers encounter. In Ayaş, farmers equally experience plant damage (38%) and disease (38%) as well as yield deterioration and financial loss (25%). In response to the experience impacts of climatic conditions to plants, farmers stated that they changed the production phases with 62%, gained knowledge and used incentives to take action with 14%, and changed the production season with 6%. This trend was consistent in all three districts, except that one third of all mentions in Beypazarı claimed that no action was taken to cope with the impacts experienced due to the changing climatic conditions. This is somewhat interesting for Beypazarı appeared as the district experiencing the highest damage on plants but being passive to cope with it. Those who do mostly alter their production methods, especially by increasing pesticide use.
In a similar vein, farmers in Ayaş faced with plant damage or diseases do not take corrective actions. Those who do, mostly adjust their production patterns. Güdül farmers appear to be the most proactive. Confronted with significant plant and product damage, a large portion are adapting their farming methods. They are also keen on understanding product resilience and collaborating regionally.

The most frequent observation among farmers is that of **plant and product damage**, accounting for almost half of all mentions. With a particular emphasis in Beypazarı (54%) and closely followed by Güdül (47%), farmers indicate a deterioration in the quality and health of their crops. The subcategories under this category include damage to products (50%), impacts on plant growth (21%), plant burn (21%), plant stress (5%), and plant freeze (2%).

Significantly, 50% of mentions refer to **damage to the products** harvested. Farmers in Güdül seem to be the most affected with 67% of the mentions compared to 38% in Beypazarı.

**Plant growth** is the second most referred impact which was noted by 21% of mentions. By plant growth, farmers consider the impacts that hinder healthy growth of the plants metabolically. Ayaş and Beypazarı showed similar impacts, each accounting for 33% and 33% respectively. However, Güdül saw the least impact at 6%. Mentions from Beypazarı form almost 80% of mentions in this subcategory, whereas only a single mention from Güdül and Ayaş refers to problems in plant growth.

“There are desired temperature scales for fertilization of some crops. When you pass those scales, you cannot experience fertilization.” (A3)

**Plant Burnt** constitutes 21% of the mentions across all districts. Equal number of farmers referred to this impact in Güdül and Beypazarı with respectively receiving 22% and 19% of mentions in each district. Whereas only one farmer (33% of all mentions in Ayaş for this category) refers to burnt plants due to changes in climatic conditions.
and external conditions. Mentions in Ayaş equally indicate damage to products, plant growth, and plant burns, with one mention for each subcategory.

“It is very hot, something that is growing starts to burn, it burns before it grows. Or it starts to ripen before it grows. If it is cold, for example, seedlings grow at night, my wife says that they grow at night. But because it's cold, the growth is retarded. It doesn't grow. That's why the climate has changed for three or four years. We are very aware of this. For example, it rains. I have tomatoes now, and if it rains nowadays, it causes diseases. It causes stains on the tomatoes, which causes the tomatoes to rot. So, the climate has changed a lot.” (G3)

Interestingly, plant stress seems to be a unique challenge for Beypazarı, with 10% of all mentions in the district, whereas the other districts don't report this concern. Lastly, one farmer in Güdül (6%) indicates impacts related to plant freeze.

“For example, before we used to plant enormous cucumbers, which were very good. Firstly, a thermal power plant was built in Çayırhan which had an impact. Secondly, the weather change....I mean, of course, climate change has a lot to do with it... Because there is no spring. It's either summer or winter. It suddenly switches. You know how they say people get stressed? It's the same with vegetables, they get stressed.” (B10)

**Plant disease** (29%) forms the second category of impact. An almost equal share of mentions among farmers in Beypazarı (28%) and Güdül (29%) refers to plant diseases. Whereas Ayaş showed a slightly higher figure at 38%. Overall, Beypazarı and Güdül farmers contribute to this category with an equal number of mentions (11 mentions from each district).

This category consists of four subcategories. Two categories show farmers experiencing increase in plant diseases (52%) and existence of plant diseases (40%). Similarly, an equal number of mentions in both districts also indicate an increase in plant diseases (55%) in Beypazarı and Güdül. The rest of the mentions (with only
one mention) belong to farmers in Ayaş. In terms of the already existence of plant diseases, Ayaş reported the highest impact (67%), followed by Beypazarı and Güdül with 36% of all mentions in each district.

Farmers links the change in climatic conditions such as change in rainfall patterns with the increase in plant diseases.

“When rain is not desired and excessive, it causes bacterial or viral diseases in the product. All these negatively affect them [plants].” (A3)

“When there is too much rain, tomatoes get diseases, and so do grapes. Excessive heat scorches, and the rain causes fungal diseases." (A4)

Relevant to the plant diseases, the representative from Ayaş DDoAF (A3) states that changes in temperatures impact the fertilization of the crops and currently there is not any measure and adaptation plan exist that can guide the climate suitability of crops.

Several farmers also link the increase in plant diseases with the use of hybrids seeds that are vulnerable to diseases and pests.

"These diseases all came from these seeds. Do you understand? Did we have these diseases before? Spinach, I don't know the type of disease; green onions, I don't know the type of disease; I don't know the type of disease that makes lettuce sick. It's all because of these seeds, these ready-made seeds, that brought diseases upon us. When we were kids, there was no such thing as these diseases. Oh my God. What's the relevance? The one who sells us the seeds also sells the chemicals.” (B1)

"For example, with chickpeas, chickpeas don't really like rain. But they still need a certain amount of rain. They need to meet their water needs. There was no disease in the chickpeas this year. What happens at other times is that they get fungal diseases when there is too much rain. This happens in both wheat and chickpeas." (B5)
Interviewee B2 mentions the impact of thermal power plants on the plants as follows:

“We used to plant cucumbers, now we can't. It doesn't grow anymore. There is a thermal power plant, there is Eti soda mine and its thermal power plant. It affects the air, the cucumbers that used to be there are no longer.... They say the dust is coming down, but the truth is that it is not happening. No matter what kind of pesticide you use, it only works in greenhouses.” (B2)

“We used to say that our vegetables were getting sick because they didn't install a filter at the thermal power plant. Of course, there are also intense diseases...What happens to the poisonous gas coming out of there? It spreads over this region. Then it lands on our soil and plants as rain.” (A1)

There are also a very limited number of mentions referring to a decrease in plant resistance (4%) and an increase in weeds (4%) that are formed by only one mention for each category. While the only mention of a decrease in plant resistance comes from Beypazarı, a mention in Güdül indicates an increase in weed.

“Due to climate change, resistance of plants decreased in increased temperature, maybe because of the seed type. We used to have spinach from our heirloom seeds, it was a very good spinach. Previously spinach is produced with bags of 30-35 kg, and it was sold to Istanbul. Now it is 10-12 kg yield and there are complaints that the spinach is burnt.” (B8)

Table 45. The impact of changes on plant dimension
## PLANT IMPACT

<table>
<thead>
<tr>
<th>(1) Plant and Product Damage</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Damage to Products</td>
<td>42</td>
<td>3</td>
<td>38</td>
<td>21</td>
<td>54</td>
</tr>
<tr>
<td>(ii) Plant Growth (Metabolic)</td>
<td>21</td>
<td>1</td>
<td>33</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>(iii) Plant Burnt</td>
<td>9</td>
<td>1</td>
<td>33</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>(iv) Plant Stress</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(v) Plant Freeze</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

| (2) Plant Disease            | 25        | 3          | 38        | 11             | 28         |
| (i) Increase in Plant Disease| 13        | 1          | 33        | 6              | 55         |
| (ii) Decrease in Plant Resistance| 10     | 2          | 67        | 4              | 36         |
| (iii) Increase in Weed       | 1         | 0          | 0         | 0              | 1          |

| (3) Yield / Financial Loss   | 14        | 2          | 25        | 6              | 15         |
| (i) Decrease in Yield        | 9         | 2          | 100       | 4              | 67         |
| (ii) Financial Loss          | 3         | 0          | 2         | 33             | 1          |
| (iii) Loss of Products       | 2         | 0          | 0         | 0              | 2          |

<table>
<thead>
<tr>
<th>(4) Seasonal Productive Cycle Change</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Change in Ripening Season</td>
<td>3</td>
<td>75</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>(ii) Loss of Plantation Time</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>1</td>
<td>100</td>
</tr>
</tbody>
</table>

## PLANT RESPONSE

<table>
<thead>
<tr>
<th>(1) Change in Production Phases</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Pattern. Change in Product Pattern</td>
<td>40</td>
<td>62</td>
<td>3</td>
<td>60</td>
<td>17</td>
</tr>
<tr>
<td>(ii) Pesticide. Chemical Struggle</td>
<td>21</td>
<td>53</td>
<td>2</td>
<td>67</td>
<td>7</td>
</tr>
<tr>
<td>(iii) Pesticide. Natural Struggle</td>
<td>9</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>(iv) Farming sequence. Replantation</td>
<td>4</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(v) Volume. Decrease in Production Volume</td>
<td>3</td>
<td>8</td>
<td>0</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>(vi) Farming type. Switched to Organic Farming</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>(vii) Fertilizers. Decrease Use of Fertilizers</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

| (2) No Action                     | 12        | 18         | 2         | 40             | 9          |
| (i) No Response                   | 5         | 42         | 2         | 100            | 3          |
| (ii) Waits Solution From the God  | 4         | 33         | 0         | 0              | 3          |
| (iii) Continue Regular Production | 1        | 8          | 0         | 1              | 11         |
| (iv) Not Harvesting               | 1         | 8          | 0         | 1              | 11         |
| (v) Fear                          | 1         | 8          | 0         | 1              | 11         |

<table>
<thead>
<tr>
<th>(3) Gain and Use of Knowledge &amp; Incentives</th>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Understanding Product Resilience</td>
<td>9</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>(ii) Regional Collective Action</td>
<td>2</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(iii) Consult</td>
<td>2</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(iv) Change in Attitude</td>
<td>1</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>(v) Agricultural Insurance</td>
<td>1</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>25</td>
</tr>
</tbody>
</table>

| (4) Change in Production Season           | 4         | 6          | 0         | 0              | 1          |
| (i) Change in Harvesting Season           | 2         | 50         | 0         | 1              | 100        |
| (ii) Change in Plantation Period          | 2         | 50         | 0         | 0              | 0          |

## TOTAL

<table>
<thead>
<tr>
<th>Frequency</th>
<th>% in Total</th>
<th>% in Ayaş</th>
<th>% in Beypazarı</th>
<th>% in Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>100</td>
<td>8</td>
<td>100</td>
<td>39</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL</th>
<th>65</th>
<th>100</th>
<th>5</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
<td>31</td>
<td>100</td>
<td>29</td>
</tr>
</tbody>
</table>
Yield deterioration and financial loss form the third category, with 16% of all indications. Again, Beypazarı and Güdül contribute an equal share of mentions from each district. 15% of all mentions in Beypazarı and 16% of all mentions in Güdül refer to yield decline and financial loss as experienced impacts on plants. Whereas one-fourth of farmers in Ayaş mention this situation.

This category consists of three interrelated impacts which are decrease in yield, loss of products and financial loss. While the majority of mentions in this category point to a decrease in yield (64%), 21% indicate financial loss, and 14% indicate loss of products.

“...the disease entered, and our tomatoes and peppers died, we couldn't save them all. They all died without selling a lira. We uprooted them. Then, this time lice got into our cucumber, and we sprayed it with ‘güllecı bulamacı’. We had to uproot them too, and we had to empty our greenhouse.” (G3)

Farmers in all districts refer to a decrease in yield with almost equal frequency. Almost 70% of mentions from Beypazarı and half of the mentions in Güdül refer to this subcategory. In addition, all mentions from Ayaş in this category refer to a decrease in yield, with 2 mentions (22% in this subcategory), whereas 44% of mentions are from Güdül.

“Climate changes exists, as there must be 3 rains in this season. There is no rain since last 3 months....Melons and watermelons could not grow too much this year. Normally they weight 10 kg. Grapes are the same, they did not grow.” (G8)

“We ourselves feel that the climate has been changing for 5-6 years. Even vegetables do not grow well, even maize does not grow evenly. Why? It gets

35 A pesticide obtained by mixing quicklime with sulfur
cold in the evening, hot during the day. For example, it is hot during the day and humid in the evening. In this way, the climate affects the vegetables.” (G9)

The second subcategory is financial loss, which received almost 70% of mentions from Beypazarı. 2 mentions indicate this situation in Beypazarı and only 1 mention from Güdül. Lastly, only two mentions from Güdül, which form 14% of the mentions in this category, indicate the loss of products as an experienced impact on plants.

“In our village, in the village where I farmed, there were at least 600-700 acres of tomatoes every year. This year, 150 acres of tomatoes, whether they will grow or not, because of the disease.” (B1)

Changes in the seasonal productive cycle are the last impact category for plants, with only 5% of all mentions. Changes in ripening and plantation periods during production form the responses in this category. The change in ripening season receives 75% of mentions in this category, with all mentions from Güdül. While only one mention from Beypazarı indicates a loss of plantation time.

The results of the interview are classified into four response categories, comprising a total of 65 mentions. The most frequently mentioned category is change in production phases which accounts for 62% of all mentions. While Güdül leans heavily towards this response at 69%, Ayaş and Beypazarı follow closely with 60% and 55%, respectively. Among the districts, Güdül has the highest contribution to this category, accounting for half of the mentions, with almost 70% of them referring to changes in production phases. Beypazarı follows with 42.5% of all mentions in this category, while Ayaş only contributes 7.5% with three mentions.

This response category consists of themes related to change in product pattern, pesticides used, farming sequence, volume, farming time and fertilizers used. Change in production pattern is the first subcategory, with 53% of the mentions. This subcategory is the most prevalent among mentions from Güdül, accounting for 57% of all mentions, followed by 33% from Beypazarı and almost 10% from Ayaş.
The second and third categories refer to the types of pesticides chosen to address plant problems. "Chemical struggle" makes up 23% of all mentions, while "natural struggle" accounts for 10%. Beypazarı has the most mentions in the chemical struggle subcategory, with almost 70% of mentions (6 mentions). On the other hand, natural struggle is more prevalent in Güdül, with 75% of the mentions (3 mentions). No mentions were recorded from farmers in Ayaş in either subcategory.

The farming sequence is another subcategory with 7.5% of all mentions, receiving two mentions from Beypazarı and one from Güdül. Three categories received equal mentions at 2.5%: "decrease in production volume," "switch to organic farming," and "decrease in the use of fertilizers." One mention from each district was recorded, with one from Güdül indicating a decrease in production volume, one from Ayaş referring to a switch to organic farming, and one from Beypazarı indicating a decrease in the use of fertilizers.

The second response category is no action, accounting for 18% of all mentions. Ayaş had a concerning figure of 40%, implying that the majority of farmers did not take any action against plant impacts. This was followed by Beypazarı (29%) and Güdül (3%) with only 1 mention indicating no action. Interestingly, Ayaş records 100% of its 'No Action' responses as 'No Response' to the impacts, while in Güdül, the sole response was 'Waits Solution from the God'. The latter subcategory forms 33% of the total, with three-quarters from Beypazarı (3 mentions) and one-quarter from Güdül (1 mention). Additionally, farmers in Beypazarı indicate continuing regular production, not harvesting, and feeling fear, with one mention for each subcategory.

Gaining knowledge and using incentives is the next response category that accounts for 14% of the mentions. 17% of the mentions in this category include mentions of farmers in Güdül, while 13% belong to farmers in Beypazarı. This category is divided into five subcategories. Farmers in Güdül lean towards understanding product resilience (60%) and regional collective action (40%), while farmers in Beypazarı indicate consulting (50%), change in attitude (25%), and
agricultural insurance (25%). Whereas farmers in Ayaş do not mention any of the themes in this category.

Lastly, only 6% of the mentions point to a change in production season. Half of the mentions refer to changes in the harvesting season, with one mention each from Beypazarı and Güdül. The remaining mentions (2 mentions) are from farmers in Güdül, indicating a change in the plantation period.

Significant climate effects on plant health and productivity have been observed by farmers in the districts of Beypazarı, Güdül, and Ayaş. The primary impact observed is the occurrence of plant and product damage, as shown by over 50% of the farmers who reported instances of concerns such as product damage, disruptions in metabolic growth, and increased plant diseases. This phenomenon is particularly notable in the region of Beypazarı. This is subsequently accompanied by the occurrence of plant diseases, decline in yields of crops, and changes in the seasonal patterns of the productive cycle. Despite the defined problems, farmers exhibit adaptability through their proactive adaptation of farming practices. A significant proportion of individuals, particularly in the region of Güdül, choose to alter their production processes, so demonstrating a proactive response to shifts in the environment. Nevertheless, there is a noteworthy proportion of individuals, particularly in Ayaş, who choose not to take action. The replies provided collectively demonstrate the efforts of a farming community to address and adapt to the changing climate conditions they experience.

5.3 Agricultural Production Steps: Current and Changed State, Experienced Impact and Response

This section deciphers the steps of agricultural production process from the responses of the farmers interviewed. There are nine steps of agricultural production that stem from expert interviews and are defined through interviews. These are (i) land preparation, (ii) seed selection, (iii) seed obtainment, (iv) irrigation, (v) plant
protection, (vi) fertilizing, (vii) harvesting and yield, (viii) storing, packing, and processing, and (ix) marketing. This section first narrates the current and changed situation for each step and then explores the experienced impact because of changed stated and emerging response mechanisms or actions if any.

Land preparation in these districts has not been without its setbacks. Overprocessing, often a reaction to the high costs and soil degradation brought about by mechanization, is prevalent. While this has significantly impacted Güdül and Ayaş, Beypazarı remains relatively unaffected. In the realm of seed selection and acquisition, local networks have been the mainstay. However, a noticeable shift towards certified seeds is apparent across these regions, with Ayaş particularly emphasizing this transition.

Water as one of the central natural sources of agriculture, and its sourcing and utilization strategies vary across the districts. From natural sources to organized systems, choices are influenced by factors such as dwindling water levels and escalating electricity costs, as seen in Beypazarı. The choice of fertilization method also diverges, with Beypazarı leaning towards chemical fertilizers despite their associated costs and downsides, while Ayaş and Güdül have shown a preference for organic options, highlighting their advantages.

When it comes to harvesting, there's no single method and response. Güdül takes the lead in mechanization, keenly adopting advanced technology and comprehensive land care practices. Ayaş, on the other hand, leans away from extensive packaging and processing. Meanwhile, in Beypazarı, the challenges of costs and labor sources impede yields.

Marketing remains a complex sub-system. Beypazarı primarily relies on traders and wholesalers, whereas Güdül predominantly favors bazaars. Amidst evolving market dynamics and regulations, districts like Ayaş and Güdül are exploring diverse channels, while Beypazarı grapples with legal and infrastructural changes. These shifts highlight the myriad impacts on agricultural commerce, from fluctuating
market prices to restrictive legislation, driving these districts towards innovative marketing channels, whether local or organized.

In essence, Beypazarı, Ayaş, and Güdül offer a mirror to the multifaceted nature of agricultural production, revealing the interplay of challenges and adaptive strategies at different steps of agricultural production.
Figure 5.35. Stages of agricultural production that focuses on current/changed state, impact/response mechanisms in the region.
5.3.1 Land Preparation

The first step during the process of agricultural production starts with the preparation of the land for cultivation. In-depth interviews reveal that although there is a tendency to shift to mechanization in land preparation, which comes with high cost and deterioration due to overprocessing of the soil, farmers seek ecologically rejuvenating, and thus, sustainable responses to the impacts occurring because of changing conditions.

Farmers apply ploughing and tilling, almost all mechanized but also manual, as well as measures for soil health particularly in fallowing and rotational cropping during their preparation of the land for agricultural production. While Ayaş and Beypazarı take the lead on mechanized ploughing and tilling, farmers in Güdül equally apply both. Additionally, Güdül also significantly applies animal manure, which differentiates itself from the other two districts. Consistently, in all three districts, farmers significantly adopt mechanized ploughing and change the relevant steps for preparing the land for production either by increasing the steps or stopping irrigation and ditching. While this is prevalent in Ayaş and Beypazarı, in Güdül farmers also claim that they stopped burning stubble in the face of changing conditions.

Interviews also reveal that all these changes are in fact translated as a high cost in labor and fuel, particularly in Ayaş emerging as a full impact but also in Güdül with a share of soil deterioration. Surprisingly, in Beypazarı, farmers claim no experienced problem in land preparation and that they adopt smoothly to mechanization of ploughing and tilling as well as to line preparation for plantation and irrigation. As a response to changing conditions, although overprocessing the soil appears as a quick way out for some farmers, mulching and applying green manure, fallowing and rotational cropping, preparing land for organic farming and seeking state support also stand as emerging ways adopted with the ecological quality of the productive landscape is concerned. While Ayaş appears as the most active district in such direction, Güdül, being the most mechanized district among all three cases, also tends to overprocess the soil the most.
Table 46 provides the details of these findings that includes current state, changed state, experienced impact and responses of farmers on the domain of land preparation.

In terms of the **current state** of land preparation, in-depth interviews reveal that almost half of all farmers’ mentions (%39) indicates the use of *ploughing and tilling* in the process of preparing the land for agriculture, of which 88% is done *mechanically* and the remaining (%13) *manually*.

Although the land preparation steps change depending on the selected crop, generally it has similar steps for land preparation. In general, steps for irrigated and non-irrigated agriculture differ based on the interview results. For instance, farmer A1 narrates the process of land preparation for tomato plantation.

> “First, we plough the soil. It is ploughed with a plough or tractor. Then these clods, which we call crowbar, are minimised. Then, if the soil is very cloddy, a ball joint is used. It breaks and prepares the clods. After that, planting rows are opened, hoses are laid, drip hoses. The rows are fertilised, if you want, you can fertilize the field completely without pulling the crowbar. Then planting is done.” (A1)

Whereas the representative from Beypazarı Gardeners Cooperative (B1-2) states different procedures for irrigated crops like spinach and carrot. For spinach, soil preparation does not require too much effort. However, for carrot, there is a process including eleven steps respectively as deep tillage with chisel plowing, regular plough, chisel plow, sunning, plough, chisel plow, fertilizer, chisel plow, hedging, sowing machine (mibzer).

The farmer G8 narrates the land preparation for nonirrigated crops and overall cultivation process of wheat, barley, and chickpea. The cultivation of wheat and barley follows a meticulous process to ensure maximum yield. After the summer harvest, the field is ploughed multiple times using a cultivator, typically known as 'kaz ayağı'. This is done primarily in the months of June and July, and then again in
October right before planting. The process aerates the soil, making it more conducive for seed germination and root growth. During planting in October, animal manure is added to the soil as an organic fertilizer. This enriches the ground with essential nutrients and improves soil structure. Using a sowing machine, seeds and fertilizers are simultaneously introduced to the soil. This ensures uniform growth and an increased chance of germination. By April, the plants begin to root. At this stage, ammonium sulfate, often referred to as 'çim gübresi', is applied as fertilizer using a manure spreader. This boosts the plant's growth and ensures a better yield. In the spring, herbicides are applied to control the growth of unwanted plants and weeds that can affect the yield of the crop. Post-June, the matured crop is harvested, and the process may be repeated for the next cycle.

Chickpea cultivation has its unique process. Before winter sets in, the field where chickpeas will be sown is ploughed and then left to rest, a process referred to as 'herk etmek'. This fallow period allows the soil to rejuvenate and regain its fertility. After winter, the seeds are sown using a plough. Unlike wheat and barley, a cultivator isn't preferred for chickpeas as it cannot sow the seeds deeply, which is crucial for chickpea growth. A second round of ploughing is done in April. This not only helps in weed control but also prepares the top layer of the soil for the upcoming stages of growth.

One third (34%) of all mentions point out the application of measures for soil health, that includes practices such as fallowing, rotational cropping, and mulching.

According to Nadeem et al., (2019), the crop rotation and land fallowing are valuable practices for optimizing resource use, improving soil health, managing pests, and minimizing environmental impact.

"I plant vegetables in the same place for two years, and then I plant them in a different place. If I plant in the same place every year, it causes diseases." (G7)

Mulching is a horticultural practice that involves the application of plant material, such as leaves, grass, twigs, crop leftovers, and straw, to the surface of the surface
Field study of FAO (2020) compares tomato cultivation with and without mulching to non-mulching practices. The findings suggest that mulching effectively conserves soil moisture, enabling tomato plants to thrive even during a month without rain. Conversely, without mulching, the plants experienced water shortages and eventually died. Moreover, mulching also hinders weed growth, further benefiting tomato plant health. In summary, mulching plays a crucial role in maintaining soil moisture and enhancing crops. For instance, farmer A4 mentions the use of plant residues to increase the soil health.

“I also do this, I never throw the plant residues out, I throw them in the field. I chop the plants that grow from the soil with a machine. I feed it under the soil. The more you feed it under the soil, whether it is grass or rubbish, the more the number of cells in the soil increases, the more vitality increases, when it increases, the earthworm works, the other thing works, I pay attention to these. That is the characteristic of the soil, if you keep it and throw it away, if you throw poison, the poison will kill the root of the weed anyway. I hoe that pepper three times. I pay a lot of attention to these. If we make green fertilization in the soil, this is also good. Not every farmer does these. We need to do these.” (A4)

Only 12% of all mentions refers to the application of animal manure. Farmer G5 in Güdül narrates how he applies animal manure and the benefits of it on the soil as below:

“I mix sheep manure with chicken manure. I let it sit with a shovel for a year, and it burns like henna. After it's burnt, I spread it on the base, and drip irrigation takes it in slowly throughout the season. That manure is sufficient for it until the end of the season. There's no need for others, just look, the

36 https://www.fao.org/family-farming/detail/fr/c/1617795/
tomatoes have grown as big as heads. Why would you add fertilizer to that? It's just agricultural fertilizer." (G5)

While farmers in Ayaş (%40) and Beypazarı (%53) represent the general tendency of all farmers towards the mechanized way of ploughing and tilling, Güdül differs with its use of traditional means, particularly animal manure (%19), in addition to not only mechanized but also manual ploughing and tilling (%29). Both Beypazarı (%27) and Güdül (%29) almost equally apply measures for soil health.

Regarding the **changed state**, almost 60% of all mention a shift to mechanized ploughing, which is a general tendency of all farmers interviewed in three districts. While half of the mentions in Ayaş and Beypazarı indicate a shift to mechanization, the rest points to a change in land preparation steps such as an increase in steps and stopping fallowing or the preparation of irrigation ditches. An increase in steps in land preparation refers to the inclusion of additional steps such as the application of fertilizer or manure to the soil and increased plowing time to increase the yield. In addition, a farmer in Beypazarı mentions stopping rotational cropping.

In terms of **shift to mechanization**, a farmer in Güdül (G7) describes the process before switching to mechanized land preparation as an effort-dense process that mechanization eased the agricultural production process.

"In the past, sowing wheat here was a death sentence. Let's say there's a 30-decare field on the flat part of that hill. We used to sow wheat. We tilled it with a plow back then. We brought it down to the threshing floor with animals. I was going up and down this slope with the animals six times a day. For example, how many days did it take? Ten days. It lasted for ten days." (G7)

**Changed steps** in production process that includes increase in steps, stopping irrigation ditching after the introduction of drip irrigation in the region, and stopping rotational cropping.

A farmer in Ayaş depicts the change in land preparation with the change in irrigation technology, adoption of drip irrigation.
“There was no drip irrigation system in the past. It used to be planted normally and watered with a sprinkler. After the tomatoes grew, they were shoveled between the rows. It was watered round and round. Such rows and roundabouts were made. Now that’s gone.” (A1)

The farmer B10 narrates the crop rotation method that was continued for years but stopped due to the change in crop choices in the village of the interviewee.

“In our neighborhood, 4 crops were planted alternately. The first one is rice. The second is wheat/barley. The third is sugar beet. The fourth was melon and watermelon. In other words, it was constantly changing as a rotation. For example, when we removed the rice, which I call paddy, we used to plant melon in its place. The next year we used to plant beetroot in the field where we removed the melon. And in the field where we removed the beetroot, we used to plant barley/wheat. Why is this? Now you know that beetroot is a taproot plant. When you remove the tap-rooted plant, you have to plant fringe-rooted plants. Because one takes [water] from the base, one takes from the surface. This is how these things were arranged in time. It continued this way for years. Then this vegetable business started. First it started with carrots. Carrots started to be planted. Then red radish, black radish. Black radish started at first. Then this red radish came out. Red radish started. After that, spinach, lettuce, parsley, cress, rocket... Now all kinds of vegetables started to be planted.” (B10)

Contrastingly, a farmer from Güdül (G11), after narrating the current state of land preparation process, explains changes in the process as the cultivation steps do not change but the farmers adopted technology through time.

“As far as I remember, the cultivation process has always been the same. That’s what our farmers who keep up with technology. Of course, in the past, there used to be something called a hand plow. Old tools and equipment. There were no tractors, none. People adapted according to that, but now everyone
has a plow, everyone has a tractor, a seed drill, a cultivator for planting. People use them as the day comes." (G11)

Güdül differs with the higher mentions of the shift to mechanized ploughing (66%), and farmers do not mention any change in land preparation steps. Contrastingly, only one farmer mentioned that he stopped burning stubble in the field.

The last changed land preparation step is stubble burning with only one mention from Güdül. Interestingly, this step has a backwards approach to production. It represents a post-harvest preparation of the land as farmers burn the plant residues on the fields. It is the direct opposite of the green manuring that farmer A4 mentions.

In terms of stubble burning, farmer G5 narrates that he stopped burning stubble as it is detrimental for soil health and stubble can be used as a green manure in the field to increase the soil carbon capacity.

"The productivity... If you take care of the soil, the soil takes care of you. If you properly apply animal manure, till the soil this way and that, and plough (kazayağı çekmek37) twice. That's what's crucial here. The more you work the soil, the better the product you get. Just tilling it once is not enough. I insistently work in the field; aeration is very important. For example, look now, I took the barley. No one... plowed the field, but I don't burn the stubble with my tractor, I directly knock it down. Why? That stubble will become fertilizer. When you burn, what happens is that the minerals on the soil die. Moreover, however many worms and insects there are, all of them will tragically die - it's a sin. Even ants will die, and there's also the risk of fire. Burning is prohibited now. But I never burn anyway. When you till twice, it becomes natural fertilizer. As the stubble decays in the soil, it becomes fertilizer." (G5)

37 It is an agricultural tool used for operations such as levelling the ploughed field, breaking the weeds in the field, breaking the clods and aerating the soil. although it is called cultivator, agriculturalists generally use this name in Turkish.
Table 46. Current State, changed state, experienced impacts and response of farmers in land preparation stage

<table>
<thead>
<tr>
<th>1 CURRENT STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayas</th>
<th>% Beypaçarlı</th>
<th>% Güdül</th>
<th>% Gülüşül</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ploughing and Tilling [mechanized, manual]</td>
<td>16</td>
<td>39</td>
<td>2</td>
<td>40</td>
<td>8</td>
<td>53</td>
</tr>
<tr>
<td>(i) Mechanized</td>
<td>14</td>
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<td>100</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>(ii) Manual</td>
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<td>13</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Applying Measures for Soil Health [Fallowing, Rotational Cropping]</td>
<td>14</td>
<td>34</td>
<td>1</td>
<td>20</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>(i) Fallowing</td>
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<td>50</td>
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<td>(ii) Mulching</td>
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<td>1</td>
<td>7</td>
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<tr>
<td>(iii) Rotational cropping</td>
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</tr>
<tr>
<td>(iv) Not Fallowing</td>
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<td>0</td>
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<td>Applying Animal Manure</td>
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<tr>
<td>Preparing Lines for Next Steps [plantation, irrigation]</td>
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<td>7</td>
<td>2</td>
<td>40</td>
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<tr>
<td>Other Practice</td>
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<td>0</td>
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<td>7</td>
</tr>
<tr>
<td>Total</td>
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<td>100</td>
<td>15</td>
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<table>
<thead>
<tr>
<th>2 CHANGED STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayas</th>
<th>% Beypaçarlı</th>
<th>% Güdül</th>
<th>% Gülüşül</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanized Ploughing</td>
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<td>57</td>
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<td>50</td>
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<td>50</td>
</tr>
<tr>
<td>Changed Steps [increased steps, stopped irrigation ditching and fallowing]</td>
<td>2</td>
<td>29</td>
<td>1</td>
<td>50</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>Stopped Burning Stubble</td>
<td>1</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>100</td>
<td>2</td>
<td>100</td>
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<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3 IMPACT</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayas</th>
<th>% Beypaçarlı</th>
<th>% Güdül</th>
<th>% Gülüşül</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Cost [labor, fuel]</td>
<td>4</td>
<td>44</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>Soil Deterioration</td>
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<td>33</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No Experienced Problem</td>
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<td>22</td>
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<td>0</td>
<td>2</td>
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<td>Total</td>
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<table>
<thead>
<tr>
<th>4 RESPONSE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayas</th>
<th>% Beypaçarlı</th>
<th>% Güdül</th>
<th>% Gülüşül</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mulching/ Green Manure</td>
<td>3</td>
<td>30</td>
<td>1</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>3</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>Fallowing and Rotational Cropping</td>
<td>2</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>Preparing Land for Organic Farming</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>50</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Getting State Support</td>
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<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td>100</td>
<td>2</td>
<td>100</td>
<td>3</td>
<td>100</td>
</tr>
</tbody>
</table>
Farmers indicate three types of experienced impacts in the face of changes in land preparation. As farmers shifted to mechanized ploughing and change steps of land preparation, more than half of the mentions (54%) about the experienced impact refers to the high costs of land preparation, including fuel and labor. All farmers interviewed in Ayaş and the half in Güdül indicate this situation while no farmer in Beypazari reports high costs as an impact. Half of all mentions by the farmers in Güdül point to soil detention, which makes up 30% of all mentions in terms of experienced impact. 18% of the mentions state that there is no experienced problem in land preparation. High cost appears to be a prominent concern among the districts, particularly in Güdül, where 50% of the practices experience high costs. In contrast, Ayaş doesn't face this impact at all, while it affects 33% of practices in Beypazari. A farmer in the interview with Beypazari Gardeners Cooperative (B1-2) depicts the change in the land preparation and impact of the change interrelatedly.

"In the past, we used to do the 'karasaban' [a traditional plowing method], then there was a plow, and after that, there was a seed drill. Maybe they used to drag some brushwood over it, for instance, 2 or 3 times. Now, to obtain a higher and better-quality product and not to waste the seeds, we literally grind the soil down to a fine consistency. It's much more suitable. Just as you need to knead the dough well, it's the same with the soil. If it doesn't reach that consistency, you can't achieve what you aim for, and you simply can't obtain the crop in the desired quantity and quality. Therefore, the input costs matter a lot. If a tractor enters a field 11 times for a single crop, there's a significant difference in terms of fuel and fertilizer support. The fuel support given to us per acre is very low." (B1-2)

Soil deterioration is a significant issue especially in Güdül, with 50% of the practices affected. Neither Ayaş nor Beypazari report any concerns related to soil deterioration. However, this does not directly suggest that the farmers in these districts have effective preventive measures in place. Based on the analysis of both
interview results and secondary data related to the region, Beypazarı and Ayaş inclines more towards conventional farming methods which could result in soil deterioration more than Güdül that follows more small scale, traditional and ecological farming method. Yet, the analysis results show that Güdül experiences more impacts from soil deterioration might stem from the developing sustainable agricultural-ecological perspective among farmers.

Equal mentions of farmers from three districts indicate that they adopted **mulching and applying green manure** (30%) and **overprocessing the soil** (30%) as a **response** to changing conditions and to their impacts. 20% of all the mentions point to the adoption of **fallowing or rotational cropping**. Güdül follows the general tendency in the region with equal mentions of mulching, applying green manure, and overprocessing the soil (40%).

Although, not all interviewed farmers provide information on their adaptive experiences to changing conditions, it is salient here to share an overview of different types of responses emerging as a response to changing conditions and experienced impact in land preparation as the first step of agricultural production.

Only three farmers in Beypazarı indicate that they adopt adaptive responses. They equally mention overprocessing the soil, fallowing, rotational cropping, and getting state support. All farmers interviewed in Ayaş mention **mulching and the application of green manure** (50%), as well as **preparing land for organic agriculture** (50%). Yet, Ayaş has the least diverse responses with only two methods.

Mentions from the interviews mark adaptive practices related to soil health by 60%. These include the practices of mulching, following and rotational cropping and preparing land for organic farming. Whereas, only 10% of all mentions indicate **receiving state support** as a response. Overprocessing the soil (30%) is a response mechanism indicated by farmers to increase the yield in different steps of production.

In terms of applying measures for soil health, farmer G7 mentions that he adopts fallowing to tackle with an experienced impact in plant growth. Farmers responses
to plant diseases by adopting not cultivating the field with the same crops for more than two years.

“Where I plant vegetables, I plant them for two years, then I plant them somewhere else. If I plant the same place every year, plants get sick, but we usually pay attention to spraying. If you don’t pay attention to spraying, it gets sick quickly. Since there is no local seed, it gets disease very quickly.” (G7)

However, the representative of an NGO, Dört Mevsim Ekolojik Yaşam Derneği (G14), that works on dissemination of agroecological agricultural practices and operates in Güdül has contrasting but more realistic opinion on the mulching and applying green manure. However, the NGO and the representative are the proponent of these type of applications and has put efforts into increasing the adoption of them among small scale farmers in Güdül. However, as the representative highlights, such applications are not fully adopted and spread across the region. Based on this background, the interviewee G14 points out that

“They [farmers in Güdül] are somewhat distant from innovative practices that increase the vitality of the soil, such as green manure applications and living mulch applications. Because of this, there’s a significant expenditure of both labor and fuel during the soil preparation process. Still, although they are small compared to large-scale farms, a tractor is introduced to the field, and that tractor tills the field. Fuel is consumed, time is spent, money is expended, and the soil starts to lose its vitality because it is continuously tilled in this manner every year. Similarly, because mulching practices are not often conducted, the soil starts to lose its vitality. These types of problems exist primarily in the preparation phase and when dealing with the soil.”

After applications for soil health, the second most mentioned response in land preparation step is the overprocessing the soil (30%). This response mechanism indicated by farmers to increase the yield in different steps of production. Interviewee B1 states the need for deep tillage to get maximum yield and good quality products from the seeds, that shows the differing attitude between
conventional and ecological/organic farming practices. In similar vein, farmer G8 also highlights the more frequent use of cultivators to increase the yield.

5.3.2 Seed Selection and Obtainment

Seed selection and obtainment is the second step of agricultural production after land preparation. The aim in this step is to decipher how farmers select seeds for cultivation and how they obtain them. Fieldwork shows that farmers in Northwestern Ankara obtain seed locally either through stores, through their informal ties or institutional networks. Particularly, in Beypazarı farmers also significantly prefer using certified seeds. With the occurring changes, farmers equally switch to certified seeds and start planting or apply no change for seedling. These are most prevalent in Beypazarı and Güdül. Farmers in Ayaş equally stop getting seeds from plants and sharing/using local seeds and switch to certified seeds. Only a limited number of farmers both in Ayaş and Güdül refer to starting use of local seeds with only one farmer from each district.

This trend, however, also comes with its disadvantages such as low quality and yield, high cost, loss of taste, and increased disease. This is most prevalent in districts where there is a higher switch to certified seeds. Moreover, leaving the use of local seeds not only because of the increase in certified seeds but also due to low yield of local seeds results in the loss of local seeds. In Ayaş, lack of accessibility, and thereby, the loss of local seeds stands as the major impact of experienced changes. Despite all these impacts mainly created by the use of certified seeds, farmers continue or switch to use them. Interestingly, this trend breaks off to some degree in Güdül with farmers who also intend to continue the use of local seeds for their own consumption.

The interview results yielded four categories for the current state. These include seed and seedling source (54%), use of certified seeds (%27), use of local seeds (%14) and the contextual selection of the seeds (%5).
More specifically, in the current state, farmers obtain seeds/seedlings from *local stores*, accounting for 33% of the mentions regarding the source of obtainment. This is followed by *producing seedlings themselves* with 23%. At a similar ratio, farmers obtain seeds from *plants* (16%) and from *informal/membership networks* (16%). Obtaining from *multiple sources* (7%) and from *the municipality* 5%) are fewer common sources of seeds and seedlings.

Interview results show that obtainment of the *seedlings from local stores* is the most referred source in the region. This is particularly a common practice in Beypazarı (50%). Overall, the dominant seedling source is local stores, with Ayaş, Beypazarı, and Güdül having 33%, 50%, and 24% respectively.

Table 47. Current State, changed state, experienced impacts and response of farmers in seed selection and obtainment stage

<table>
<thead>
<tr>
<th>1 CURRENT STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayaş</th>
<th>% Beypazarı</th>
<th>% Güdül</th>
<th>% Gülüll</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed/Seedling Source</td>
<td>43</td>
<td>54</td>
<td>6</td>
<td>55</td>
<td>12</td>
<td>50</td>
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<tr>
<td>(i) Obtaining seedling from local stores</td>
<td>14</td>
<td>33</td>
<td>2</td>
<td>33</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>(ii) Producing seedlings</td>
<td>10</td>
<td>23</td>
<td>2</td>
<td>33</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>(iii) Obtaining seed from plants</td>
<td>7</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(iv) Obtaining from Informal/Membership Network</td>
<td>7</td>
<td>16</td>
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<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(v) Obtaining from multiple source</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>17</td>
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<td>8</td>
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<tr>
<td>(v) Obtaining from municipality</td>
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<tr>
<td>Using Certified Seeds [international /national]</td>
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<td>3</td>
<td>27</td>
<td>10</td>
<td>42</td>
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<tr>
<td>Using Local Seeds</td>
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<td>14</td>
<td>1</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Selecting Seeds Context-Dependently [region, land, activity]</td>
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<td>5</td>
<td>1</td>
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<td>11</td>
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Table 48. Current State, changed state, experienced impacts and response of farmers in seed selection and obtainment stage continued

<table>
<thead>
<tr>
<th>2 CHANGED STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayaş</th>
<th>% Beypazar</th>
<th>% Güdül</th>
<th>% Güdül</th>
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<tbody>
<tr>
<td>Switched to Certified Seeds</td>
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<td>31</td>
<td>3</td>
<td>20</td>
<td>4</td>
<td>36</td>
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<td>No Change</td>
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<td>18</td>
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<td>7</td>
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<td>18</td>
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<tr>
<td>Stopped Using/ Sharing Local Seeds</td>
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<td>15</td>
<td>3</td>
<td>20</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Started Planting from Seedling</td>
<td>5</td>
<td>13</td>
<td>2</td>
<td>13</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>Stopped Getting Seeds from Plants</td>
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<td>10</td>
<td>3</td>
<td>20</td>
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<tr>
<td>Changed External Conditions</td>
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<td></td>
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<td>[seed law, climatic]</td>
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<td>8</td>
<td>2</td>
<td>13</td>
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<td>9</td>
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<td>Started Using Local Seeds</td>
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<td>0</td>
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<tr>
<td>Total</td>
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<td>15</td>
<td>100</td>
<td>11</td>
<td>100</td>
</tr>
</tbody>
</table>

| 3 EXPERIENCED IMPACT                                 |           |         |        |            |         |         |         |           |
| Disadvantages of Certified Seeds [decreased quality/yield, high cost, hardships, loss of taste, plant disease, new seed-dependent, soil pollution] | 20        | 35      | 2      | 22         | 10      | 37      | 8       | 38       |
| Lack of Accessibility / Loss of Local Seeds [Kunduru wheat, Ayaş tomato, spinach] | 16        | 28      | 4      | 44         | 7       | 26      | 5       | 24       |
| Low Yield of Local Seeds                            | 10        | 18      | 1      | 11         | 6       | 22      | 3       | 14       |
| Benefits of Certified Seeds [variety, yield, proper-shaped, reproducibility] | 8         | 14      | 1      | 11         | 2       | 7       | 5       | 24       |
| Disadvantages of Buying Seedling                    | 2         | 4       | 0      | 0          | 2       | 7       | 0       | 0        |
| Disadvantages of Preparing Own Seedling             | 1         | 2       | 1      | 11         | 0       | 0       | 0       | 0        |
| Total                                                | 57        | 100     | 9      | 100        | 27      | 100     | 21      | 100      |

| 4 RESPONSE                                          |           |         |        |            |         |         |         |           |
| Continuing the Use of Certified Seeds               | 14        | 33      | 3      | 33         | 7       | 47      | 4       | 24       |
| Switching to Certified Seeds                        | 12        | 28      | 2      | 22         | 4       | 27      | 6       | 35       |
| Continuing the Use of Local Seeds for Own Consumption| 6         | 14      | 1      | 11         | 1       | 7       | 4       | 24       |
| Continuing the Use of Local Seeds for Seedling      | 4         | 9       | 1      | 11         | 2       | 13      | 1       | 6        |
| Searching for Local Seeds                           | 3         | 7       | 0      | 0          | 1       | 7       | 2       | 12       |
| Ready Seedling                                      | 2         | 5       | 2      | 22         | 0       | 0       | 0       | 0        |
| Searching for New Seed Sources [municipality, multiple source] | 2         | 5       | 0      | 0          | 1       | 7       | 1       | 6        |
| Total                                                | 43        | 100     | 9      | 100        | 15      | 100     | 17      | 100      |
Particularly, farmers in Beypazarı (B1) and Güdül (G3) both refer to not being self-sufficient in seed production and the necessity or choice of acquiring seeds or seedlings from traders or local stores.

“Everyone buys from traders. We must. We had to. You can't buy and plant your own seed. Which means you can't keep it going. You have to buy it again every year.” (B1)

“We produce the seed ourselves, but where we don't produce it, we buy it from the local store. Sometimes we get the seed ourselves and ... sometimes we buy hybrid seeds from them. We buy seedlings from them.” (G3)

The production of seedling from seed still exists as a traditional practice and is referred most dominantly by the farmers in Ayaş (33%) as well as by the farmers from Beypazarı (25%) and Güdül (20%). Güdül differs with almost %70 of all mentions pointing to traditional approaches such as obtaining seeds from plants (20%), from local stores (%24), and through informal and membership networks (24%). Farmers in Beypazarı also produce their own seedlings (%25), and equally prefer obtaining seeds from plants (8,3%), informal, and membership networks (8,3%) and multiple sources (8,3%).

Additionally, one person from each district refers to obtaining seed and seedling from multiple sources such as combination of different stores, chambers, municipality, and networks. Although it is seen as a relatively rare practice, obtaining seed and seedling from municipality stands as an emerging practice with the growing support of metropolitan and district municipalities. One person from Ayaş and one from Güdül point out that they obtain seed and seedling from the municipality. For instance, Farmer G9 states that he uses Ankara Metropolitan Municipality’s seed support as a result of price incentive.

The use of certified and local seeds forms the two most mentioned subthemes emerged in the interview results. Respectively, almost 27 % of the mentions indicate the use of certified seeds and 14% of the mentions state the use of local seeds. The
use of certified seeds is more predominant in Beypazarı (42%) whereas Güdül represents a hybrid state in the use of both certified seeds (18%) and local seeds (18%). Farmers mention the use of manual and machinery techniques for seed sowing after selecting and obtaining the seeds.

Whereas, only 5% indicate selecting seed context dependently, according to region, land, or agricultural activity. Güdül stands out in selecting seeds context-dependently, with 7% of the people making choices based on factors like region, land, and activity.

Both farmer A1 and G11 emphasize the importance of choosing seeds based on what is suitable or adaptable to the unique characteristics of their respective regions. For instance, farmer A1, who conducts organic farming explains the seed selection process for organic farming.

“We choose the seed from the varieties that are suitable for our region and from which we get yield. I mean from them. We always continue the varieties we have tried. These are of course hybrid and foreign seeds. Unfortunately, there are no local ones.” (A1)

Another farmer in Güdül (G11) indicates the selection of seeds based on the topography and habitat of the region which indicates a clear intersection of agricultural practices with the local socio-ecological system.

“Now we have learnt how to choose the seeds according to the condition of the soil in the barren fields…. We have fields all around Güdül. If we have fields all around Güdül, we also have wild animals. ...In other words, if we sow wheat without awns, the pig crushes it, chews it and eats it. Therefore, we sow our wheat without awns in places where pigs do not come, and wild animals are not present. In our other mountainous regions, we either sow spelt wheat, barley, or triticale. In other words, we do this according to the conditions of the field, that is, according to the field with good yields or the field with poor soil.” (G11)
Following the current practices in seed selection and obtainment, five subthemes emerged from the interviews relevant to the **changed state** in the seed selection process. 30% of the mentions highlight **switching from local to certified seeds**. Beypazarı shows a notable shift towards certified seeds (36%).

For instance, farmer A2 states the local seeds changed with hybrid seeds. Local seeds, like tomato, are only used for own consumption of farmers. In similar vein, farmer A1 states that Seed Law no. 5553\(^{38}\) enacted in 2006 has triggered the switch from local to certified seed. Before the law, farmer A1 stated that she was using their own seed. They were getting their own seed from plants with high yield and productive in their field. They were sharing the seeds with the neighbors. Now they cannot get the seeds due to the law. However, there are misclarifications regarding the domain of the law. While the law bans the marketing of non-certified seeds, it does not ban farmers who cultivate using the heirloom and local seeds. The law bans the marketing of the seeds that the farmers obtain from the plants grown from the local varieties. Farmers must register and certify the seed if they want to sell the seeds in the market. It means farmers can get and share local seeds among each other. Yet, as Aysu (2015) states, the law built barriers in the use of local seeds among farmers but opens the doors for exported certified seeds.

Overall, 18% of all mentions indicates **no change** in the seed selection and obtainment processes. Specifically, in Güdül, where traditional agricultural practices still exist, a transition to certified seeds is more frequently mentioned than in the other two districts. 15% of all mentions indicate that farmers **stopped using and sharing local seeds** due to several reasons associated with external and climatic conditions. For example, Farmer G4 used to get seed from plants but switched to buy hybrids seeds available in local market in Beypazarı.

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\(^{38}\) https://www.resmigazete.gov.tr/eskiler/2006/11/20061108-1.htm
Only 8% of all mentions refer to the *changed external conditions*. Similarly, farmers in Ayaş also *stopped using and sharing local seeds* (20%) in response to *changed external conditions* including law and climate related changes (13%), like the statement of Farmer A1 related to the change in seed law. Climatic conditions form another external condition that impacts the seed selection of the farmers, as farmer A2 mentions as follows:

“In tomatoes, the old Ayaş tomato is no longer cultivated, only for eating, so that the seeds are not lost. The old seed of Ayaş tomato does not exist because of the climate. That seed is not available now. Therefore, it is not cultivated.”

(A2)

Farmers also *use seedlings* (12%) rather than planting from the seeds. Especially, more than quarter of all mentions (27%) in Beypazari indicates this transition which is relevant with a high share of using ready seedling from local stores as an overall trend. In the same vein, relevant with the use of seeds, almost equal mentions indicate *stopped getting seeds from plants* (10%). Especially farmers in Ayaş (20%) mention this situation most frequently.

“We used to get it [seed] ourselves, but not anymore. We buy it ready-made. We buy it from an agriculturalist in Beypazari.” (G4)

Overall, 40% of mentions in Ayaş points out that farmers stopped traditional techniques including the use of local seeds and obtaining seeds from plants. Only one farmer each in Güdül and Beypazarı highlighted that they started using local seeds.

In terms of *experienced impacts* resulting with the changed state in seed selection, *disadvantages of certified seeds* are the most frequently mentioned issue with 35%. In particular, farmers in Beypazarı (37%) and Güdül (38%) almost equally mention these disadvantages. They include decreased quality, high cost, loss of taste, plant diseases, new seed dependence and soil pollution.
The quotations of the farmers below describe the trade-off between benefits of local and certified seed when choosing seeds to sow, particularly the shift towards hybrid seeds due to their higher yields and economic benefits despite potential drawbacks in terms of taste, tradition, and quality.

“In the past, the farmer used to use his own seed, but now the farmer cannot get this yield if he uses his own seed.” (A3)

Farmer A4 highlights another aspect of hybrid seed use. Even if the hybrid seed is not sterile and can be replanted, its yield and quality diminish over time, leading farmers to renew their seed source.

“In domestic hybrid, you can make the next production. It is not sterile, it has fertility, but you renew it because the yield decreases. Yield decreases, quality decreases, so you take it and make it again” (A4)

Specifically, farmer B10 emphasizes the commercial appeal of hybrid seeds, suggesting that the financial aspect drives many farmers' decisions to switch to them.

“Hybridised. We're planting genetically modified seeds. Why are we planting it? Domestic seed has no commercial input. Why not? It doesn't make money because it gives very little. But hybrid seed makes money because it gives a lot. Because of the commercial thing, citizens turn to it more.” (B10)

The second most mentioned experienced impact concerns lack of accessibility to local seeds such as local varieties like Kunduru wheat, Ayaş tomato, and spinach. While this is observed in almost half of all mentions by the farmers in Ayaş (44%), it is almost quarter of mentions in Beypazarı (26 %) and Güdül (24%).

For instance, Farmer B7 provides a clear illustration of both the trade-off between yield and traditional value, and also the decreased accessibility to local seeds in the region.

“We lost our essence, our wheat, the wheat seed that is special to us...Now you use hybrid seeds, you plant hybrid seeds willy-nilly because they have high
yields. You get 1 to 20 from one of them and 1 to 10 from the old wheat seed. Would you prefer one to ten or one to twenty? You turn to hybrid inevitably. When it is a hybrid, your yield is high, but you can't taste the old flatbread that we eat, for example, when you make flour. For example, we have a wheat variety called kunduru, which is unique to this region, there is no flour on it, it is perfect. Unfortunately, kunduru wheat is rarely cultivated in this neighbourhood.” (B7)

Farmer B10 states that local spinach seed which is more resilient to plant diseases is lost and relates this situation to the introduction of hybrid seeds into the market around 1980s.

“This started after ’85, in other words, it began like this. It first started with spinach. This mildew issue began in spinach. Of course, in the hybrids. There wasn’t such a thing in local spinach seeds. We even lost that seed.” (B10)

Almost one fifth of all mentions (17.5 %) refers to low yield of local seeds meaning the lower productivity of local seeds compared to certified seeds. Particularly, farmers in Beypazarı (24%) point to such impact compared to other two districts. In-depth interviews reveal that farmers in Beypazarı experience problems in increasing the yield when using local seeds, and thus, they tend to shift to certified seeds. For example, Farmer B2 states that local seeds can give 2 tonnes of yield and farmers lose money. As a response, foreign seeds that give 7-8 tonnes are used. This, indeed, constitutes a problem rather than an experienced impact, that might work as a driver of change in transition to certified seeds.

Only 14% of mention the benefits of certified seeds such as variety, high yield, proper shape, and reproducibility. Farmers in Gündül equally mention the benefits of certified seeds (24%) and lack of accessibility to local seed (24%). These are contrasting concerns but considering that the tendency of farmers in Gündül shifting to certified seed and adoption of local seeds, these experienced impacts are meaningful. Additionally, disadvantages of buying seedlings (4%) and disadvantages of
preparing own seedlings (2%) are categories that farmers mention in terms of experienced impacts in seed selection and obtainment process.

Compared to the mentioned experienced impacts (total of 57 mentions), there are less responses (35 mentions). Overall, the most common response is the continuation of farmers in their use of certified seeds with almost 38% of all mentions. But similarly, farmers also tend to switch to certified seeds (32%). Especially, farmers in Güdül (%35) highlight this tendency.

There are also farmers indicating the use of local seeds only for their own consumption with 16% of all mentions. Although switching to certified seeds, farmers prefer to use local seeds for the products they cultivate in their garden. Especially, almost one fourth of the mentions from the farmers in Güdül points out that this practice takes place.

“There's old wheat here, there's Kunduru. I continue to cultivate it. I sowed it myself, there is bulgur and kunduru. I plant 4-5 decares of it for myself. I make tarhana, bulgur and the rest into flour.” (G2)

Additionally, 8% of the mentions refers to searching for local seeds. This response pattern is particularly relevant to the farmers who use certified seeds but want to cultivate with local seeds. A representative statement below exemplifies this:

“Now even the seed changes every year. That's why, for example, we don't use most of the fertilizers we used to throw away. It is renewed every year. For example, we cannot use local seeds. All imported. So, we use seeds from outside.” (B8)

Ready seedling use (5%) is adopted by the farmers in Ayaş with a significant trend (22%) of, which is not observed in the other two districts. Lastly, searching for new seed sources (5%) such as municipality or adoption of multiple sources is a response strategy adopted by one farmer each from Beypazarı and Güdül.
5.3.3 Irrigation

Irrigation is the third step of agricultural production. This section presents what farmers experience with irrigation in the current state through their own descriptions, what changes, the impacts on their irrigation practice, and their responses to the changing conditions. In general terms, in-depth interviews confirm that farmers in Northwestern Ankara use a variety of water sources including natural and organized, and mainly apply drip and sprinkle irrigation methods but also turn to wild and rainfed methods. Ayaş stands as the district which adopts the most natural-resource-based irrigation system among all studied districts. It also uses only the drip irrigation method while the other two apply a variety of methods. Interviews with farmers show that water levels decreased, and farmers switched to organized irrigation systems with an intention to leave wild irrigation methods.

In the face of changing conditions, farmers experience water scarcity. To deal with this and because of their new irrigation choices, on the one hand, high electricity prices come as an emerging consequence. This is particularly experienced by the farmers in Beypazarı. On the other hand, inadequate irrigation infrastructure and problems arising due to switching to the drip irrigation system also appear as other important impacts in all districts. While this is equally experienced by the farmers in Güdül, not only inadequate irrigation infrastructure but also lack of cooperation in the face of changing conditions stand as the most frequently lived impacts in Beypazarı. In response to such impacts, farmers tend to seek alternative water sources and to switch to the drip irrigation method. Additionally, in Ayaş, farmers apply their own irrigation systems, in Beypazarı, farmers tend to change their product pattern, and in Güdül, farmers tend to apply both.

More specifically, in terms of the current state of irrigation, interview results indicate that farmers using natural water resources for irrigation comprise almost 60% of all mentions. In terms of water resources, the rest of the mentions indicates that irrigation through organized systems (41%) such as systems like state irrigation, dams and irrigation cooperatives is common in the region. Farmers use water directly
from underground water resources (54%) and from the river (46%) for irrigation. The use of water from the river is especially frequent among farmers in Güdül (67%). Two-thirds of all mention in Beypazarı that states the use of natural water resources indicates the use of underground water.

According to the 2017 data of DDoAF in Beypazarı, which is only available data regarding the situation of irrigation in the district, reveals that the total irrigated area in Beypazarı was reported to be 11,581 hectares, with the majority of irrigation being carried out through above and underground facilities. Ground irrigation facilities accounted for a total of 2,700 hectares and included Kirmir Stream (2,000 ha), Süveri Stream (300 ha), Aladag Stream (200 ha), İlhan Stream (100 ha), while underground irrigation facilities comprised of approximately 2,000 wells. The agricultural irrigation wells in Beypazarı have a depth ranging from a minimum of 10 meters to a maximum of 200 meters (MoAF, 2017b).

In Güdül, 2132 ha of the total 30478 ha agricultural land can be irrigated. While 70% of the irrigation is made up of public irrigation, 30% is made by using irrigation ponds, dams and canals built by the State Hydraulic Works (DSİ) and irrigation systems built by cooperatives (MoAF, 2017c). When these figures compared with the interview results also considering the time gap between these two datasets, it is seen that farmers adoption of organized irrigation systems has increased to 45% in Güdül whereas the use of natural water resources such as ground and underground water with individual incentives decreased to 55%. The results of the interviews considering the adoption of organized irrigation systems as a response strategy in irrigation in Güdül support such a decrease in individual incentives.

The second water resource type for irrigation is using water from organized systems. Almost half of all mentions (41%) also highlight this. In this water resource, farmers mainly stated the use of water from dams (78%) as well as water from irrigation cooperatives (22%). While all farmers in Ayaş and Beypazarı turn to using water from dams of State Hydraulic Works (DSİ) built for irrigation purposes, only farmers
in Güdül mention that they use water from irrigation cooperatives (40%) in addition to dams.

*Irrigation method* is the second most mentioned category and includes five sub-categories: (i) *Drip Irrigation*, (ii) *Sprinkle irrigation*, (iii) *Wild Irrigation*, (iv) *Rainfed Irrigation*, and (v) *Non-Irrigation*. Out of 36 mentioned, 50% reported using *drip irrigation*. While in Ayaş, all mentions indicate using drip irrigation, more than 40% all mentions in Beypazarı (40%) and in Güdül (50%) reported using drip irrigation.

Among all respondents who reported using an irrigation method, 22% mentions refer to sprinkle irrigation. Particularly farmers in Beypazarı (40%) refers to sprinkle irrigation. Wild irrigation has a limited share as an irrigation method in the region by 14%. Dominantly, farmers in Güdül (22%) indicate using wild irrigation compared to other methods in Güdül.

The results of the interviews are correlated with the 2017 data of Beypazarı DDoAF. While interview results shows that 80% of farmers in Beypazarı use drip and sprinkler irrigation and 7% uses wild irrigation, the data of DDoAF states that sprinkler and drip irrigation account for 95% of irrigation and the remaining 5% consists of wild irrigation systems (MoAF, 2017b). These results show accordance with the decrease of wild irrigation and increase of more advanced irrigation systems between 2017 and 2020-2021 when interviews conducted.

The statements of the interviewee B10 support the above data on irrigation that dominant irrigation methods in Beypazarı are drip and sprinkler irrigation. In addition, farmers also mention different irrigation methods for different crops.

“We have been using drip irrigation for more than 10 years. So, we have been using it. There are places where we use dripping and places where we don’t. For example, dripping does not work for carrots. We use sprinkle irrigation…. We use drip in tomato. It is very good in tomatoes. We use dripping for zucchini
and cucumbers. But apart from that, sprinkling is also used in carrots, spinach, lettuce."

The least frequently mentioned irrigation method is rainfed irrigation. This irrigation method only uses rainwater for irrigation and is used in non-irrigated agricultural products. Only 8% of all mentions, all from Güdül, refer to the use of rainfed irrigation. Lastly, 6% of mentions by the farmers state no use of any irrigation method.

Farmer G11 narrates the rainfed irrigation for cereals and irrigation needs for irrigated crops.

“Our farmers initially don't do any irrigation or anything of the sort. Since it's still winter, of course, we get our rain around November, and the cereals grow on their own. Well, once they've grown, in areas with irrigated agriculture, if there's a need for water in April and May, that's when irrigation is done. They lay lines in the field – irrigation lines – and with that, our farmers conduct their irrigation” (G11)

In terms of the changed state in irrigation step of agricultural production, farmers most frequently indicate decreased water levels (29%). This consists of two dimensions: decreased underground water (67%) and decreased ground water (33,3%). While all farmers in Beypazarı and Ayaş emphasized decreased underground water levels, 80% of all mentions in Güdül refers to decreased ground water levels. This is consistent with farmers who use the river as a water resource for irrigation. Farmer A2 in Ayaş refers to decreasing underground water levels as follows:

"We used to irrigate with a water engine, but now, even when we place the submersible pump next to the water, we still can't get the water. The water is decreasing." (A2),
Farmer B6 in Ankara also indicates the decreasing underground water levels. Farmer states that the underground water level was 6 to 10 m in 2000s and now it decreased to 100 m.

Table 49. Current State, changed state, experienced impacts and response of farmers in irrigation stage

<table>
<thead>
<tr>
<th>1 CURRENT STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayaş</th>
<th>% Beypazarı</th>
<th>% Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Source</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Natural Resources</td>
<td>22 38</td>
<td>4 57</td>
<td>7 32</td>
<td>11 38</td>
<td></td>
</tr>
<tr>
<td>(a) Underground Water</td>
<td>7 54</td>
<td>2 67</td>
<td>3 75</td>
<td>2 33</td>
<td></td>
</tr>
<tr>
<td>(b) Water from the River</td>
<td>6 46</td>
<td>1 33</td>
<td>25 4</td>
<td>6 67</td>
<td></td>
</tr>
<tr>
<td>(ii) Through Organized Irrigation Systems [DSI, dam, irrigation cooperative, closed irrigation system]</td>
<td>9 41</td>
<td>1 25</td>
<td>3 43</td>
<td>5 45</td>
<td></td>
</tr>
<tr>
<td>(a) Water from the Dam (DSI, closed irrigation system)</td>
<td>7 78</td>
<td>1 100</td>
<td>3 100</td>
<td>3 60</td>
<td></td>
</tr>
<tr>
<td>(b) Water from Irrigation Cooperative</td>
<td>2 22</td>
<td>0 0</td>
<td>0 0</td>
<td>2 40</td>
<td></td>
</tr>
<tr>
<td>Irrigation Method</td>
<td>36 62</td>
<td>3 43</td>
<td>15 68</td>
<td>18 62</td>
<td></td>
</tr>
<tr>
<td>(i) Drip Irrigation</td>
<td>18 50</td>
<td>3 100</td>
<td>6 40</td>
<td>9 50</td>
<td></td>
</tr>
<tr>
<td>(ii) Sprinkle irrigation</td>
<td>8 22</td>
<td>0 0</td>
<td>6 40</td>
<td>2 11</td>
<td></td>
</tr>
<tr>
<td>(iii) Wild Irrigation</td>
<td>5 14</td>
<td>0 0</td>
<td>1 7</td>
<td>4 22</td>
<td></td>
</tr>
<tr>
<td>(iv) Rainfed Irrigation</td>
<td>3 8</td>
<td>0 0</td>
<td>0 0</td>
<td>3 17</td>
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</tr>
<tr>
<td>(v) Non Irrigation</td>
<td>2 6</td>
<td>0 0</td>
<td>2 13</td>
<td>0 0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>58 100</td>
<td>7 100</td>
<td>22 100</td>
<td>29 100</td>
<td></td>
</tr>
</tbody>
</table>

Integration or disintegration to organized irrigation systems (29%) received equal mentions with decreased water levels. This category of change refers to integration to organized irrigation system such as dams and cooperatives operated by different institutions such as state bodies, municipalities, or operations.

All mentions in Beypazarı and 85% of mentions from Güdül point out integration to organized systems and facilities. In contrast, one person in Ayaş also stressed the dysfunctionality of the existing irrigation cooperative.

Table 50. Current State, changed state, experienced impacts and response of farmers in irrigation stage continued
## 2 CHANGED STATE

<table>
<thead>
<tr>
<th>Decreased Water Levels [underground, ground]</th>
<th>Frequency</th>
<th>% Total</th>
<th>Ayaş</th>
<th>% Ayaş</th>
<th>Beypazarı</th>
<th>% Beypazarı</th>
<th>Güdül</th>
<th>% Güdül</th>
<th>Çiğli</th>
<th>% Çiğli</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Decreased Underground Water Level</td>
<td>12</td>
<td>29</td>
<td>1</td>
<td>17</td>
<td>6</td>
<td>55</td>
<td>5</td>
<td>21</td>
<td></td>
<td></td>
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<tr>
<td>(ii) Decreased Ground Water Level</td>
<td>4</td>
<td>33</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>80</td>
<td></td>
<td></td>
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<tr>
<td>(Dis)Integration to Organized Irrigation</td>
<td>12</td>
<td>29</td>
<td>1</td>
<td>17</td>
<td>4</td>
<td>36</td>
<td>7</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Organized Irrigation Systems and Facilities</td>
<td>10</td>
<td>83</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>100</td>
<td>6</td>
<td>86</td>
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<td></td>
</tr>
<tr>
<td>(ii) Disfunctionalized Irrigation cooperative</td>
<td>2</td>
<td>17</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switched from Wild to Drip Irrigation</td>
<td>10</td>
<td>24</td>
<td>3</td>
<td>50</td>
<td>1</td>
<td>9</td>
<td>6</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changed Land Preparation</td>
<td>6</td>
<td>15</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No change</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>100</td>
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<td>11</td>
<td>100</td>
<td>24</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## 3 EXPERIENCED IMPACT

| Water Scarcity                             | 12        | 26      | 2    | 29     | 3         | 17          | 7     | 33      |       |         |
| High Electricity                           | 8         | 17      | 0    | 0      | 6         | 33          | 2     | 10      |       |         |
| Inadequate Irrigation Infrastructure       | 8         | 17      | 2    | 29     | 1         | 6           | 5     | 24      |       |         |
| Decrease in Yield                          | 5         | 11      | 1    | 14     | 2         | 11          | 2     | 10      |       |         |
| Benefits/Disadvantages of Drip Irrigation  | 5         | 11      | 0    | 0      | 0         | 0           | 0     | 5       | 24    |         |
| (i) Benefits                               | 4         | 80      | 0    | 0      | 0         | 0           | 4     | 80      |       |         |
| (ii) Pollution from Drip Irrigation        | 1         | 20      | 0    | 0      | 0         | 0           | 0     | 1       | 20    |         |
| Water Salinity                             | 4         | 9       | 0    | 0      | 4         | 22          | 0     | 0       |       |         |
| Lack of Cooperation                        | 4         | 9       | 2    | 29     | 2         | 11          | 0     | 0       |       |         |
| Total                                      | 46        | 100     | 7    | 100    | 18        | 100         | 21    | 100     |       |         |

## 4 RESPONSE

| Water Sources [alternative, underground]    | 13        | 42      | 1    | 25     | 9         | 56          | 3     | 27      |       |         |
| (i) Search for Alternative Water Sources   | 7         | 54      | 0    | 0      | 4         | 44          | 3     | 100     |       |         |
| (ii) Continuing the Use of Underground Water | 6       | 46      | 1    | 100    | 5         | 56          | 0     | 0       |       |         |
| Irrigation Method [drip, wild]             | 6         | 19      | 2    | 50     | 2         | 13          | 2     | 18      |       |         |
| (i) Switch to Drip Irrigation              | 2         | 33      | 2    | 100    | 0         | 0           | 0     | 0       |       |         |
| (ii) Continuing the Use of Wild Irrigation | 2        | 33      | 0    | 0      | 1         | 50          | 1     | 50      |       |         |
| (iii) Continuing the Use of Drip Irrigation| 2        | 33      | 0    | 0      | 1         | 50          | 1     | 50      |       |         |
| Product Pattern [non-irrigated, irrigated] | 5         | 16      | 0    | 3      | 19        | 2           | 18    | 2       |       |         |
| (i) Changed to Non Irrigated Agriculture   | 4         | 80      | 0    | 0      | 3         | 100         | 1     | 50      |       |         |
| (ii) Changed to Irrigated Agriculture      | 1         | 20      | 0    | 0      | 0         | 0           | 0     | 1       | 50    |         |
| Organized/Individual Irrigation            | 5         | 16      | 1    | 25     | 2         | 13          | 2     | 18      |       |         |
| (i) Organized                              | 4         | 80      | 0    | 0      | 2         | 100         | 2     | 100     |       |         |
| (ii) Individual                            | 1         | 20      | 1    | 100    | 0         | 0           | 0     | 0       |       |         |
| No Action                                  | 2         | 6       | 0    | 0      | 0         | 0           | 2     | 18      |       |         |
| Total                                      | 31        | 100     | 4    | 100    | 16        | 100         | 11    | 100     |       |         |
Farmer G5 narrates to the disfunctionalized irrigation cooperative in his region to due dept and establishment of a new cooperative that farmer becomes integrated for irrigation. Farmer expresses the benefits of the cooperative as follows:

“The water comes through the irrigation cooperative. There were two of them, but when one didn't pay, it went bankrupt; it was a huge amount, trillions. That one was even bigger cooperative. Now, a new one has been built here, called "Köprübaşı" and it has been operational for 3 years. If you have 10 decare land, it costs 400 TL per month. Now, the electricity bill is 40 lira for electricity. It's very, very good. If you were to irrigate with diesel, you would pay that amount anyway, and not to mention, not everyone has access to water. They need to bring it, and it's far.” (G5)

Almost a quarter of the mentions referred to a switch from wild irrigation to drip irrigation in the region. Half of all responses (50%) from Ayaş and a quarter of all mentions (25%) in Güdül indicate this change. Change into drip irrigation resulted in changed land preparation for irrigation with 15% of all mentions in changed state. The change in land preparation is the most dominantly expressed by farmers in Güdül (21%) and only a single farmer mentions in Ayaş.

The representative from Beypazarı Gardener's Cooperative states that the current irrigation methods in Beypazarı are sprinkler and drip irrigation that replaced wild irrigation method.

"[In Beypazarı] Wild irrigation is over. We used to do it when we were kids. There's no wild irrigation left... The water source came from Kirmir... There were earthen canals. There were rice fields, the paddy fields of the past, that is. That's how it was before, but later, when the water from these streams and rivers was not enough, the drilling of wells began. You could get water from 10 meters, 20 meters, I'm talking about the 1990s. Now, we're talking about 150, 200, 300 meters." (B1)
The farmer A1 in Ayaş and G11 in Güdül both refer to changed farmer talks about building irrigation channels for application of wild irrigation and states that as follows:

"In the past, there was no drip irrigation system. Previously, plants were normally planted and watered with fountains. After the tomatoes grew, furrows were made between the rows with a hoe. It was irrigated in a rotational manner. Such rows and rotations were created. ... The water was provided like pouring, from behind these furrows. The tomatoes were watered in rotation. Now, everyone uses drip irrigation. That has changed since the old days. It was the same with carrots; trenches were made, and water was poured into them. Now, there are sprinkler irrigation systems, meaning pressurized irrigation systems. They have changed." (A1)

“Because of technological advancements, we initially irrigated with surface water. There were no motors, but we had barriers. We set up barriers. We set barriers on the upper part of the stream. The water came from irrigation channels. It flowed within these channels. We call them "ark" in our language. That's how we irrigated, that's how we maintained our gardens. But now, none of that exists anymore. Now we have electricity. I have a dynamo; when I press the button, I can irrigate 30 acres with drip irrigation.” (G11)

Although it is few, there are also farmers, particularly in Güdül, who apply no change in their irrigation system.

Overall, farmers interviewed referred to seven **experienced impacts** resulting from changed conditions. The most frequently mentioned impact is **water scarcity** which received more than quarter (%26) of all mentions. Specifically, farmers in Güdül (33%), Ayaş (29%), and Beypazarı (17%) almost equally mention this situation.

39 Çizgi in Turkish, farmer uses the word “Evlek” in local tongue.
Farmers equally indicate *high electricity prices* (18%) and *inadequate irrigation infrastructure* (18%). High electricity prices form an important impact category in Beypazarı with almost 33% of all mentions whereas inadequate infrastructure is mentioned among farmers in Ayaş (29%) and in Güdül (24%).

Farmer in Beypazarı (B7) complains about the high electricity prices does not compensate the costs of agricultural production.

> “I pay 500 liras a month for electricity. For irrigation. If I buy 500 liras worth of tomatoes, eggplants and peppers, that's enough for the villagers. Tomatoes cost 1 lira a kilo and peppers cost 2 lira a kilo. I swear, buying is a thousand times better.” (B7)

Similarly, *decrease in yield* (11%) and *benefits and disadvantages of drip irrigation* (11%) are equally highlighted. The advantages of drip irrigation seem to be most recognized in Güdül (%24). While four-fifths of all mention (80%) concern benefits of drip irrigation, one farmer in Güdül points out the pollution problem arising from drip irrigation.

Farmer G5 expresses the benefits of drip irrigation that gives more yield compared to wild irrigation that requires more effort.

> "Before, we used to manually dig furrows with a shovel, moving the water from one side to the other... For instance, we used to get tired. I would irrigate with the strength of my hands holding the shovel. Now, you lay drip irrigation automatically. Every one or two hours, you clean it, and it self-irrigates. Not only does the plant get better yields from this, it grows and thrives, giving good results. Since the water goes directly to its base, it's better. The plant prefers drip irrigation; the base becomes like bulgur. When you give wild irrigation, the soil becomes crumbly, it cracks and gets air, but with drip irrigation, the base remains constantly moist. The plant has a cover on top, it likes that too. It keeps on giving generously.” (G5)
Water salinity constitutes another experienced impact that is mentioned with 9% of all mentions. Specifically, farmers in Beypazarı (16%) refer to this issue. Additionally, the lack of cooperation (9%) is also highlighted as an impact which is mentioned by equal number of farmers in Beypazarı and Ayaş.

Interviewee B1 discusses the challenges faced by local farmers due to changes in water quality and the implications for irrigation and costs.

"After reaching a certain level, our waters became saline and calcified. Naturally, this dries out anything green, and we can't sustain them. Our production costs have also increased significantly. Now, since we don't go too deep, what happens? To obtain high-quality water, we source it from short distances at high points. From there, we gather what we refer to as 'three spouts or five spouts.' To ensure more efficient irrigation, you collect this in a reservoir and then pump it directly where needed. This results in three, four, or even four times the electricity costs. All because we don't have access to proper water." (B1)

Concerning responses to changing conditions and experienced impacts in irrigation, four response patterns emerge: searching new/continuing same water resources, irrigation method, product pattern, and organized or individual irrigation practices.

Responses related to water resources comprise 42% of all mentions. This includes almost equally searching for alternative water resources (54%) and continuing to use underground water (46%). All mentions in Güdül about this indicate a search for alternative water resources, such as transfer from other sources or implementing water-saving techniques.

Whereas more than half of the mentions in Beypazarı (55%) refer to the continuation of the use of underground water by practices such as drilling deeper or increasing the number of drills, one farmer in Ayaş also indicates the continued use of underground water even if water level decreases and water gets salty.
"The water sources for irrigation are Kirmir river and underground water. Underground water was accessible from 10 to 20 meters in the 1990s, however, currently the water is accessible from 150 to 300 meters. The salinity of the water also increased as the farmers draw water from deeper levels and this situation has impacted the products of irrigated agriculture. When farmers try to get water from shallow parts, they need to collect water from multiple sources in a pond which needs more energy as farmers do not direct water directly to irrigation system but collects at one location and then distributes. This situation leads to increase consumed energy and respective prices." (B1)

Farmer B9 states the problem of decreased underground water levels. The high costs of electricity to continue irrigation and water salinity are experienced impacts that farmer mention along with other farmers in the region. The response of farmer B9 is to continue use underground water through increasing number of drills.

"There is no water. For example, there was water in the other field, one kilometers away from this field. We used to irrigate that field too. This year we couldn't irrigate that field since the water level was so low. Now we will look for another water source there. We already had a diver, we will put something there, another diver. It [the well] has water, but it is a little bitter. So we have to irrigate from there. We laid a pipe from there to there. It costs money. If you don't do that, drilling costs money. If you don't, the electricity comes more one kilometer from here. Everything affects us a lot. The farmer's job is hard." (B9)

Irrigation methods are the second most frequently mentioned category with 20% of all mentions. Switch to drip irrigation (33%), continuing the use of wild irrigation (33%), and continuing the use of drip irrigation (33%) are equally mentioned. All mentions in Ayaş refer to switching to drip irrigation. Both in Beypazarı and in Güdül, farmers mention equally continuing the use of wild irrigation (50%) and drip irrigation (50%) by one farmer from each district.

Product pattern changes (16%) and preference of organized or individual irrigation systems (16%) received equal mentions from farmers as response strategies. Among
all mentions relevant to product pattern, while 80% indicate a change to non-irrigated agriculture, 20% indicate a change to irrigated agriculture. Specifically, all mentions from Beypazarı farmers in this topic refer to their switching to non-irrigated agriculture as a response to the change and impact experienced in the irrigation process.

Organized and individual irrigation have similar trends in their product patterns. However, all mentions in Güdül and Ayaş indicate organized irrigation systems as a response action. One mention in Ayaş indicated a switch to individual irrigation.

5.3.4 Plant Protection

Plant protection comes as the fourth stage of agricultural production. The type and source of plant protectives and method of weed management stand as significant components of this stage. While in Beypazarı, farmers highlight the use of chemicals obtained from stores and cooperatives, in Ayaş, farmers tend to ensure the protection of plants by applying both hand and machine hoeing. Differently in Güdül, significant number of farmers claims no chemical use in this stage. The most common changed state obviously refers to the use of chemicals in general and this is most seen in Ayaş and Beypazarı. In Güdül, farmers tend to either transform their agricultural practice to natural farming or apply no change. Limited number of farmers in Ayaş also adopts organic farming.

The impact of plant protection activities manifests as a dependency on chemical use and its impacts as well as high input prices, and thus, an increase in plant disease and pests. While this is particularly seen in Beypazarı, it also leads to an increase in production control and inspection in Ayaş. Additionally, farmers in Güdül claim a significant increase in plant disease and pests. As a response, on the one hand, farmers adopt biological, ecological, and organic methods of protection, consult others, educate themselves and collaborate with others against plant disease, on the other hand, they also continue the use of chemicals, make their choices according to
their budget, use credit and loans when needed. While this duality is most seen in Beypazarı, farmers in Güdül and Ayaş tend to consult ecological and training-based methods.

The current state of plant protection refers to categories emerged from interview results. There are four categories under this stage: type of plant protectives, source of chemical protectives, method of weed management, not applying chemicals.

More specifically, in-depth interviews show that more than half of all mentions (55%) indicate type of plant protectives including chemical protectives (65%), applying natural/biological solutions (22%) and using organic chemicals (13%). Farmers who are using plant protectives in Beypazarı (%89) and Güdül (64%) reflect that the general tendency of all farmers is towards using chemical protectives. The rest of the farmers in Güdül (%36) indicate that they apply natural and biological solutions.

For instance, farmer A4 states the use of beneficial insects as a natural pest control method in collaboration with Ankara University, emphasizing the natural and organic approach over chemical treatments.

"This year, together with Ankara University, we are using what we call 'smart bugs' against pests like the walnut worm, tomato leafminer, and grape moth. We're introducing these biological insects. Normally, we have organic pesticides ... But before using that pesticide, we introduce these beneficial insects. They eradicate harmful pests. When a harmful insect lays eggs, the beneficial insect comes and lays its eggs on top of them, infiltrating the pest's eggs and feeding on them. This way, the population of beneficial insects increases. This is a natural process" (A4)

In terms of the source of chemical protectives, almost 17% mentions indicate obtaining chemical protectives from stores and cooperatives. In particular, almost 70% mentions in Beypazarı indicate obtaining chemicals from the store and 30% indicate obtaining from cooperatives.
Method of weed management (14%) is another category that illustrates the current state of plant protection emerged from interviews. Two methods of weed management include hand hoeing (67%) and machine hoeing (33%). Almost two-thirds of all mentions from farmers in Ayaş refer to weed management whereas only one farmer in Güdül refers to this situation. Not application of chemicals receives equal mention also as method of weed management, particularly stated among the farmers in Güdül (28%).

In terms of the changed state, interview results reveal five major changes in plant protection. The most frequently mentioned change is associated with the diffusion of the use of chemical protectives with more than one third of all mentions (35%). This refers to an increase or a decrease in chemical use and starting or quitting the use of chemical protectives. Increased use of chemicals, starting using chemicals and stopped using chemicals receives equal mentions with 31% each. There's a noticeable shift in the use of chemical protectives across all districts. While Beypazarı has a trend of increasing or starting chemical use, Ayaş presents a contrasting trend with many farmers stopping chemical use. Whereas decrease use of herbicides receive limited number of mentions with only one farmer in Ayaş.

Respondents interviewed in Beypazarı Gardeners’ Cooperative narrate the times when they used to grow tomatoes without facing diseases and reflects on the introduction of foreign seeds, which brought new challenges and increased dependency on chemicals.

"For years during our childhood, we planted tomatoes. Ever since I was born, we always grew tomatoes the natural way. We never knew what plant diseases were. But then these foreign seeds came, and with them came the diseases. We learned about plant diseases then. We used to plant melons too. If you put sulfur on the melons... some of the neighbors would, some wouldn’t. Sulfur. Other than that, we were unaware. We didn’t know about pesticides. Now, how many types of pesticides are there?” (B1-2)
"If you do not use chemicals now, you cannot grow the crop now.... It wasn't always like that. We would use chemicals once, if there was a worm on the floor, we would use chemicals, otherwise we would not know any." (B5)

Table 51. Current State, changed state, experienced impacts and response of farmers in plant protection stage

<table>
<thead>
<tr>
<th>1 CURRENT STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayas</th>
<th>% Ayas</th>
<th>% Beybpazan</th>
<th>% Beybpazan</th>
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<th>% Gidil</th>
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Table 52. Current State, changed state, experienced impacts and response of farmers in plant protection stage continued

385
3 EXPERIENCED IMPACT

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<th>Beypazarı</th>
<th>% Beypazarı</th>
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4 RESPONSE

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<th>Adopting Biological, Ecological and Organic Methods</th>
<th>Frequency</th>
<th>% Total</th>
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<th>% Ayaş</th>
<th>Beypazarı</th>
<th>% Beypazarı</th>
<th>Güdül</th>
<th>% Güdül</th>
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<td>18</td>
<td>0</td>
<td>25</td>
<td>4</td>
<td>15</td>
<td>4</td>
<td>19</td>
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<tr>
<td>(Not) Following Chemical Prescriptions</td>
<td>9</td>
<td>16</td>
<td>1</td>
<td>13</td>
<td>5</td>
<td>19</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>(i) Not Following [Unpermitted chemicals, random use, not obey refinement period of chemicals]</td>
<td>5</td>
<td>56</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>60</td>
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<td>67</td>
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<tr>
<td>(ii) Following [Obeys Refinement Period of Chemicals]</td>
<td>4</td>
<td>44</td>
<td>1</td>
<td>100</td>
<td>2</td>
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<td>33</td>
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<tr>
<td>Continuing the Use of Chemicals [grains, market products, more yield, in combination]</td>
<td>8</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>19</td>
<td>3</td>
<td>14</td>
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<tr>
<td>Quitting/Decreasing Production for the Market</td>
<td>5</td>
<td>9</td>
<td>1</td>
<td>13</td>
<td>4</td>
<td>15</td>
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<td>0</td>
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<td>Chemical Selection [budget, yield, refinement]</td>
<td>5</td>
<td>9</td>
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<td>0</td>
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<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Using Credit and Loans [banks, traders]</td>
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<td>1</td>
<td>13</td>
<td>4</td>
<td>15</td>
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</tr>
<tr>
<td>Continuing the Use of Regular Weed Management Methods</td>
<td>2</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>100</td>
<td>8</td>
<td>100</td>
<td>27</td>
<td>100</td>
<td>21</td>
<td>100</td>
</tr>
</tbody>
</table>

Farmers also talk about a change in agricultural practice (22%). This mainly implies a change to natural and organic farming, whose half comes from Güdül. There's a
noticeable shift towards natural and organic farming, especially in Güdül and Ayaş. Additionally, farmers express the change of external conditions (19%) in plant protection referring to increased chemical varieties and knowledge, change in rainfall and change in regulations. Farmers in the three districts almost equally mention the changed external conditions that include increase in chemical varieties, increase in knowledge, change in rainfall and change in legislation.

Farmer B10 highlights the shift in agricultural practices and conditions that creates based for this shift, emphasizing the introduction of modern techniques and the increased knowledge and self-reliance of the younger generation in managing crops and problems.

"In my opinion, the old ways are completely gone. Now, everyone is adapting to the new system. However, the new system is, that's how they continue. How, you ask? For example, they measure even the pH of the water they use and adjust their usage in the field accordingly. They get soil tests done, for instance. Based on those results, they decide on fertilizers and such. Our younger generation has now learned which pesticide to use for which disease in a plant. Now, there's no need to consult an agronomist. If there's powdery mildew, they go and get the powdery mildew treatment, for example. If there's a fungal issue, they bring in the fungus treatment. If they notice the Tuta (a pest) in tomatoes, they already know which pesticide to use for it and how to apply it. They're very knowledgeable now." (B10)

The third category concerns the experienced impact in plant protection. A significant proportion of farmers (22%) express a dependency on chemical use. This can be seen as a reflection of the challenges they face in plant protection. A quarter of farmers both in Ayaş and Beypazarı refer to becoming dependent on chemical use.

Farmer B2 discusses the increased productivity from using fertilizers, but also addresses the challenges and complications that arise from natural and animal
fertilizers, leading to the inevitable use of pesticides due to increased pests and weeds.

"As we use fertilizer, productivity increases. Some use natural fertilizers, and others certainly use animal manure and such. Even if all of these are natural, like animal manure, pests and insects increase inevitably. The need to combat these pests also inevitably increases. If you use animal manure, the weeds grow more. To kill the weeds, you need to apply some sort of pesticide. Labor is not what it used to be, it's expensive now. That's another problem. You are compelled to use pesticides; you have no other choice." (B2)

“No matter what crop you plant, it emerges with pests and mites. There's no chance of not using pesticides. The soil has also become exhausted, it's not like before, and there's no possibility of avoiding the use of fertilizers.” (B2)

In a similar manner, B5 refers to the use of chemical protectives due to productivity concerns.

"No matter what the yield is. The man will die, the one who eats it will die, there is no account of it. If the truth is to be spoken. As long as the yield is high. Whatever it is, we take it (chemicals)." (B5)

Such dependency also results in another impact in the form of high input prices. High input prices are a concern for 20% of all farmers. Specifically, more than quarter of the farmers in Beypazarı (28%) indicate high input prices which is higher than the Güdül (12%) and Ayaş (13%).

Farmer B7 details the challenges faced by farmers due to the high costs and necessities of certain pesticides, implying that these challenges might deter farmers from continuing to grow certain crops.

"Let me give an example from grapes. I'm a grape grower. There's this pesticide, and if we don't apply it, diseases attack the grapes, and they don't grow properly. ...Officials from the Provincial Agriculture Directorate came and said there's a pesticide called 'prateus' which we should use. You apply it
once when the plant is in the flowering stage and once when the fruit is about the size of a walnut. Okay, so you apply it. How much does one unit of the pesticide cost? Is it 200 Lira for 250 grams? And you'll use it twice. How much land does it cover? One unit isn't enough for 10 decare. Before you even harvest the melons, you'll have spent a billion lira, just on pesticide costs. And this doesn't even include water costs; we plant in dry land. So, how much will you earn? Almost nothing. That's why, mark my words, farmers will eventually stop planting tomatoes, peppers, and eggplants. Really, believe me.” (B7)

An increase in plant diseases and pests is another experienced impact that received 17% of all mentions. While farmers in Güdül show less dependency on chemical use, 35% of the farmers refer to an increase in plant diseases and weed problems which is five times higher than farmers in Beypazarı (7%).

Production control and inspection (13%) divide into two almost equal mention categories, one indicating the presence of controls (57%) and another indicating a lack of controls (43%). For this, farmers in Beypazarı equally mention two impacts of presence and lack of presence. Contrastingly, while farmers in Güdül only refer to lack of production control, all farmers in Ayaş refer to the presence of controls.

Farmer B5 points out the lack of control that exists not only in conventional agriculture but also in organic and good farming practices. Farmer states that market pressure and lack of control results in not following chemical prescriptions.

Impacts of chemicals (11%) also divide into two categories: negative impacts of chemicals (83%) and benefits of chemical use (17%). Negative impacts of chemicals include mentions such as soil pollution and overall pollution, tired soil, an increase in pests, and overuse of chemicals. All mentions from Ayaş and Güdül for this category refer to negative impacts. Beypazarı holds half of the mentions in this category and 67% of all farmers in the district refer to negative impacts. The rest (33%) with a single mention from Beypazarı indicate benefits of chemical use as it prolongs the marketing period.
The following quotations from farmers in Beypazarı presents both negative impacts and benefits of chemicals as a perceived farmers to meet market demands and expectations.

“Real Ayaş tomato is indurable in the market counter more than 2 days. As a result farmers has to use chemicals” (B2)

“If I spray chemicals, I don't know, I mean, I don't know if it's from the seed, I can't grow the seed without spraying. I plant lettuce. I can grow it [without chemicals], but there will be bugs in it. You put it on the market and no one will buy it.” (B8)

Other impact categories include the lack of education and incentive for less chemical use (7%), decreased yield (6%), and lack of cooperation and trust (4%). Farmers in Beypazarı and Güdül equally mention the lack of education and incentive for less chemical use. While almost 12% of all mentions in Güdül refer to the lack of education, the same share of mentions also refers to decreased yield which makes Güdül as the largest contributor of mentions in this category (67%). Only farmers in Beypazarı refer to lack of cooperation and trust which makes up 7% of all mentions from Beypazarı.

Also relevant with incentive for less chemical use and presence of controls in the field, farmer B2 highlights the necessity of collaboration among consumers, farmers and institutions operating in the region on agricultural production.

"For instance, the Provincial Agriculture Department. They can't keep track. You claim to practice 'good agriculture,' get the support for it, but it's still the same. However, if there was seamless collaboration between the consumers, farmers, and local agricultural offices, I would adjust my fertilizer use, my pesticide application, and even my harvesting schedule accordingly." (B2)

There are eight response categories that emerged from the interviews. The most dominant response form in plant protection is the adoption of biological, ecological,
and organic methods (21%). While 43% of all mentions in Güdül express this trend, there is no single mention of this situation in Beypazarı.

Consultation, education, and collaboration are the second most-referred trends, with almost 18% of the mentions. Beypazarı and Güdül equally share 80% of all responses in this category, and farmers in Ayaş refer to this category by 20%. Following chemical prescriptions is the category (16%) that divides into two depending on whether one follows (56%) or does not follow (44%) the prescribed use of chemicals. The trend of not following prescriptions is most common in Beypazarı, where 60% of all mentions fall into this category.

Farmer B2 and B5 refers that various factors like high costs and lack of controls/inspection result in the misuse of fertilizers and pesticides in agriculture that might not be in the best interest of human health.

“People apply fertilizers disproportionately and use whatever pesticide they have on hand because the costs are very high." (B2)

"Organics are actually very good for human health. For instance, the produce directly enters our dining table from the farmer. It meets us on the table. Let me give an example. What does the farmer do? He sprays pesticide, like a worm or bug repellent. Only after 10 days does this pesticide lose its efficacy on the vegetable. But what does the farmer do? He sprays today, and by tomorrow, he will take the produce to the market. I am a live example of this. I spray, and the very next day I harvest the produce and send it to places like Istanbul and Ankara. This reaches the consumer's table directly. But there's no one really monitoring this. For instance, the Provincial Agriculture Departments can't keep track. You claim to practice good agriculture, get the support for it, but it's still the same. However, if this was perfectly coordinated between the consumer, the farmer, and the local agriculture department, I would adjust my use of fertilizer, my use of pesticides, and my harvest time accordingly." (B5)
Moreover, farmers continue to use chemical pesticides for reasons such as increased yield or to control pests in combination with other methods. This trend is most common in Beypazarı, where 19% of farmers in the district reported continuing use of chemicals.

"The better the farmer's condition to plant, the better the living conditions, the more he tries to produce and the more he pays attention to chemicals. If you give people not enough to survive, people turn to the logic of killing in order not to die, you force them to do so." (B2)

Additionally, some farmers quit or decrease their production for the market due to plant protection concerns, with a frequency of 9% in the overall total. This trend is most pronounced in Beypazarı, where 15% of the mentions in the district reported quitting or decreasing production for the market.

In addition to the previous category, an equal share of farmers also mentions chemical selection (9%) and using credit and loans (9%), specifically by the farmers in Beypazarı. The final response category is continuing to use regular weed management (4%) methods as their plant protection response, as indicated by one mention each from Güdül and Beypazarı.

In summary, the data indicates that farmers in the analyzed districts use a variety of plant protection responses, with the adoption of biological, ecological, and organic techniques being the predominant trend. However, the use of chemical pesticides is still prevalent, and a number of producers have resigned or reduced their production due to concerns about plant protection. The analysis also reveals differences in the plant protection methods utilized by farmers across districts, with Güdül having the highest adoption rate of biological, ecological, and organic methods and Beypazarı having the highest adoption rate of consultation, education, and collaboration.
5.3.5 Fertilizing

Fertilizing is the fifth stage of agricultural production and stands for supporting the plants and the soil with chemical or natural supplements to improve their productivity. In-depth interviews with farmers in Northwestern Ankara reveal that both chemical and organic/natural fertilizers are equally preferred in agriculture as a general tendency. However, case districts show differences from one another. While farmers in Ayaş significantly use organic and natural fertilizers, and this is also considerably valid in Güdül, farmers in Beypazarı tend to use liquid, urea, and normal chemicals to fertilize the plants. One of the most important changes happens in market conditions, legislation, trade system as well as with the fertilizer types introduced to the national agricultural system while legislatively encouraging farmers to adopt.

This kind of change expectedly comes with its high cost and disadvantages of using chemicals in terms of yield, variety, and quality. This particularly occurs in Beypazarı which uses chemical fertilizers with a higher tendency. As a response to high cost of chemical fertilizers, farmers, in turn, seek support mechanisms to afford them. Differently, Güdül and Ayaş, using natural fertilizers, benefit more from their advantages such as in growing better, healthier, accessible, and cheaper plants. They continue animal manure or tolerate the high fertilizer costs.

In terms of the current state of fertilizing step of agricultural production in the region, four categories emerge including, and the dominant trend in the data set is the equal distribution of chemical and organic/natural fertilizers used. According to the data, 40% of the farmers use chemical fertilizers, while another 40% use organic/natural fertilizers. The rest of the farmers use animal manure or obtain chemical fertilizers from stores and cooperatives.

In Ayaş, the use of chemical fertilizers is lower than the overall average (29%), while the use of organic and natural fertilizers, particularly animal manure (71%), is higher. In Beypazarı, the use of chemical fertilizers is higher than the overall average.
(47%), while the use of organic and natural fertilizers is lower (21%). In Güdül, the use of animal manure as an organic or natural fertilizer is particularly high, at 89% of all mentions from Güdül in this category. Overall, it seems that there is a divide between those who prefer chemical fertilizers and those who prefer organic or natural fertilizers. However, the use of animal manure as an organic or natural fertilizer is consistently high across all districts.

Only 13% of farmers mention obtaining chemical fertilizer from a store or cooperative, and all farmers in this category are from Beypazarı. It is also interesting to note that none of the farmers in Ayaş and Beypazarı obtain animal manure locally, while the highest percentage of farmers doing so is 16% of mentions in Güdül.

Interview results reveal three categories for changed state in fertilizing step of agricultural production. The change categories are changed market conditions (54%), changed fertilizer type (38%), and no change in fertilizer use (8%).

The first and most dominant category concerns changed market conditions (54%) and it includes four categories: legislative changes, increased input prices, the emergence of the trader system, and the introduction of liquid fertilizers.

The most dominant trend in this category is the increased production costs and fertilizer prices (64%). This trend is observed in all three districts, with the highest percentage among mentions in this category of the farmers in Güdül (75%).

Relevant to the production costs, farmer B5 refers to past farming practices of using higher amounts of fertilizer compared to the reduced quantities used in the present times, emphasizing the economic constraints.

"Back when we were kids, for example with fertilizers, we would fill the seed drill with just fertilizer until we got tired. We'd roam around the field until the fertilizer ran out. Then it'd be like, 'Bring some more fertilizer, fill it up, and go around again.' We used to spread around 40 to 50 kg. Now, what do we do? We've reduced it to maybe 10 kg. You can't go beyond that. When you think of
applying 25 to 30 kg, the yield you get from the crop doesn't even cover the costs." (B5)

The legislative changes (14%) are observed by only one mention each from Ayaş and Güdül. The emergence of the trader system (14%) and the introduction of liquid fertilizers in the market (7%) are other trends in this category that are particularly observed in Beypazarı.

**Changed fertilizer type** (38%) forms the second-most-mentioned category. This category divides into two types of changes, which are from natural to chemical (70%) and from chemical to natural (30%).

Switching from natural to chemical fertilizers (70%) is mentioned equally both in Beypazarı and in Güdül in the form of switching from animal manure to chemical fertilizer.

The second trend in this category is switching from chemical to natural fertilizers (30%). While one-third of the mentions in Ayaş indicate this change, the rest of the mentions in this category are indicated by farmers in Güdül. Only farmers in Güdül indicated that they had stopped using chemical fertilizers (67%) in this subcategory. In addition, only one mention, which is from Ayaş, indicates switching from regular to organic fertilizers (33%). Only about 7% of all mentions indicate no change in fertilizer use. Only farmers in Beypazarı indicated no change, with 14% of all mentions in the district.

Farmer A1 narrates the motivation behind switching to chemical to organic fertilizers, the adverse effects of overusing chemicals on the soil, and their positive experience with microbial fertilizers leading to both increased crop yield and improved soil health.

"Of course, it [chemical fertilizers] was causing pollution. The soil was losing its fertility, turning into something like lime or stone in areas that were continuously cultivated.... In fact, we weren't using that much [chemical fertilizers]. Because those always come with costs, it affects our pockets. There
isn’t enough power anyway. This year, we didn’t use any chemicals and, on top of that, we used microbial fertilizers. I mean, the fertilizers that break down the soil and clean it faster. Both the yield of the vegetables increased, and I noticed a change in the soil. Like, this year, when plowed, the soil was crumbling nicely. Every year, it used to clump together. I hope to see this improvement continue year by year.” (A1)

Table 53. Current State, changed state, experienced impacts and response of farmers in fertilizing stage

<table>
<thead>
<tr>
<th>1 CURRENT STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayas</th>
<th>% Beypazar</th>
<th>% Güdül</th>
<th>% Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Chemical Fertilizer</td>
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<td>40</td>
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<td>29</td>
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<td>47</td>
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<tr>
<td>[liquid, urea, normal]</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Using Organic and Natural Fertilizers</td>
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<td>40</td>
<td>5</td>
<td>71</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>[animal, organic, natural]</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(i) Using Animal Manure</td>
<td>14</td>
<td>78</td>
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<td>60</td>
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<td>75</td>
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<td>(ii) Using Organic and Natural Fertilizers</td>
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<td>22</td>
<td>2</td>
<td>40</td>
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<td>25</td>
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<td>Obtaining Chemical Fertilizer from Store and Cooperative</td>
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<td>13</td>
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<td>Obtaining Animal Manure Locally</td>
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<tr>
<td>[from own animals, local farms]</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Total</td>
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<td>7</td>
<td>100</td>
<td>19</td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>2 CHANGED STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayas</th>
<th>% Beypazar</th>
<th>% Güdül</th>
<th>% Güdül</th>
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<tbody>
<tr>
<td>Changed Market Conditions</td>
<td>14</td>
<td>54</td>
<td>1</td>
<td>33</td>
<td>9</td>
<td>64</td>
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<tr>
<td>[Legislative changes, increased input prices, emergence of trader system, introduction of liquid fertilizers]</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>(i) Increased Production Costs and Fertilizer Prices</td>
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<td>64</td>
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<td>6</td>
<td>67</td>
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<td>(ii) Legislative Changes</td>
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<td>(iii) Emergence of Trader System</td>
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<td>22</td>
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<td>(iv) Introduction of Liquid Fertilizers in the Market</td>
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<td>7</td>
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<td>1</td>
<td>11</td>
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<tr>
<td>Changed Fertilizer Type</td>
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<td>38</td>
<td>2</td>
<td>67</td>
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<td>21</td>
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<tr>
<td>[from natural to chemical, from chemical to natural]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Switched from Natural to Chemical</td>
<td>7</td>
<td>70</td>
<td>1</td>
<td>50</td>
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<td>100</td>
</tr>
<tr>
<td>(a) Switched from Animal Manure to Chemical</td>
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<td>86</td>
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<td>14</td>
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<td>100</td>
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<td>0</td>
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<tr>
<td>(ii) Switched from Chemical to Natural</td>
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<td>30</td>
<td>1</td>
<td>50</td>
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<td>(a) Stopped Use of Chemical Fertilizer</td>
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<td>(b) Switched from regular to organic fertilizers</td>
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<td>33</td>
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<td>3</td>
<td>100</td>
<td>14</td>
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Table 54. Current State, changed state, experienced impacts and response of farmers in fertilizing stage continued

<table>
<thead>
<tr>
<th>3 EXPERIENCED IMPACT</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayaş</th>
<th>% Beypazarı</th>
<th>% Güdül</th>
<th>% Gülül</th>
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<tr>
<td>High Cost of Fertilizer Prices</td>
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<td>23</td>
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<td>32</td>
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<td>31</td>
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<td>45</td>
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<tr>
<td>(i) Decreased Soil Fertility and Yield</td>
<td>6</td>
<td>38</td>
<td>2</td>
<td>50</td>
<td>4</td>
<td>40</td>
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<td>(ii) Increased Variety</td>
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<td>20</td>
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<td>(iii) Excessive Use</td>
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<td>19</td>
<td>1</td>
<td>25</td>
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<td>20</td>
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<td>(iv) Increased Dependency</td>
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<td>(v) Decreased Taste</td>
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<tr>
<td>(ii) Increased Variety</td>
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<td>8</td>
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<tr>
<td>Lack of Incentives, Support and Cooperation</td>
<td>4</td>
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<td>1</td>
<td>2</td>
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<table>
<thead>
<tr>
<th>4 RESPONSE</th>
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<tr>
<td>Seeking Support Mechanisms to Afford Fertilizers</td>
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<td>Starting the Use of Natural Fertilizers</td>
<td>4</td>
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<td>Continuing the Use of Animal Manure</td>
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<tr>
<td>No response to High Fertilizer Prices</td>
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<td>Quitting Farming Due To High Input Prices</td>
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<td>0</td>
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<td>1</td>
<td>7</td>
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<tr>
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<td>100</td>
<td>5</td>
<td>100</td>
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</tbody>
</table>

As a result of changes, farmers mention seven categories of **experienced impacts** in the fertilizing stage of agricultural production.
High Cost of Fertilizer Prices stated as an experienced impact received the highest number of mentions with 33% of all. Farmers in Beypazarı (41%) and Güdül (41%) contributed with equal share of mentions.

The second-most-referred category is the disadvantages of using chemical fertilizers (31%). Among all, decreased soil fertility and yield (38%) receive the most mentions, particularly in Beypazarı and Ayaş. 45% of all mentions from Beypazarı farmers indicate the disadvantages, including decreased yield, increased variety, excessive use, increased dependency, and loss of taste in products.

Farmers equally mentioned increased variety (19%), excessive use (19%), and increased dependency (19%) among the disadvantages of using chemical fertilizers. Beypazarı farmers contribute 20% of all mentions in these categories, except for the decreased taste, which is only mentioned once in Güdül.

The farmer G2 emphasizes the quality and health implications of using natural fertilizers over chemical ones in farming.

"When we use the animal manure with water, it produces well. During those times, the plant grows healthier. Do you know? Vegetables grown with animal manure... Whereas with the other method, the yield is high, and the plants grow tall like a pencil, but what's the point if they lack taste? We see those diseases, like cancer, have increased among us. We are trying to ensure at least the future generations don't suffer the same fate. We speak out, but who listens? Health should always come first." (G2)

Advantages of using natural fertilizers received 14% of total mentions. This subcategory covers the characteristics of natural fertilizers such as enabling better plant growth; having healthier, slow, and prolonged impact; being accessible and cheaper. Ayaş had the highest percentage of responses in this category (31%), followed by Güdül (19%). Whereas no farmer in Beypazarı refers to the advantages of natural fertilizers.
The representative from Güdül Chamber of Agriculture (G11) refers to the prolonged impact of animal manure over soil fertility compared to the continuous renewal of chemical fertilizers for effectiveness.

"With the other [chemical] fertilizer, both during planting and as a top dressing or germination fertilizer, we have to apply it every year. However, when we use more of the animal manure, even if applied once in 2-3 years, its benefit continues. I applied it many years ago, probably over 10 years now, although it might have been a bit too much. Still, when harvesting that area with a combine, its effect is noticeable." (G11)

Almost 10% of all mentions refer to the disadvantages of using animal manure. Equal number of farmers in Güdül and Beypazarı (two farmers from each district) indicate disadvantages of animal manure concerning increased weed and plant diseases and low productivity when using animal manure.

Moreover, almost 8% of all mentions indicate a lack of incentives, support, and cooperation. For instance, Farmer B7 expresses frustration over the perceived inadequate support from the government regarding diesel and fertilizer subsidies with the following quotation:

"Now they say, 'we provide support for diesel and fertilizer.' But what support for fertilizer are they giving, and how much? A few pennies? It would be better if they didn't give anything at all. At least then they wouldn't keep saying 'I'm giving, I'm giving.' There's no support; the support is nonexistent." (B7)

From the interview results, six response categories emerge as a response to changing conditions and experienced impacts in the fertilizing stage of the agricultural production process.

The most frequently mentioned response category is seeking support mechanisms to afford fertilizers, with 32% of all mentions. Seeking support mechanics include options like traders, banks, cooperatives, municipal, and government supports. This
trend is most visible in Beypazarı where almost half of the farmers (47%) interviewed in the district refer to this response.

Interviewee B10 describes the control that a few traders have over farmers, especially when the farmers are financially constrained to continue production and afford input prices.

"There are 4-5 merchants dominating the scene. Now, how does it work? Let's say you can't manage additional farming activities on your own. You go to the merchant and tell him you have no money for your farm, no seeds, no fertilizer, no pesticide, or perhaps you can't find labor. You ask the merchant, 'What should I plant? What do you want me to sow?' The merchant tells you to plant lettuce, say, on 5 acres. He covers all the expenses for the lettuce, but in return, you must sell the produce only to him. You can't sell it to anyone else." (B10)

Whereas a significant 40% of farmers in Beypazarı are still continuing with chemical fertilizers which forms the The second most common response category was continuing the use of chemical fertilizers. Only farmers in Beypazarı indicate this response. Ayaş follows a different trend as major responses include starting the use of natural fertilizers (40%) in addition to seeking support mechanisms (20%).

The farmer B7 highlights the challenge of coping with rising costs of fertilizers and how it affects the choice and amount of fertilizer used as farmer continue with using chemical fertilizer.

"What can you do about these rising costs? I mean, to be able to sow your field, let's say you need at least 20 kg of fertilizer. DAP (diammonium phosphate) fertilizer is expensive, so if you consider using it, you use it sparingly, like 20-20. If you used to use DAP, now you might shift to a slightly cheaper fertilizer. This, of course, affects your yield; if you were going to get a 20:1 return, it now drops to 18:1 or 17:1. It would be great if you could afford the good fertilizer and use it without any issues." (B7)
Almost 14 percent of all mentions indicate starting the use of natural fertilizers. Güdül and Ayaş mention this trend with an equal number of farmers mentioning this situation, while no one from Beypazarı indicates this trend.

Farmer G6 narrates that his motivation for starting use of natural fertilizers is a response to financing high costs of chemical fertilizers. He describes his efforts in seeking cost-effective fertilizer alternatives.

"Finances. One day, while sitting, I thought about planting strawberries. While researching on the computer about which fertilizers and elements affect strawberries, I saw that phosphorus and potassium were beneficial. There's a fertilizer that has these. I called the agriculturalist and asked for its price. They said something like 160 liras for 50 kg of fertilizer. At that time, I didn't have it. I thought, 'What would be the natural alternative?' I saw that wood ash contains high amounts of phosphorus and potassium. I mixed it with animal barnyard manure. I made an equivalent to the agricultural fertilizer. I began using that." (G6)

The use of natural fertilizers (14%), continuing the use of animal manure (14%), and no response to high fertilizer prices (14%) receive an equal share of mentions. A noticeable 38% of the mentions from the farmers in Güdül refer to no response to high fertilizer prices, while 25% are continuing the use of animal manure and another 25% are starting the use of natural fertilizers.

Farmer G4 comments on the fluctuating costs of fertilizers and emphasizes that farmers have no choice but to continue using chemicals.

"Of course, the prices change every year. What we bought for 50-70 cents last year was not purchased for less than 1 lira this year... Of course, sometimes we struggle, but there's nothing we can do. If you're going to do this job, you have to buy it." (G4)
Interviewee G2 states that he continues use of animal manure and discusses the trade-offs between the frequency of harvests and the methods of fertilization, comparing natural fertilizers to chemical fertilizers.

"Of course, you can't get the same yield [with animal manure]. If you use agricultural fertilizer, you'd harvest every two days, but now I harvest weekly. What does that equate to in a week? 6 times. For example, a person using agricultural fertilizer harvests three times a week; I do it twice. That person applies foliar spray, uses agricultural fertilizers, and it becomes very costly for them. I harvest once a week, pray for God's blessings, and move on. That person harvests three times a week. As long as the produce is abundant, it doesn't matter to them if it's toxic." (G2)

The representative from Güdül Chamber of Agriculture (G11) provides insight into the possible response strategies of farmers against increasing costs of fertilizers. According to the G11, farmers will switch to animal manure due to its lasting benefits and cost-effectiveness.

“.. Lately, there's been a shift. Our farmers have returned to using animal manure because its productivity seems to be higher. To ensure that the soil retains its moisture, that is, remains damp, they've started to use animal manure. ...I suspect that everyone might return to animal manure, perhaps due to the rising cost of regular industrial fertilizers. This is because the residue in the soil from animal manure lasts much longer.” (G11)

While farmers in Güdül and Ayaş mention the use of natural fertilizers equally, no one from Beypazarı indicates this trend. Interestingly, continuing the use of animal manure is most dominant in Güdül, where 25% of farmers refer to this response. No response to high fertilizer prices, which concern those who continue paying for them or tolerate the situation. This trend is consistent across Ayaş and Güdül, with 20% and 38% of farmers in each district indicating no response, respectively. However, no farmer in Beypazarı refers to this trend. Finally, the least common response
category was *quitting farming due to high input prices*, with only one farmer mentioning this situation in Beypazarı.

**5.3.6 Harvesting, Processing and Packing**

Harvesting, processing, and packing constitute the sixth stage of agricultural production. This stands for harvesting to processing and packing the products. The fieldwork shows that farmers in Northwestern Ankara apply a variety of harvesting methods including mechanized, manual, and with external labor use. Farmers either pack and process the products for the market and for their own consumption or they do not process at all. Beypazarı stands as the most mechanized and the most advanced technology user among all three districts in harvesting and Ayaş stands as the least engaged district in packaging and processing, and thus, with no claim of change. The use of machinery for harvesting is most prevalent in Beypazarı and Güdül, while hand harvesting is more common in Güdül. The use of external labor for harvesting is also more prevalent in Beypazarı. In terms of packing and processing, there is a higher prevalence of traditional food preservation techniques and organized packing, and storage services are more commonly mentioned in Güdül. Overall, the data suggests that farmers in the three districts differ in their harvesting practices and approaches to packing and processing.

As farmers state, changed climatic conditions, cost and labor sources decrease the yield. This is most highlighted by the farmers in Beypazarı and the least in Ayaş. Being stated that, Ayaş stands as the leading district which adopts measures to increase the yield through seed certification, land care, animal manure and rotational cropping.

The current state consists of *harvesting* and *processing and packing* as separate categories. The data in the table indicates that the most frequently mentioned step in agricultural production among farmers interviewed is harvesting, accounting for 65% of all responses.
Mechanized harvesting is the most frequently mentioned method of harvesting, accounting for 51% of all responses in harvesting category. The use of machinery for harvesting is prevalent in all districts with more than half of the responses in all districts. Farmers in Ayaş equally refer to mechanized harvesting (50%) and hand harvesting (50%). Hand harvesting is the most frequently cited harvesting method with almost 32% of harvesting methods existing in Güdül. Farmers also refer to changes in harvesting techniques based on the crops. For instance, interview with B1 refers to mechanized harvesting for grains and carrots while vegetables are harvested by hand.

External labor use in harvesting is mentioned by 18% of mentions in harvesting category, with the highest percentage being in Beypazarı (30%). In contrast, no farmers in Ayaş mentioned the use of external labor for harvesting. Farmer B2 indicates the current situation in labor dynamics in agriculture in Beypazarı noting the shift in workforce numbers and the contribution of Syrian workers which are replaced by the workers from the Southeastern Turkey.

"This isn't about the things [technology and mechanization] we see in Germany or Europe. It's manual labor. Hence, one of the advantages of Beypazarı is that, while previously there were about 7-8 thousand workers from the Southeast, now it's around 2-3 thousand. Currently, there are also 6-7 thousand Syrians. So, we're not only fostering social peace here but also generating added value and employment." (B2)

In terms of using packing and processing, 38% of farmers mentioned this step. Of those, the most mentioned technique is using traditional food preservation techniques (64% of mentions under using packing and processing), with the highest percentage being in Güdül (71%). Furthermore, 27% of the mentions in this subcategory indicate organized packing and storage services, such as the facilities of cooperatives or municipalities, with the highest percentage of share belongs to Güdül (67%), the rest to Beypazarı. The use of machinery for processing was mentioned by only one
farmer from Beypazarı. Farmer B5 owns a private company that provides the farmers with the facilities that sift and clean the wheat and chickpeas.

Lastly, a quarter of the mentions refer to processing of products for market (57%) or for own consumption (43%). Processing for own consumption often includes traditional food preservation practices such as preparing tomato paste or drying summer vegetables to consume in the winter. While farmers in Ayaş only refers to processing for market, farmer in Güdül diversifies in both preparing for the market and for their own consumption.

Interview results yielded five categories of the changed state concerning in this step: improved technology in harvesting, changed climatic conditions, changed cost and labor source, increased plant disease, and established packaging systems. Leading the changed state category is the adoption of improved technology in harvesting, accounting for 31% of the total mentions. This is closely followed by the impact of changed climatic conditions, contributing to 25% of the total. Other noteworthy changes encompass changed cost and labor source (19%), increased plant disease (13%), and established packaging systems, including municipal and digital, at 13%

The most frequently mentioned category was improved technology in harvesting with 31% of the total mentions. Only farmers in Güdül mention this situation and 63% of all mentions from Güdül points improved technology in harvesting.

For example, the representative from Güdül DDoAF (G11) discussed the modern method of harvesting using combine harvesters, while noting that some traditional methods are still used in certain areas.

"Harvesting is done with combine harvesters nowadays. But in the past, we had scythes and sickles. Yes, in our very mountainous areas, there are places where people need straw or where combine harvesters can't access. In those areas, individuals use scythes and sickles to meet their straw needs and also thresh the crop themselves” (G11)
Table 55. Current State, changed state, experienced impacts and response of farmers
in harvesting, processing and packing stage

<table>
<thead>
<tr>
<th>1 CURRENT STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayaş</th>
<th>% Beypazarı</th>
<th>% Güdül</th>
<th>% Güdül</th>
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<tr>
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<td>Using Packaging and Processing Techniques [traditional, organized, machinery]</td>
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<td>38</td>
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<td>20</td>
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<td>(ii) Organized Packing and Storage Service [cooperative, municipality]</td>
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<td>(iii) Using Machinery for Processing</td>
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<table>
<thead>
<tr>
<th>2 CHANGED STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayaş</th>
<th>% Beypazarı</th>
<th>% Güdül</th>
<th>% Güdül</th>
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<tr>
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<td>Established Packaging Systems</td>
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<table>
<thead>
<tr>
<th>3 EXPERIENCED IMPACT</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayaş</th>
<th>% Beypazarı</th>
<th>% Güdül</th>
<th>% Güdül</th>
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<tr>
<td>Changed Yield [decreased, increased]</td>
<td>11</td>
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<td>1</td>
<td>20</td>
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<td>78</td>
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<td>(i) Decreased Yield [due to plant disease, hail, harvest loss]</td>
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<td>73</td>
<td>1</td>
<td>100</td>
<td>5</td>
<td>71</td>
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<td>(ii) Increased Yield</td>
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<td>27</td>
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<td>0</td>
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<td>29</td>
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<td>No Experienced Impact</td>
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<td>21</td>
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<td>High Cost of Labor and Yield Increasing Applications</td>
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<tr>
<td>Unable to Use Machinery for Harvesting</td>
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<td>0</td>
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<tr>
<td>Lack of Equipment for Processing/Packing</td>
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<td>9</td>
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Table 56. Current State, changed state, experienced impacts and response of farmers in harvesting, processing and packing stage continued

<table>
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<tr>
<th>4 RESPONSE</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayaş</th>
<th>% Beypazarı</th>
<th>% Güdül</th>
<th>% Güdül</th>
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<tr>
<td>Adopting Measures to Increase Yield</td>
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<td>64</td>
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<td>100</td>
<td>83</td>
<td>1</td>
</tr>
<tr>
<td>[certified seeds, chemical inputs, land care, animal manure, rotational cropping]</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreasing Plantation Area</td>
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<td>0</td>
<td>0</td>
<td>2</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Not Harvesting</td>
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<td>9</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
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<td>100</td>
<td>1</td>
<td>100</td>
<td>4</td>
<td>100</td>
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</tbody>
</table>

25% of all mentions indicate *changed climatic conditions*. Three-thirds of the mentions in this category belong to farmers in Beypazarı and the rest comes from the farmers in Güdül. This category is the most dominant changed state among farmers in Beypazarı with (40%). Also, a producer in Ayaş (A2) mentions a shift in tomato harvest season due to change in climatic conditions. While the tomato used to be harvested earlier than July, now it is harvested in July. Similarly, B3 refers to changes in the yield of wheat and chickpea due to decreased rainfall.

The third most mentioned category was *changed cost and labor source* received 19% of the total mentions. Only farmers in Beypazarı mentioned this change and equal number of farmers in Beypazarı indicate changed climatic conditions (38%) and changed cost and labor source (38%).

*Increased plant disease* (12.5%) and *established packaging systems* (12.5%) receive equal mentions from Güdül and Beypazarı. None of the mentions came from Ayaş for these two categories. Farmer B3, for instance, refers to overall increase in the yield due to improved seed and chemical technology but farmer states that increasing yield means increasing vulnerability to plant diseases.

The experienced impacts in the harvesting step of agricultural production in three districts clustered in six categories. The predominant concern weaving through the
diverse experienced impacts across the districts is the factors influencing the yield, particularly the decreased yield, change in soil fertility, harvesting expenses and machinery and equipment related problems.

The most frequently mentioned experienced impact was *changed yield*, either a decrease or increase, with 46% of all mentions. Out of these, the highest frequency was observed in Beypazarı, where 35% of farmers reported a change in yield, followed by Güdül with 27%. Overall, 73% of all mentions in this category indicate decrease in yield due to plant disease, hail, and harvest loss.

Contrastingly, almost a quarter of mentions indicate an increase in yield.

For instance, the President of the Beypazarı Chamber of Agriculture (B2) discusses the evolution of tomato yields over the years, emphasizing the impact of changed seeds and rising costs on increasing productivity.

"Previously, for example, the Ayaş tomato would yield 2 tons and your market was mainly Ankara, there weren't many places [to sell]. But now, from the 2 tons of tomatoes you produce, you suffer a loss, which is why you're using European seeds which give yields of 7-8 tons. Of course, it [the yield] has changed. Because the pesticides and fertilizers being used are evolving and increasing. Costs are rising and so is productivity. If you don't increase productivity, you can't stay afloat. Labor costs are also high, it's not like before." (B2)

21% of all mentions refers to *no experienced impact*. Ayaş had the highest frequency of no experienced impact, with 60% of mentions in Ayaş reporting no impact, followed by Güdül with 20%.

*Change in soil fertility* (13%) and *high cost of labor and yield increasing applications* (13%) received equal mentions. Farmers in Güdül mention the change in soil fertility the most frequently with 20% of mentions from Güdül supports this fact. In addition, no farmers in Ayaş refer to change in soil fertility.
The remaining experienced impacts, such as *unable to use machinery for harvesting*, and *lack of equipment for processing, packaging, and storing*, were reported by a relatively small number mentions, one mention each from Güdül.

Four **response** categories emerged in this step. There are rather lower number of mentions (11) compared to the number of mentions in the state, change and impact categories. In terms of harvesting, 64% of mentions indicate **adapting measures to increase yield**. In this response category, farmers’ responses cluster around the topics of switching to certified seeds, use of chemical inputs, and land care applications such animal manure and rotational cropping. Specifically, 83% of mention from farmers in Beypazarı refers to such measures while only one farmer from Ayaş and Güdül indicates adoption of such measures.

The head of Ayaş Chamber of Agriculture and Ayaş DDoAF refers to the adoption of certified seed for chickpea that allows machine harvesting as a response to increased labor costs. Interviewees discuss how the introduction of a new chickpea variety, Askan, has greatly reduced the labor-intensive process and costs for farmers. This also presents how decisions in another steps of agricultural production impacts another steps.

> "For instance, our biggest issue with chickpeas was hand harvesting. Then the Askan chickpea came onto the market, saving the farmers. What did the farmers do before? They harvest by hand. That was the major problem. Since Askan chickpeas grow a bit taller, you can use a combine harvester. It provided almost a 100% return in labor and cost. So, farmers can’t say no to this." (A3)

18% of the responses consider **decreasing plantation area with** the mentions only from Güdül. Half of the farmers in Güdül who stated any response in this stage refer to decreasing plantation area as a response. Farmer G7 states that the plantation area decreases due to technological developments in seeds and agricultural chemicals that have improved the maximum yield get from a unit of land. For example, in the past the farmer got 100-150 kg of wheat from 60-70 decare of land. Now, farmers get the same yield from 10 decare of land.
Continuing traditional methods for harvesting (9%) and not harvesting (9%) received one response each from Güdül and Beypazarı respectively.

A farmer in Güdül (G1) considers that traditional seed obtainment methods from plants help to secure a good yield. He discusses the challenges faced in seed selection and the preference for local seeds over commercial ones, emphasizing the need for proper knowledge about seed selection for better yields.

"Now, the yield is actually good, but whether it's us or the agriculturalists, if I go to the district agriculture office now and say I can't get a yield, they'll immediately give me a regular pesticide, or they'll direct me to another seed. We want to plant native seeds. However, in this area, they should teach about seed collection because agriculturalists don't know. You'll cut the tomato in half and take from the top half; if you take it from the bottom, half of it will be sterile, and the other half will be unproductive. It won't work. More of the male ones come out, but if you take it from the top, after cutting the tomato in half and not using the bottom, then you can compete with the other seeds. In terms of yield, we don't know how to collect seeds. If we knew how to collect seeds, there'd be no problem in yield." (G1)

In terms of not harvesting as a response, farmer G11 states not to harvest the crops as drought conditions impacted the plant growth and the response of farmer against an impact experienced due to climatic condition.

“...And this year (2020), there is the drought. So here in most places, in our chickpea places, drought in partial places, up to 100%. As a farmer, I planted 250 acres of chickpeas. I will neither put a combine harvester on 100 acres, nor will I go plucking. I'm not going to do anything. Now the animals there will spread. Well, that's it.” (G11)

In analyzing the agricultural trends in Ayaş, Beypazarı, and Güdül, it's evident that changes in yield, particularly a decrease attributable to factors like plant diseases,
hail, and harvest losses, stand out as the most significant experienced impact across the districts.

5.3.7 Marketing

Marketing, as an integral and the last stage of agricultural production, reflects the changing dynamics of agricultural production that builds over the previous steps of production. An examination of data from Northwestern Ankara sheds light on the diverse marketing approaches farmers employ, dependent on their respective districts.

Farmers in Northwestern Ankara predominantly market their produce through methods such as bazaars, traders, networks, and more structured methods like wholesale markets and factories. An analysis of marketing locations exhibits Ankara as the dominant marketplace, followed closely by regional and local venues. Each district possesses its unique marketing methods. For instance, Ayaş emphasizes selling in market chains, while Beypazarı has a balanced spread across bazaars, traders and wholesale market. In contrast, Güdül stands out with a significant preference for network-based marketing, involving relatives and food networks in addition to bazaars. However, the methods of marketing has changed in the region. Some farmers have transitioned away from traditional methods, like selling in bazaars, and have adopted newer channels. The emerging market, legal regulations, infrastructure conditions, and even climatic changes, as the data suggests, have been pivotal in guiding these changes. For example, the significant shift from bazaar selling in Güdül or evolving regulatory environment and market infrastructure that famers in Beypazarı dominantly refers are some examples of the changed state.

However, with change comes experienced impacts and responses. Farmers most frequently refer to the impacts in six main categories. These impacts such as the problem of being unable to earn the value of the product and market access on the domain of marketing opportunities. These problems are accompanied or sometimes
resulted by the restricting legislation for expanding market opportunities such as access to food markets and wholesale market rules. The data also indicates that fluctuating or controlled market prices and widening gap between producer and consumer prices exacerbates the impacts in marketing stage. In this market environment, inadequate cooperation and coordination among farmers and relevant institutions create another layer of impact in the marketing stage of the production. As a result, farmers even experience the risk of wasting products, efforts and resources.

As a response to these changes and impact, a discernible trend is the increasing inclination towards community-centric or unmediated marketing channels. This pivot towards local marketing strategies, whether through unmediated methods, food initiatives, or organized markets, signifies a pursuit of autonomy and control over their produce. Additionally, the diversification in search of alternative marketing channels reflects farmers' adaptability and their pursuit of the most viable and profitable methods.

The current state of marketing steps consists of two dimensions: marketing method and marketing location.

The marketing method refers to the way farmers sell their products and includes several methods that emerged from the interview results. Selling goods in bazaars (27%) and selling to traders (14.6%) are the two marketing methods that are most frequently mentioned in the region.

Farmers in Beypazari equally indicate selling in the bazaar (22%), selling to traders (22%), and selling to the wholesale market (22%). Interview results with the farmers in Ayaş follow the same pattern for marketing methods with 14% of farmers refers to aforementioned three dimensions.

As farmers in Beypazar have noted, traders have become dominant actors in production.
Selling in networks, such as to relatives and recently emerging food networks, received equal mention with selling to the wholesale market (12.5%). This method is particularly dominant in Güdül, as 83% of the responses in this subcategory come from the Güdül district. One reason behind this situation might be the higher number of interviews with the farmers in Güdül who are involved in civic initiatives such as food networks, as 22% of the farmers in Güdül refer to selling to networks.

In similar manner with farmer B4, farmers in Güdül are more likely to sell directly to consumers through bazaars (62%), and networks (83%), whereas farmers in Beypazarı are more likely to sell to intermediaries such as traders (57%), wholesale markets (67%).

In the same manner, 10% of all mentions related to marketing methods refer to marketing chains. Market chains include municipal markets in Ankara, cooperative markets, and regular supermarkets. For instance, farmers in the region refers to Ankara Metropolitan Municipality markets buying products from producers in Ankara.

Among all districts, selling the market chains receives the most mentions, as 29% of all mentions in Ayaş refer to this method. The similar number of farmers that forms 9% of mentions in Güdül also refers to market chains in the marketing stage of agricultural production.

Selling to factories (8%) and selling to the Turkish Grain Board (8%) received an equal share of mentions. This type of marketing method is more popular among farmers who continue non-irrigated agriculture with grain-based crops. After the harvest, they sell the yield to flour factories or to the Turkish Grain Board.

An equal number of farmers in Güdül indicate selling to market chains (9%), factories (9%), and the Turkish Grain Board (9%), while only one farmer from Beypazarı and Ayaş indicates selling to the Turkish Grain Board. The changed state of marketing and experienced impacts also refers to the Turkish Grain Board, which has been a powerful market actor in agricultural production in Turkey.
Internet selling (%3) received mentions from only one farmer from each district.

Marketing location is another category under the current state of marketing. This category forms four subcategories that represent the locations where farmers sell their products. Selling in Ankara (29%) and selling in the region (29%) receive equal mentions in the regions, followed by selling in local surroundings (24%). 18% of the mentions indicate selling outside of Ankara, to the cities of Istanbul, Mersin, Izmir, and Antalya.

Almost three-fourths of the farmers in Beypazarı (75%) choose to sell outside of the case study area including other districts of Ankara and other cities. Only one quarter refers to selling in the region and local surroundings of production and residence.

The representative from Beypazarı DDoAF states that produced goods dominantly sell to Istanbul Market rather than Ankara. He stated that about 30% of the products in Istanbul Market comes from Beypazarı. In addition, wheat is sold through traders and directly to flour mills in Ankara and Polatlı. The villages close to Polatlı in the southern parts of the district directly sell wheat to flour mills in Polatlı.

Whereas almost 80% of all mentions from farmers in Güdül refer to selling within the case study area, including selling in the region (47%), such as Beypazarı and Güdül districts, and selling in the local surroundings (33%), such as in the village, field, or roadside close to the farm. Farmers in Ayaş uniformly mention the abovementioned four categories with 25% of mentions each.

Interview with farmers presents five categories of the changed state in marketing stage changed marketing method (44%), changed state law, regulations and practices (19%), changed market and infrastructure conditions (19%), emergence of traders (14%) and changed climatic conditions (5%).

76 % of mentions in Güdül and 63% of mentions in Ayaş refer to the changed marketing method, while only 6% of all mentions in Beypazarı refer to changed marketing method (44%).
This changed marketing method which includes subcategories such as selling through other channels such as organized markets and local networks (47%), stopping sales at bazaars (37%), and stopping sales to TMO and exporting (16%) is the category that received almost half of the mentions. Interestingly, 80% of farmers in Ayaş refers to started selling through other marketing channels such as organized markets, local networks or exporting to other countries. Whereas farmers in Beypazarı do not refers a change in marketing method except stopping selling to Turkish Grain Board with only one farmer.

While almost half of the mentions in Güdül indicate that farmers stopped selling in bazaars (46%), 80% of all mentions in Ayaş indicate that farmers started selling through other channels. Only one mention comes from Beypazarı, where farmers state they stopped selling to TMO and exporting in terms of changed marketing method. Farmers in Güdül also refer to started selling through other channels (38%) which can both be considered as an impact and as a response.

“Our marketing approach has changed. We can’t really go to the government anymore; we now turn to the traders. In the past, if a trader was buying something for 1 lira, the government would offer 1,2, 1,3, 1,4 - a bit more, so that we’d line up to sell to the government, hoping to get a few extra kurus in our hands. But now, it's the complete opposite." (B7)

Supporting the same change, the representative from Güdül DDoAF (G11) refers to the changing relationship between the state and private traders as becoming a choice of farmers as a marketing channel.

“Farmer does not sell to Turkish Grain Office since 2009 as the institution does not give less price that the market and it does not open on time leaving farmers in the need for storing. The take price from local tradesman and choose the most efficient option.” (G11)
Table 57. Current State, changed state, experienced impacts and response of farmers in marketing stage

<table>
<thead>
<tr>
<th>1 CURRENT STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>Ayaş</th>
<th>% Ayaş</th>
<th>Beypazarı</th>
<th>% Beypazarı</th>
<th>Güdül</th>
<th>% Güdül</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Marketing Method</strong> [bazaar, trader, network, wholesale market, factories, market chains, TMO, Internet]</td>
<td>48</td>
<td>56</td>
<td>7</td>
<td>47</td>
<td>18</td>
<td>55</td>
<td>23</td>
<td>61</td>
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<tr>
<td>(i) Selling in Bazaars [organic, farmers market, normal]</td>
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<td>27</td>
<td>1</td>
<td>14</td>
<td>4</td>
<td>22</td>
<td>8</td>
<td>35</td>
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<tr>
<td>(ii) Selling to Traders</td>
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<td>1</td>
<td>14</td>
<td>4</td>
<td>22</td>
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<td>9</td>
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<tr>
<td>(iii) Selling in Network [relatives, food network]</td>
<td>6</td>
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<td>0</td>
<td>1</td>
<td>6</td>
<td>5</td>
<td>22</td>
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<td>(iv) Selling to Wholesale Market [wheat exchange market, wholesale market]</td>
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<td>13</td>
<td>1</td>
<td>14</td>
<td>4</td>
<td>22</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>(v) Selling to Factories</td>
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<td>2</td>
<td>29</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>(vi) Selling to Market Chains [municipality, cooperative, supermarket]</td>
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<td>0</td>
<td>2</td>
<td>11</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>(vii) Selling to Turkish Grain Board (TGB/TMO)</td>
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<td>14</td>
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<td>9</td>
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<td>(viii) Internet Selling</td>
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<td>14</td>
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<td>6</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Marketing Location</strong> [Ankara, Outside of Ankara, Local, Regional]</td>
<td>38</td>
<td>44</td>
<td>8</td>
<td>53</td>
<td>15</td>
<td>45</td>
<td>15</td>
<td>39</td>
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<td>(i) Selling in Ankara [Center and other districts]</td>
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<td>29</td>
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<td>25</td>
<td>6</td>
<td>40</td>
<td>3</td>
<td>20</td>
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<tr>
<td>(ii) Selling in the Region [Güdül, Beypazarı]</td>
<td>11</td>
<td>29</td>
<td>2</td>
<td>25</td>
<td>2</td>
<td>13</td>
<td>7</td>
<td>47</td>
</tr>
<tr>
<td>(iii) Selling in Local Surroundings [village, roadside, field]</td>
<td>9</td>
<td>24</td>
<td>2</td>
<td>25</td>
<td>2</td>
<td>13</td>
<td>5</td>
<td>33</td>
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<td>(iv) Selling other cities [Istanbul, Antalya]</td>
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<td>18</td>
<td>2</td>
<td>25</td>
<td>5</td>
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<tr>
<td><strong>Total</strong></td>
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<td>100</td>
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<td>100</td>
<td>33</td>
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<table>
<thead>
<tr>
<th>2 CHANGED STATE</th>
<th>Frequency</th>
<th>% Total</th>
<th>Ayaş</th>
<th>% Ayaş</th>
<th>Beypazarı</th>
<th>% Beypazarı</th>
<th>Güdül</th>
<th>% Güdül</th>
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<tr>
<td><strong>Changed Marketing Method</strong></td>
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<td>76</td>
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<tr>
<td>(i) Started Selling through Other Channels [organized markets, local network, exports]</td>
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<td>47</td>
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<td>80</td>
<td>0</td>
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<td>(ii) Stopped Selling at Bazaars</td>
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<td>20</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>46</td>
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<td>(iii) Stopped Selling to TMO/Exports</td>
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<td>16</td>
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<td>0</td>
<td>1</td>
<td>100</td>
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<td><strong>Changed Law, Regulations and Practices</strong></td>
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<td>13</td>
<td>7</td>
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<td>(i) Changed Law and Regulation [Wholesale market, TMO Volume, Farmer protection]</td>
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<td>0</td>
<td>3</td>
<td>43</td>
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<td>(ii) Changed Prices</td>
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<td>100</td>
<td>2</td>
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<tr>
<td>(iii) Imports/Exports</td>
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<td>0</td>
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<tr>
<td><strong>Changed Market and Infrastructure Conditions</strong> [market, infrastructure]</td>
<td>8</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>33</td>
<td>2</td>
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<tr>
<td>(i) Market Conditions</td>
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<td>83</td>
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<td>(ii) Infrastructure Conditions</td>
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<td>17</td>
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<tr>
<td><strong>Traders Emerged</strong></td>
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<td>13</td>
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<tr>
<td><strong>Changed Climatic Conditions</strong></td>
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<tr>
<td><strong>Total</strong></td>
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<td>8</td>
<td>100</td>
<td>18</td>
<td>100</td>
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Table 58. Current State, changed state, experienced impacts and response of farmers in marketing stage continued

<table>
<thead>
<tr>
<th>3 EXPERIENCED IMPACT</th>
<th>Frequency</th>
<th>% Total</th>
<th>% Ayas</th>
<th>% Beypazar</th>
<th>% Güdül</th>
<th>% Güdül</th>
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<tr>
<td>Economic and Financial Challenges</td>
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<td>41</td>
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<td>23</td>
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<td>17</td>
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<td>(ii) Fluctuated/Controlled Market Prices</td>
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<td>33</td>
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<td>(a) Price Control</td>
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<td>60</td>
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<td>100</td>
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<td>50</td>
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<td>(b) Price Fluctuation</td>
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<td>50</td>
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<td>(iii) Deficiencies of the Trader System</td>
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<td>(a) Manipulated prices</td>
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<td>67</td>
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<td>(b) Suppression</td>
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<td>(iv) Lack of Access/High Cost Transportation</td>
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<tr>
<td>(a) High Cost of Transportation</td>
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<td>(b) Lack of Access to Transportation</td>
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<tr>
<td>(v) Gap between Producer and Consumer Prices</td>
<td>5</td>
<td>11</td>
<td>1</td>
<td>33</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Market Access and Consumer Preferences</td>
<td>34</td>
<td>31</td>
<td>3</td>
<td>23</td>
<td>15</td>
<td>33</td>
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<td>(i) Lack of Marketing Opportunities</td>
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<td>0</td>
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<td>33</td>
</tr>
<tr>
<td>(ii) Restricted Access to Food Market</td>
<td>11</td>
<td>32</td>
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<td>67</td>
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<td>(iii) Consumer Preferences</td>
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<td>33</td>
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<td>(iii) Certification [organic, geographical indication]</td>
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<th>% Ayas</th>
<th>% Beypazar</th>
<th>% Güdül</th>
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*Changed state law, regulations, and practices* received 19% of all mentions after the changed marketing method. This category consists of changes relevant to the market, production volume, market prices, and import/export rates. Under this category, *changed laws and regulations* (38%) and *changed prices* (38%) received equal mentions. 39% of all mentions from farmers in Beypazarı refers to such change. 43% of mentions in Beypazarı refer to changed laws and regulations concerning wholesale market law, changes in TMO volume, and protection for farmers. Farmers in Güdül did not mention any change. Under this category, one farmer in Ayaş only mentioned *changed prices*, forming 13% of all mentions in this category. Farmers in Beypazarı refers to change in import and export conditions by 29%.

Relevant to this impact category, B1 reflects on the challenge faced by farmers due to state-led import policies and the trader-centric system, suggesting an absence of equitable profit distribution in the agriculture sector.

"So, one tries to cultivate grains, barley, but when our government activates its import mechanism at times when prices might rise, traders again make money. They buy from us at a lower price. So, you have no chance of making money even in dry farming. If we don't spread the profit equitably to the producer, to the grassroots level, and keep the trader system or supermarket system dominant, it doesn't seem like a very healthy process." (B1)

*Changed market and infrastructure conditions* (19%) receive equal mentions as the previous category. While only farmers in Beypazarı refer to *changed market conditions* (100%), farmers in Güdül (67%) refer to *changed infrastructure conditions*.

Farmers in all districts indicated *the emergence of traders* (14%). While 67% of mentions in this category belong to farmers from Beypazarı, only one farmer each from Ayaş and Güdül said that traders emerged in the region.
The transition of truck drivers from merely transporting goods to becoming middlemen in the trade process is highlighted not only by B3 but the quotation of the farmer illustrates their increased role in the market better.

“Traders who were truckdrivers once who were carrying products from farms to wholesale market, have entered commerce and began to act as intermediaries to sell products. They sell to Istanbul market and become rich. The old truck drivers/new traders started to buy the products of farmers from the field. The trader took the workers and farmer started sell from the field. Even wholesale markets started to work with traders as they get better products.” (B3)

The final topic is the changed climatic conditions (5%) in relation to marketing. Again, only farmers in Ayaş and Güdül referred to this type of change.

“Last year it was a bit good. This year the weather was dry. Because of the dry weather, for example, if the money we spend is 3000 liras, we can only sell 3000 liras worth of wheat. So, there is no more. So, there is no profit.” (G7)

The third category concerns the experienced impact in marketing. These impacts gather around six main categories concerning economic and financial challenges (41%), market access and consumer preferences (31%), restricting legislation and practices: (11%), inadequate cooperation and coordination (6%), risk of wasting the products, effort, and resources (6%) and no experienced impact (5%).

Economic and financial challenges are a prevalent concern in the region, accounting for 41% of the overall concerns. Güdül farmers specifically express not earning their products' value, with 48% of the mentions, compared to 33% in Ayaş and only 17% in Beypazarı.

The representative of Beypazarı Gardeners’ Cooperative (B1) both describes the surpression of traders in the market and the potential financial losses when they're unable to sell their crops due to market conditions that enable farmers to earn efforts.
"You either sell to the trader or you don't. If you can't sell, it stays in the field. Last year, I couldn't sell my carrots, Ahmet knows about it too. They did a little digging in our fields. We got 25 lira from a 35 decare land. We took that and gave it to the seed seller. I didn't put a single lira in my pocket. Let alone the expenses I incurred. The green onions remained in the field. Do you think there are no issues in marketing? Of course, there are." (B1)

The representative of Güdül DDoAF (G11) refers to the impacts of changed climatic conditions that led farmers to unable to earn the products value.

“For instance, Güneyce neighborhood was sending tomatoes with trucks to Ankara market before. Now, due to weather conditions, drought, diseases in tomato and increased production costs, villagers plant less vegetables as they do not get the result of their efforts” (G11)

*Fluctuating market prices*, price controls (60%) and price fluctuations (40%), receive equal shares in Beypazarı and Güdül.

Farmer B8 describes the unpredictable and volatile nature of produce prices in the current market, contrasting it with more stable trends from the past. In addition, farmer states that product speciality and product seasons of different regions in Turkey changed and impacting the prices of the products.

"The prices we get when we sell vary from time to time. Sometimes it's worth almost nothing, and then suddenly, it's highly valuable. But in the past, how was it? When a product started to gain value, it would continue for at least, at the very least, 10-15 days. Now, that's not the case. For instance, a product's value may surge one day, and by the next day, it has hit rock bottom. It's extremely volatile. Now, all regions have learned; I am speaking in terms of Beypazarı, for example, carrots used to be very popular here, but now it has started to be cultivated in neighboring provinces as well. Greens, for example, were much cultivated. There was a Mediterranean season and an Inner Anatolia season. During our time, everyone cultivates now. The product yield
has increased, and the big traders are lowering prices, drawing, how can I put it, different paths for themselves. So, that's how it is." (B8)

*Deficiencies of the trader system* forms 20% of all mentions under economic challenges. Trader system deficiencies, including manipulated prices and suppression, emerge more in Beypazarı and Güdül. Specifically, 60% of Beypazarı farmers refers to experience manipulated prices, and 40% of them are concerned about suppression. In contrast, Güdül reports higher price manipulation rates at 75%.

"The traders agree among themselves and set the price... This type of production is 40% of the Beypazarı, but it seems that it will increase, the dependency on the trader will increase" (B3)

Further B3 describes the challenges farmers face when dealing with wholesalers and traders, focusing on the unpredictable nature of payments, reliance on traders due to labor shortages, and their variable pricing strategies depending on the market conditions.

"You send produce to the wholesale market, but the wholesaler says your produce hasn't sold and that there's no money to pay you. You can't find workers, so you're forced to deal with the trader. The trader might also claim to have no money, but somehow, they manage to sell. This year, lettuce isn't fetching a good price. The trader buys it in the field at 10 TL per decare. When it's not fetching a good price, they buy per crate. If there's a low supply and the price is high, they buy per decare; if the price is low, they buy per crate. When the money comes from the wholesaler, they say, 'I'll send it once I sell it'. " (B3)

In response to the question whether the farmer faces difficulties in selling products, in a sarcastic tone, a farmer expresses the lack of agency they feel in selling their produce, implying that they are at the mercy of the buyers.
“We do not face difficulties in selling; we give them whatever they ask for. They take however they want, so we don't experience any hardships. It always goes their way anyway. That's how it is.” (B6)

Lack of Access/High Cost of Transportation compromises 11% of mentions under economic challenges. Transportation concerns are starkly divided, with Beypazarı singularly referring to high transportation costs, with 28% of the mentions.

The interviewee B2 highlights the challenges small-scale producers face, such as increasing transportation costs and the competitive advantage of larger firms, indicating a potential shift towards integration into larger firms/traders in the near future.

"We are experiencing it [marketing problems]; as I said, there are about 10 big firms/traders here now. Of course, transportation costs are high. They operate on a truck or trailer scale, working with several trailers. For those of us who plant less, the transportation costs become high. We can't deliver on time, so our chance to compete diminishes, and in 3-5 years, we will vanish. We will be integrated. The system is going this way, and we too will be integrated." (B2)

Lastly, farmers in all three districts referred to the gap between producer and consumer prices (11%) in but felt most in Gündül (13%). Farmer A1 highlights the disparity in pricing for agricultural products, where the producer struggles to earn their efforts, while consumers in urban areas face high prices, revealing a margin taken by traders or middlemen.

"Unfortunately, it seems like there are hardly any real farmers left in agriculture. The people of our village are hardworking. They never tire or give up. However, what exhausts and wears us out is the fact that after putting in immense effort to cultivate our tomatoes and vegetables, when the season comes to introduce them to the market, they sell for far less than the cost of production. Moreover, while we can't sell our tomatoes for 1 lira, even though
they cost one and a half lira to produce, my relatives in Ankara tell me they can't find them for less than 3, 4, or even 5 lira, whether in markets or bazaars. There's an extraordinary difference in these rates. If a market buys these tomatoes from the wholesale for 1 lira, they should sell them for 2 lira. Why is the effort of the farmer, who puts in so much work in agriculture, being wasted and exploited like this? Why is it squandered?” (A1)

When considering **market access and consumer preferences**, which constitute 31% of the experienced impacts, it is noteworthy that both Beypazarı (33%) and Güdül (32%) emerge as a location with notable impacts. Specifically, the primary issue identified is the lack of marketing opportunities, accounting for 56% of the mentions. More than half of the farmers in Güdül (56%) in the impact category of market access refer to this condition which is followed by farmers in Beypazarı (33%). Ayaş, on the other hand, has a notable absence of problems within this particular sub-category. On the contrary, Beypazarı experiences a significant impact due to restricted access to the food market, with 53%. Almost 70% of the farmers in Ayaş also refer to restrict food market access.

Customer preferences, (26%) is the third subcategory that includes the preferences of consumers to seek the cheapest, well-shaped products with other possible contextual preferences. It becomes evident that Güdül displays a significant preference for products that are priced at the lowest end of the spectrum, accounting for 50% of their choices. While half of the farmers in Güdül complain about the consumers searching for the cheapest products (50%), farmers in Beypazarı refer to the preference of consumers towards well-shaped products (100%). Ayaş remains distinct in its concerns, with 100% of its farmers referring to other factors like natural production or the pandemic conditions that shape the consumers’ preferences.

11% of mentions indicate restricting legislation and practices that create a base for farmers access to market in general. Specifically, 38% of all mentions from Ayaş refer to this impact, which is the highest number of mentions in Ayaş in terms of all
experienced impacts. Whereas only 7% and 8% of all mentions in Beypazarı and Güdül refer to this impact.

Restricting legislation and practices include four sub-categories: inadequate state planning and measures (33%), restricting legislations and practices (25%), certification (25%), and inspection (17%). While farmers in Ayaş refer to both states planning measures, restricting legislations and certification issues, each at 20%, farmers in Beypazarı indicate only inadequate state planning and measures as an experienced impact in this category. In addition, farmers in Güdül mention two subcategories: restricting legislation and practices and certification with equal mentions.

"Anyone who says they do natural farming is lying. The biggest danger is those who say they are doing natural farming. Those who say I have a little space in front of my house, who say they do not use anything, and those who put a crate in front of them and sell are time bombs. Be sure of this because it does not go to inspection." (B2)

Inadequate cooperation and coordination (6%) and the risk of wasting products, effort, and resources (6%) each received an equal percentage of mentions. Inadequate cooperation and coordination is composed of several types of practices among farmers, with public institutions and cooperatives, and between farmers and customers. While only one farmer from Ayaş and Güdül mentions inadequate cooperation and coordination, 11% of farmers in Beypazarı mention this category. The statement of B8 summarizes the state of cooperation in Beypazarı.

"Nobody engages in collective production here; there's no such tradition." (B8)

The risk of wasting products, effort, and resources (6%) is another experienced impact. While one-third of the mentions come from farmers in Güdül, two-thirds come from farmers in Beypazarı. Farmers in Ayaş do not mention such an impact.
Interviewee G11 highlights the significant price disparity between what producers receive for their products and what consumers end up paying, attributing this gap to district-level marketing challenges, wastage of unsold produce, and the presence of middlemen who inflate costs. By eliminating these intermediaries, G11 suggests that consumers could pay less while ensuring farmers earn more.

Only 5% of all mentions indicate no experienced impact with 80% of the mentions in this category belonging to farmers in Güdül. Only a single mention in Ayaş indicates no experienced impact.

The responses of farmers against the changed state and experienced impacts in marketing stage cluster under five categories. Adopting community-led, unmediated marketing techniques receives the highest percentage of mentions, at 53% of the total. It is not surprising that almost 80% of the farmers in Güdül refer to the adoption of alternative marketing channels. Such emerging alternative marketing in Güdül, and exploration of the changes and impacts that lead to the emergence of such motivations is one of the focuses of this present study.

Unmediated marketing (48%), food initiatives (30%), and farmers' markets (22% each) are the subcategories under alternative marketing channels that emerged from the interview results. Analysis reveals that both unmediated marketing and food initiatives have an equal mention in Güdül (both at 35%). Interestingly, while Ayaş has 40% of its farmers indicating to these channels, it exclusively focuses on unmediated marketing. Beypazarı, while also inclined towards these channels at 25%, has a more diversified approach than Ayaş including unmediated marketing (75%) and food initiatives (25%).

In terms of adopting unmediated marketing channels, farmer B4 discusses the role of local associations and networks that help them reach potential customers in Istanbul and Ankara.

"In Istanbul, there's the 'Wheat Association' that sells in Istanbul markets, and in Ankara, we have an association we founded called the 'Ankara Organic
Producers and Entrepreneurs Association’. So, there are groups, WhatsApp groups but they learn in some way through their social circles, establish a connection, and later become our customers.” (B4)

Farmer G1 and G2 are part of community initiative, TADYA, that supports agroecological agricultural practices and community supported agriculture. The Tahtacıörençik Natural Living Collective (TADYA), founded in April 2013 in Ankara's Güdül district, is dedicated to preserving and promoting sustainable rural development, eco-friendly lifestyles, and ecological production practices. Locating in Tahtacıörençik Village, families practice small-scale, chemical-free farming and raise local Anatolian livestock breeds. Being a part of collective, farmers have access to direct-selling opportunities through the networks of food communities and participatory guarantee systems exists in Ankara⁴⁰.

G4 refers to unmediating marketing as a response to not to bring the products back from selling in Ankara bazaars. After the bazaars, farmers were selling the leftover products in neighbourhoods of Ankara by truck.

Interviewee G6 describes their modern marketing approach using social media platforms to directly connect with consumers, eliminating the need for intermediaries.

“I market through acquaintances in Ankara. I connect with people I've met from the previous year, and we share through the internet, specifically on Instagram and Facebook. Those interested get in touch. We deliver as per their orders once a week. I provide directly to the consumer, without any middlemen.” (G6)

A noteworthy observation is the inclination of Güdül towards the farmers' market (29%), as there was a farmers' market initiative when the interviews were held in

⁴⁰https://tahtaciorenck.org/info-page-on-tadya/
Güdül, which finds no preference in Ayaş and Beypazarı. However, the farmers’ market operated only during the research period and currently, it is not operating.

The search for other marketing channels is the second dominant response strategy, capturing 28% of the regional responses. Beypazarı stands prominent here, with 44% of its farmers tending to explore these alternative channels that cover alternative markets, wholesale and exports, traders, and companies. One mention from all districts indicates wholesale and exports, whereas selling to traders (25%), and other companies (17%), is only mentioned among farmers in Beypazarı in this category.

As an example of search for alternative markets that might be a viable option for the region considering its capacity of vegetable production, a farmer (B3) in Beypazarı refers to a need to vegetable stock market such as grain stock market existing in Polatlı districts, adjacent to the region on the south, to determine vegetable product prices.

“"A vegetable stock market could be a viable option. Farmers take their goods; they can sell them on the stock market. Such an initiative does not exist in Turkey. The stock market would be better, not the wholesale market (hal in Turkish). If all wholesale markets are regulated in the form of a vegetable stock market, at least quality goods will get their value. Just as there is a grain stock market in Polatlı, there can also be a vegetable market in Beypazarı, which produces in Central Anatolia... Serve for Nallhan, Güdül, and Ayaş. It would be great for the farmer. If only 40–50 such places were established in Turkey. (B3)

Adopted product pricing forms 12% of all mentions. This category includes farmers that have adopted a specific pricing strategy for their products. Among these, the highest percentage is from Beypazarı (25%), followed by Güdül (5%). Farmers in Ayaş do not indicate a response to adopting certain pricing. These farmers refer to selling products at lower price levels, adapting traders to set market prices, or selling whoever gives the best price for their products.
In conclusion, the marketing stage is a dynamic stage with the highest number of mentions compared to the previous steps of production. While districts like Ayaş, Beypazarı, and Güdül have their distinct marketing characteristics, external factors like regulatory changes, consumer preferences, and economic dynamics play a crucial role in shaping the farmers’ responses.
CHAPTER 6

CONCLUSION

The rural landscapes of Northwestern Ankara exhibit a complex mosaic, which is influenced by various interactions among spatial, environmental, productive, and administrative systems. This research aimed to gain insight into the continuously changing dynamics of these landscapes, with a particular focus on the notable interaction between human activities, particularly agriculture, and the natural environmental processes of the socio-ecological productive landscape of Northwestern Ankara. The research also attempted an in-depth examination of these systems and their interrelationships in the context of a constantly evolving productive environment.

The concept of socio-ecological productive landscapes (SEPLs) serves to enhance and expand upon this particular viewpoint. These landscapes are characterized by a harmonious coexistence of human activities and natural ecosystems, and they play a vital role in delivering sustainable services. These areas encompass a wide range of habitats, land uses, and cultural sites, and are influenced by various factors like land use, climate, and biodiversity. The understanding of SEPLs is fundamentally rooted in the socio-ecological systems (SES) approach. Respectively, SES is defined as interconnected social and ecological subsystems functioning as complex adaptive systems (CAS) and emphasizing the interdependent relationship between human and natural components. This study emphasizes the need to integrate social, economic, and environmental factors in response to changes impacting the landscape within a SES understanding.

Research on SES has yielded a thorough understanding of the complex interactions that take place within these landscapes. However, it was crucial to re-examine the notion of SES resilience, by integrating a wider range of social aspects into the
research process. The incorporation of this element was essential for comprehending the fundamental drivers of change and the way in which local communities, namely farmers, respond and adapt to these changes.

Farmers have a crucial role in sustaining the relationship between agricultural productivity and environmental sustainability, thereby serving as the primary actors in this socio-ecological system. The role of farmers is determined by a multitude of elements, and these roles have substantial impacts for the entirety of the socio-ecological productive landscape. Hence, employing a uniform policy approach is unsustainable. The recognition of farmers' particular motives, attitudes, and conditions is of utmost importance in order to achieve efficient landscape management.

The primary objective of this study was to investigate this relationship and to develop a deeper understanding about the socio-ecological landscape of Northwestern Ankara from a perspective concerning agricultural productivity and environmental sustainability. By conducting an in-depth analysis of the complex processes involved, the study shed light on the present condition of the landscape and the diverse impacts caused by changes on natural resources and agricultural products, namely soil, water and plants, and different steps of agricultural production processes. Moreover, gaining understanding of the adaptive responses displayed by farmers has yielded crucial insights into the way in which communities effectively address the various challenges and opportunities that arise from these changes.

The study has revealed complex interconnections that characterize the socio-ecological productive landscape of Northwestern Ankara, which should be considered not as fixed entities, but rather as a process which undergoes in constant change due to the dynamic conditions and adaptive behaviors of their actors.

The dynamic and continuously changing characteristics of rural landscapes require a comprehensive strategy that encompasses both the physical transformations and the complex socio-cultural aspects. Adopting such a holistic viewpoint can play a
crucial role in formulating approaches that promote sustainable development, so guaranteeing the preservation of rural landscapes that maintain livelihoods, biodiversity, and cultural heritage.

Nevertheless, studies on landscape changes and socioeconomic status (SES) have revealed certain shortcomings. The exploration of the integration between ecological and social processes is of utmost importance, however, it has not been thoroughly investigated. Moreover, prevalent research on SES resilience frequently exhibits a limited focus by relying excessively on indicator-driven assessments, often neglecting the complex social dynamics involved.

To fully understand the resilience of SES, it was crucial to incorporate a more profound comprehension about the social dimension of the rural landscape. The inclusion of local knowledge, human decision-making, and actor responses can greatly enhance our understanding of social-ecological system dynamics and resilience. Farmers, as crucial stakeholders, function as both catalysts and adaptors in response to socioeconomic and environmental shifts. The outcomes of their actions are often diverse, influenced by a multitude of factors such as market prices, technical advancements, and political contexts as discussed throughout text in detail.

Based on this ground, this research is devoted to an in-depth exploration of the socio-ecological landscape dynamics within Northwestern Ankara. Central to this investigation is understanding how various interconnected systems—spatial, environmental, productive, and administrative—shape and are shaped by this landscape, especially under shifting conditions. The study is underpinned by twin sub-aims: first, to delineate the existing and changing conditions of the productive landscape, with a keen focus on the impacts upon water, soil, plants, and the entirety of production processes through focusing on each step individually; and second, to interpret the adaptive responses of local farmers to the impacts stemming from these changes. At its core, the research seeks to provide a holistic perspective on Northwestern Ankara’s socio-ecological productive landscape. It seeks to identify the complex networks of interconnectedness among the components of this
productive landscape, highlighting the adaptability and resilience of farmers to shifts in human-induced factors, climatic conditions, and production procedures. Ultimately, this inquiry aims to inform resilient planning and policymaking, offering fresh insights that could recalibrate prevailing planning practices for rural areas. Through an integration of both quantitative and qualitative methodologies, typified as a mixed-methods approach, the study integrates insights from in-depth interviews, geospatial analysis, and an array of secondary data. The overarching objective is to represent a comprehensive narrative about the socio-ecological landscape's operations and its complex interactions with many influence systems in the context of changing conditions in the productive landscape of Northwestern Ankara.

The selection of a suitable methodology is dependent upon the nature of the given research purpose. Within the framework of this research, understanding the complex socio-ecological landscape of Northwestern Ankara, particularly in the face of changing conditions, necessitated an elaborate methodology that surpassed simplistic analysis.

In this respect, the study employed a mixed-methodology to provide an in-depth understanding of the socio-ecological productive landscape. The utilization of a methodology integrating qualitative and quantitative research methods presented an opportunity to address the inherent limitations of each respective approach. Furthermore, the use of a mixed-methodology design, where one type of data supports a study primarily focused on another type of data, allowed the study to rely on qualitative insights while also benefiting from and enhancing the analysis with quantitative data.

This study was conducted in pursuit of the interpretivist paradigm, aiming to understand individuals’ perspectives who directly engage with the landscape, namely the farmers and representatives of agriculture-related organizations. This study utilized hermeneutics as a methodological approach, which at its essence, primarily concerned with the process of interpretation. The utilization of a hermeneutic approach was appropriate and essential in line with the study's aim to analyze the
experiences of individuals involved in agricultural production. The aim was to gather individuals’ perception and reaction to changing conditions in productive landscape. Considering the research focus on farmers’ responses to changing circumstances, the use of an interpretivist perspective was not only suitable but also essential. The case study design also allowed an in-depth exploration of the topic and enabled a detailed contextual examination of the landscape's operation, its challenges, and its actors’ experiences.

Overall, the research aims to answer the central research question of “How does the socio-ecological landscape of Northwestern Ankara operate through the interrelations between spatial, environmental, agricultural productive, and administrative systems in response to the changing conditions?”

To answer this question, the study posed three sub questions:

- **Sub-RQ1.** What is the socio-ecological productive landscape of Northwestern Ankara, operated by spatial, environmental, productive, and administrative systems?
- **Sub-RQ2.** How have changing conditions impacted natural resources and agricultural products within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?
- **Sub-RQ3.** How has the production practice changed within the socio-ecological landscape of Northwestern Ankara and how have local farmers responded adaptively to deal with change?

A diverse data collection technique was utilized to address this major research question, which sought to get a comprehensive understanding of the operational complexities within the socio-ecological landscape of Northwestern Ankara. The research methodology employed in this study involved the utilization of in-depth interviews, which were further supported by spatial and secondary data collected from multiple resources. The obtained data underwent a rigorous analytical procedure that encompassed basic statistical analysis, qualitative content analysis,
and complex geographical analysis. The subsequent sub-questions, which were tailored to shed light on the impacts and adaptive strategies emerged as a response to changing productive environment within the landscape, were predominantly approached through a qualitative lens. Nevertheless, quantitative methodologies were integrated where necessary to ensure a comprehensive understanding.

The research employed a multilayered set of variables grouped under three central dimensions which are addressed by three sub-research questions to deeply analyze the productive landscape in Northwestern Ankara:

I. Productive Landscape Components

   a. Socio-Ecological Interrelations:

   This dimension evaluated spatial factors (such as geomorphology, land use, and vegetation), ecosystem components (like water, climate, and soil), and the socio-economic context (including population demographics). It provided a deep understanding of the socio-ecological productive landscape, integrating both biophysical and human factors. The data in this dimension largely came from secondary qualitative and quantitative sources.

   b. Agricultural Production Context and Producer Characteristics:

   This variable category examined the specific agricultural practices, farmer count, landownership patterns, types of crops and products, and further delves into aspects like time in agriculture, income, labor, and lastly, aspects on agricultural organization. The aim was to grasp the foundational productive characteristics of the region's farmers. Data for this subcategory is both primary (field-based) and secondary in nature.

II. Man-Made and Climatic Conditions:

   This category of variables focused on explaining the second sub-research question on the alterations in man-made and climatic conditions, impacts and responses by the farmers. The variables were further divided into the impacts of these changes,
particularly the effects on water, soil, and plants, and how farmers respond to these impacts. This dimension underscored the pivotal role that climate plays in determining agricultural production and implications on the different steps of agricultural production. The data for this category came from in-depth interviews and fed with the analysis of socio-ecological system components using official statistics and secondary data obtained.

III. Agricultural Production Steps:

This category of variables offered an in-depth division into the sequential processes involved in agricultural production. The variables and analysis based on these steps spans land preparation, seed procurement, irrigation, plant protection, fertilization, through to harvest, processing, and marketing stages. Aims to present a thorough picture of the agricultural practices, highlighting both the current and changed states, the impacts experienced, and the adaptive responses of the farmers, emphasizing the interplay among socio-ecological system components throughout different agricultural production stages.

In essence, these variables in given three dimensions work synergistically to offer a holistic perspective on the productive landscape of Northwestern Ankara, considering both the ecological components and human-induced influences.

6.1 Inferences on the Research Results, Theoretical Underpinning and Planning Practice

Inferences on the results of the research

From a spatial and environmental perspective, the diverse topography and geomorphology in Northwestern Ankara significantly affect the choice of agriculture and its intensity. The hilly terrains, plateaus, valleys, and basins uniquely shape the agricultural potential of each district. The region's climate, with its transitional characteristics, influences the crop choices and the farming techniques employed.
The use of both surface and underground water resources underpins the significance of hydrology in shaping the region's agricultural decisions.

Demographic shifts in Northwestern Ankara present a multifaceted picture. While there has been a notable migration of older populations back to the region, their reduced engagement in farming activities is inadvertently affecting land prices and the continuity of agricultural practices. Concurrently, the migration trend from villages to district capitals leads to a physical and perhaps emotional disconnect between individuals and their agricultural properties. Compounding this, the allure of urban lifestyles and the perceived stability they offer has the younger generation reconsidering farming as a viable long-term occupation, jeopardizing its future in the region.

The water challenges faced by districts in Northwestern Ankara are multifaceted. Ayaş, despite 40% of its problems being water scarcity-related, largely depends on subsurface water sources and drills deeper to access water, highlighting a concerning reactive rather than proactive approach. Beypazarı, although facing issues like pollution and salinity (accounting for 40% of their water problems), similarly opts for the short-term solution of drilling deeper. Interestingly, while Güdül exhibits a lesser dependence on underground water (only 5% of their water problems relate to it), they too continue with it, albeit not as heavily as the other districts. Güdül distinguishes itself with the unique issue of ground water decrease, constituting 30% of its water-related challenges. Their primary mitigation strategy leans towards tapping river water sources and occasional reliance on dam water. This implies that while some areas have more diversified water sources, most regions still lean heavily on underground water, suggesting a potential future vulnerability if water levels continue to decrease.

Changing climatic conditions have differentially impacted the soil health across the districts of Ayaş, Beypazarı, and Güdül. The soil-related challenges in Beypazarı and Ayaş appear to be more pronounced, yet these districts also demonstrate remarkable resilience compared to Güdül. The adaptation methods, ranging from enhancing soil
carbon, using animal manure, to more radical shifts like moving from conventional to organic farming, underscore the proactive nature of some of these farming communities. The varied experiences in Güdül, where some farmers observe increased soil fertility and others witness deterioration, highlight the complexity of soil responses to climate and human intervention. The feedback loop between soil and agricultural practices demands a keen understanding and balanced approach to ensure long-term agricultural viability.

Ayüş farmers' somewhat passive stance, especially when facing significant impacts, could indicate either an acceptance of the status or a lack of resources and knowledge to adapt. Beypazarı farmers exhibit a mixed response, with some attempting to change production methods, while others remain unresponsive. This could point to the varied resources, knowledge levels, or even personal beliefs within the district. Güdül farmers emerge as the most adaptive, adjusting production cycles and seeking collective solutions. Their consistent response of changing product patterns in the face of challenges emphasizes a community that’s both observant and flexible. Furthermore, when dealing with plant diseases, the inclination in Beypazarı and Güdül towards both chemical and natural treatments suggest a pragmatic approach to problem-solving. A notable cultural insight from Güdül is the unanimous inclination towards awaiting a divine solution. This perhaps reflects a deeper cultural or spiritual belief system in the face of adversity. As a researcher in the field, I came across collective ceremonies for rain prayers in the region that were also acknowledged by the local municipalities in drought seasons. This highlights the tendency of these rural communities to accepting the situations and changes as “God-given.”

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42 https://www.ankara.bel.tr/haberler/gudul-de-baskan-tuna-sevgisi-11438
Agricultural practices across the districts illuminate both tradition and transition. Güdül, with its pronounced family farming, leans towards subsistence farming, while Beypazarı's mixed labor paradigm suggests a tendency towards larger, commercial farming operations. Notably, an over-reliance on singular agricultural sources of income, a trend observed in specific areas, can render farmers vulnerable to economic downturns from factors like crop failures or market volatilities.

Technology’s pervasive influence on agriculture is undeniable, with mechanization becoming dominant in many districts. However, its adoption isn't uniform; while some areas have wholly embraced technological advancements, others, possibly due to resource constraints or deep-rooted traditions, showcase a mixture of practices.

In wrapping up, the research provides a nuanced view of Northwestern Ankara's agricultural landscape, spotlighting the delicate balance between tradition and modernity, resilience and vulnerability, and local insights and broader climatic trends. The findings highlight the importance of an integrated, holistic approach to understanding and addressing the multifaceted challenges faced by the region’s agricultural community.

**Inferences on the theoretical underpinnings of the research**

At the heart of the study is the recognition of rural productive landscapes as complex adaptive systems (CAS) exhibiting emergent behavior, self-organization, and adaptability, the ever-changing dynamics of Northwestern Ankara, influenced by a mosaic of spatial, environmental, and administrative systems, testify to the region's CAS nature. These transformations, driven by both human activities like farming and natural environmental processes, emphasize the system's ability to adapt and reorganize in the face of change, manifesting inherent traits of CAS.

The socio-ecological systems approach (SES) applied in Northwestern Ankara showcases the deep interconnections between human actions and ecological consequences. This interconnectedness initiates feedback loops, evident in the relationship between climate, agricultural practices, and farmer responses.
Furthermore, the multi-scale nature of SES is apparent, where individual decisions made at a micro-level, such as those by farmers, are both influenced by and have implications for broader regional and global shifts in productive environment.

Resilience and vulnerability emerge as contrasting characteristics within these systems, defined by the regions’ adaptive capacities and exposure to external stressors. The farmers’ adaptive responses, land-use patterns, and interactions with the environment (such as soil, water, and plants) showcase the intertwined relationship between human and ecological entities, reinforcing the SES approach's essence. Moreover, their diversified strategies, whether they involve altered irrigation methods or shifts in planting patterns, emphasize their ability to adjust to changing conditions. The proactive and reactive adaptations evident in the region, supplemented by local knowledge and experiential learning, exemplify different levels of adaptive capacity inherent among these communities and individuals.

**Inferences on the planning paradigms for rural and urban areas**

The described research offers an in-depth and comprehensive exploration of the socio-ecological productive landscape of Northwestern Ankara, focusing on the interactions and adaptabilities of various systems and their stakeholders, especially farmers. Given its depth and breadth, this study has several significant implications for urban and regional planning as well as rural planning theory and practice.

The research underscores the importance of a comprehensive understanding of landscapes, considering both their ecological and socio-economic components. Planning practice must emphasize more holistic planning approaches that go beyond defining agricultural areas as single dimensional greenish colored land use piece. By doing this, planning practice might acknowledge this complex web of interrelations to ensure sustainability.

Farmers play a pivotal role in shaping and sustaining the socio-ecological landscape. Their insights, experiences, and adaptive strategies must be central to urban and rural planning processes. Such bottom-up participatory approaches ensure that rural
planning measures and policies are grounded in local realities that is fed with both lived and experienced spatial dynamics that considers the farmers both as a community and as a separate individual who makes decisions for and against the landscape based on personal and communal interests and perspectives.

The research suggests that static or one-size-fits-all policies are inadequate given the dynamic nature of socio-ecological landscapes. Planners should develop adaptive rural planning and policy frameworks that start with thorough analysis of the productive landscape and that can evolve based on changing conditions and feedback mechanisms of actors in the landscape to adapt to changing conditions.

The research suggests that a multi-dimensional perspective is essential to explore the socio-ecological productive landscapes where multiple components interact simultaneously. Such interdisciplinary approaches can lead to more robust and sustainable planning strategies. In addition, inclusion of the local knowledge gives a tendency to transdisciplinary research that is based both on scientific and indigenous knowledge. In this sense, the adaptive strategies of local farmers, rooted in their intimate knowledge of the land, offer lessons in resilience and adaptation to impacts of climate change.

The study provides empirical data that can expand and refine existing rural planning theories. By understanding the interrelations of spatial, environmental, productive, and administrative systems in Northwestern Ankara, the nuances and complexities of rural landscapes can be better integrated into theoretical frameworks. Current literature dominantly focuses on urban complexity whereas rural complexity also requires a critical inquiry which could be a further research topic.

The research illuminates the resilience of farmers and their ability to adapt to various shifts, which can be a focal point for developing resilient urban and regional food systems. Urban planners can learn from these adaptive strategies to ensure food security in the face of challenges like climate change, economic fluctuations, and other unforeseen disruptions. Furthermore, the findings reinforce the idea that rural
agricultural landscapes are not isolated entities but are deeply connected to urban centers in terms of food production, distribution, and consumption. This may call for developing more integrated rural-urban planning strategies.

In conclusion, the research on the socio-ecological productive landscape of Northwestern Ankara conveys the potential to challenge existing paradigms of urban, regional, and rural planning and to transform them into becoming more production-sensitive. The nuanced understanding of landscape dynamics, stakeholder roles, and adaptive strategies can serve as a guide for developing sustainable and resilient planning frameworks for Ankara and for other cities in Turkey.

6.2 Contributions of the Research

The theoretical discussions present the social and ecological components of agricultural production as an integrated phenomenon. Although we conceive that real life processes continuously engage social and ecological actors in co-production, and thus, create the context of its consequences in an interactively exchanged manner, the available methodological tools do not allow the scientific observation of such processes fully.

First, territorial analysis separates the spatial from the social. The spatial data, on the one hand, comes from a variety of sources arising the question of trust about its validity, on the other hand, makes it possible to draw a picture of spatial change. Social data remains inadequate in terms of its complete overlap to the land, but it extracts the real-life processes that emerge either as a reason or because of what takes place spatially. When social processes are investigated in detail, the behavior of the structure drawn from spatial analysis is understood.

This social part of the inquiry conducted in the Northwestern of Ankara revealed a methodological guidance that contributed to the enrichment of the more static structural part of the analysis. The hermeneutic approach applied in fieldwork,
allowing a free-flow dialogue with farmers, and thus, providing the verbal space to freely transmit their experiences in agricultural production, revealed four main deriving issues to their behavior as expressed by the involved farmers in the face of change. They include (i) the current state, (ii) the changed state, (iii) the experienced impact, and (iv) the response. Farmers’ answers to these issues helped draw the general characteristics of the behavior of agricultural production that did not only overlap with the spatial findings but also explained the dynamics of the agricultural land.

This research showed that the land as indicated in various degrees of yellow colors or some sort of gradual hatching on two dimensional plans is dynamic, and in fact, accommodates the social processes in an integration with the ecological occurrences leading to a radical transformation or adaptive change on that land. Two-dimensional plans do not represent this dynamism, and thus, remain inadequate in guiding the future of the rural districts of cities as well as the future of cities as a whole. To illuminate the future as a dynamic phenomenon, the plan preparation requires knowing the insight of the change, impact and response of production, and thereby, the resilience capacity of the farmer communities and the possibility of preserving such land.

With this approach, the findings of this study provide strong support for the value of employing a variety of research methods, thereby challenging conventional dichotomous perspectives on research paradigms and methodologies. This dissertation proposes a holistic approach to scientific inquiry by combining qualitative and quantitative approaches within the interpretivist paradigm. This method not only expands the academic perspective but also enhances the depth of the derived insights. To give an example to the integration of data from different sources such as using statistical data and farmers experience on meteorological observations, a striking disparity was noted between the centralized meteorological data and the experiential insights of farmers. This accentuates the importance of integrating local, grassroot-knowledge into broader research and policy frameworks.
and considering various strategies that farmers employed, from proactive modifications in irrigation to shifts in crop patterns.

The methodological choices not only addressed the research problems but also established a foundation for future investigations in this topic. Furthermore, the flexibility of the mixed-methodology research, combining spatial data with the interpretive power of hermeneutics as well as the depth of the case study design, offered a working framework for researchers for exploring productive landscapes elsewhere.

6.3 Limitations of the Study

Throughout my research journey, I encountered a multitude of constraints, from data availability to unforeseen global events like the COVID-19 pandemic. Recognizing these challenges and their potential impact on the outcomes is critical for understanding the broader context of my findings.

Temporal and Spatial Scope: The research fundamentally presents a territorially limited case study, constrained both by funding and time. While I endeavored to capture the essence of Northwestern Ankara, its scope can guide the search for the broad-scale applicability of the findings.

Impact of COVID-19: The pandemic undoubtedly impacted the methodology of my case study. Its effects meant that some interviews had to shift to phone or online platforms. This change, while necessary for health and safety, may have influenced the depth and authenticity of the responses. However, I worked diligently to continue face-to-face interviews whenever the pandemic restrictions and my personal travel funding permitted.

Trust Issues: Particularly with government officials, there were notable trust barriers. In several instances, this led to declined interview requests. To mitigate this,
I adopted a transparent and collaborative approach, ensuring interviewees of the research's academic intent.

**Spatial Data Collection Challenges:** Gathering consistent spatial and quantitative datasets was an uphill task. With the growing trend of spatial data production by public institutions in Turkey, I faced problems in accessing uniform spatial data and associated metadata. Consequently, the spatial data analysis had to accommodate different time periods, depending on data availability. Future researchers are encouraged to tap into more consistent spatial datasets, ideally within similar time intervals, to potentially derive clearer insights.

**Biophysical and Biodiversity Data Limitations:** The research provides a limited lens into changes in biophysical processes and shifts in biodiversity. Changes observed in plant and animal groups were bound by available data and knowledge. Similarly, the examination of agrobiodiversity change leaned heavily on secondary sources and qualitative interviews. While these sources provide a foundation, they undoubtedly offer a more segmented view of the entire picture.

**Quantification of Qualitative Data:** While qualitative data holds immense contextual value, I undertook the challenge of quantifying certain aspects. This approach aimed to bolster the objectivity of the findings. Nevertheless, there's an inherent complexity in translating lived experiences and perceptions into quantifiable metrics.

As the final word, while these limitations presented challenges, they also paved the way for innovation and adaptability in my research approach. I believe it's essential to see them not as decisive limitations but as contexts that shape the research narrative. Future studies can indeed learn from these constraints, adopting refined methodologies and leveraging more comprehensive data sets.
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APPENDICES

A. Ethical Permission of the Research

20 Şubat 2020

Konusu: Değerlendirme Sonucu
Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (IAEK)
İliş: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof. Dr. Ahı ATAOV


Seyaheninize birliklerinde sunarım.

Prof. Dr. Mine MISIRUSOY
Başkan

Prof. Dr. İsmail CAN
Üye

Doç. Dr. Pınar KAYGAN
Üye

Dr. Öğr. Üyesi Ali Emre TURGUT
Üye

Dr. Öğr. Üyesi Şerife SEVİNÇ
Üye

Dr. Öğr. Üyesi Müge GÜNDAZ
Üye

Dr. Öğr. Üyesi Süreyya Özcan KABASAKAL
Üye
### A. GENEL BİLGİLER

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<tr>
<th>Üretici/Kişi</th>
<th>İkamet / Süresi / Nereden</th>
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<th>Yaş / Cinsiyet</th>
<th>Hane halkı Sayısı</th>
<th>Hane geçim kaynakları / tarımsal üretim ek gelirler - hayvan varlığı - bahçe -</th>
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<th>Faaliyet Alanı</th>
<th>Bölgede Faaliyet Süresi</th>
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<th>Uygulamada İhtiyaçlar</th>
<th>Kurdukları İş Birlikleri ve Alanları</th>
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<th>Tanımsal Üretim Biçimi (eko, organik, endüstriyel)</th>
<th>Arazi sahipliği durumu</th>
<th>Arazi büyüklüğü (eklendi/eklenmiyor)</th>
<th>Emek (Aile, İşçi, Bireysel)</th>
<th>Ürün Seçimi ve Nedeni</th>
<th>Üretim biçimi (geçmişten kalma üretim yöntemleri, günümüz pratikleri vb.)</th>
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### B. ÜRETİM AŞAMALARI, YAŞANAN PROBLEMLER, ÇÖZÜMLER

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**Nası?**

Doğum / Hangi üretim yani varır? de棕m adı var, hangi üretim? Ne zaman olur?

Problem / Kaynak! Öne öne çekildir?

Yaşanan problemlere üretilen çözümler

Örgütlenme

Bölgedeki durum, problem, çözümler, örgütlenme

Sorunların çözümü için yapay tablo zikletar?
### C. PROBLEM KAYNAĞI TESPİTLERİ

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<th>Toprak Verimliliği</th>
<th>Çevre Kirliliği</th>
<th>Biyoçeşitlilik Değişimi</th>
<th>Aşırı Doğa Olayları</th>
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### D. TARIMSAL ÖRGÜTLENME

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<th>Kooperatif Birlik</th>
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Problemler / Bulunan Çözüm / Neye İhtiyacı ver

Görev modellinde değişim
## C. List and Characteristics of the Secondary Data and Spatial Data

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<th>Received Data</th>
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**Ministry of Agriculture and Forestry Directorate General of Agricultural Affairs**

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**Ministry of Agriculture and Forestry Directorate General of Agriculture**

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**Ankara Provincial Directorate of Agriculture and Forest**

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** Ankara Provincial Directorate of Agriculture and Forest**

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E. Field Diary from the Qualitative Part of the Research

Initial Phase

At this phase of the research, short visits to the region were held in 2017 and 2019. The visits started with the exploration of Güdül and then the wider bioregion it resides in. This journey starts with volunteering at an international civil society gathering for community-supported agriculture in the Mediterranean Region with the support of URGENCI in 2017. It is an international grass-roots network advocating for a transnational network of regional and local partnerships between producers and consumers (URGENCI, 2021). The event is titled "Learning Journey for Local Solidarity Partnerships for Ankara," and I volunteered with the organization of the three-day event and participated as a stakeholder representing the NGO that focuses on ecological advocacy and rights in rural and urban areas I was working in at the time. Although I take several trips to Beypazar and Güdül, I perceive Ayaş as a transitional location between Ankara and Beypazar and have visited less than two districts.

This event is where my path intersects with Ceyhan Temürcü. Meeting him enabled me to meet the team and efforts behind "the Four Seasons Ecological Life Association" (Four Seasons Ecology) and "the Tahtacörencik Natural Life Collective" (TADYA) based in Güdül. The visits to Güdül as a part of volunteering with the association allowed me to meet farmers and local government officials and understand the context. Moreover, these visits enabled me to locate the region in a wider socio-ecological context and allowed me to visit nearby districts. These visits helped me shape the borders of the case study area. Observations from rural areas and meetings with emerging networks and organizations on agriculture and food-related issues triggered my interest in response mechanics, which emerge as a response to the impacts of change in the landscape.

Being a volunteer in the Four Seasons Ecology enables me to contact other civil society organizations operating in the region based on issues of rural development,
agricultural production, and environmental protection. The Turkey Development Foundation is one of the national institutions that has worked on rural development since 1969. With their support and collaboration with Four Seasons Ecology, I was able to attend a rural policy forum held under the European Union-funded project titled "ALTER: Active Local Territories for Economic Development of Rural Areas" in Bosnia and Herzegovina in 2018. This forum enhanced my knowledge of agricultural systems and economic structures in rural areas, not only in Turkey but also in other southeast European countries.

To gather information and gain insight about agricultural production and organization in both Ankara and the districts under study, I visited the Ankara Provincial Agriculture and Forest Directorate. Through personal contact, an agricultural engineer set up the meeting. I was able to meet with several officers to request data for my petition. Data on agricultural production methods, crop patterns, production, support, and organization covering Ankara and, specifically, Güdül, Beypazar, and Ayaş are requested. In addition to production-related data, socio-economic data, rural development schemes, sectoral data on agriculture and agribusinesses, and spatial data covering land classification, soil capability, and type maps are requested. In response to my petition, I received data on agricultural production for overall Ankara, which is publicly accessible in TurkStat, and a list of numbers of rural development projects without any time reference in Ankara or about the selected districts. The provincial directorate seemed not to be willing to share the detailed data but rather replied to the petition with open-access data from TurkStat, not as detailed as requested. In addition, the institution did not want to share the district-level data and wanted me to send other petitions to district directorates of agriculture. Overall, data on the agricultural production pattern and organizational structure specific to districts could not be obtained at this stage. Rather, open-access qualitative and quantitative data are gathered from the online databases and websites of the institutions, such as TurkSTAT, the Ankara Development Agency, and the Ankara Metropolitan Municipality, to understand the general view of the case study area. The data, such as agricultural statistics on the district and municipal levels and
demographic and economic data on the municipal level, are gathered from the free-access database TurkSTAT. Secondary qualitative data, which covers plans, policies, project regulations, reports, and gray literature, is collected through both desk-based reviews and interviews.

1st Phase Field Study

Even though I've been keeping an eye on the study area since 2018 through short trips to the field and conversations with producers, I did a preliminary field study to prepare for interviews to be done between August 13 and 17, 2020. I made 40 open-ended questions in 5 categories: general socioeconomic and demographic information; general information on types, processes, and changes in agricultural production; environmental changes that affect agricultural production; and agricultural organization. All interviews were recorded with a professional recording machine. Afterward, the recordings were deciphered.

I conducted 13 in-depth interviews with the farmers in the region. I started with the Tahtacörencik village of Güdül because of my familiarity with the farmers in the village. I conducted six interviews in this district. I spent four days in the village, camping in the Süvari Creek Basin. This place was selected because of its closeness to farms and a village, so I could set up interviews with farmers easily and observe and experience the productive landscape. I conducted two interviews in this village. Due to the COVID-19 pandemic, I received rejections from two families in the village. They did not want to interview in an open space either. Also, I received a rejection from another farmer because he feels hopeless about his situation in farming. He replied that an interview on the problems of agricultural production he faces could not change the overall situation. However, I later conducted an interview with his wife at the farmers market in the center of Güdül. During my stay in Güdül, I visited a farmers market that was established with the efforts of local actors such as the Four Seasons Association and Güdül Municipality. In the market, there were farmers from different villages in Güdül who were practicing natural farming. I conducted three interviews in this market and received a rejection from one who did
not want the recording made available. In addition, I conducted one more interview on the phone with a farmer from Güdül after my stay in Güdül.

2nd Phase Field Study

The second phase of the field study consists of two field trips in the region between July 13 and 14, 2021, and September 6 and 9, 2021. In addition, a period of phone interviews continued between those two trips. In this phase, similar interview questions were used but reorganized to get more clear and sequential answers.

13–14 July, 2021

On July 13, I arrived at Güdül Center by taking Kızıleahamam road from the northwestern part of Ankara. This road leaves Güdül and follows the Kirmir Creek valley to the center of Güdül. The first stop in the Güdül center was the office of the Güdül Local Action Group Association. The EU Leader Framework was the driving force behind this association. A personal contact who is an officer in the association agreed to an interview, but it was held online due to time constraints. However, she and her coworker, who also has a seat in Güdül Municipality, helped me with giving contacts for associations and cooperatives in Güdül and the assistant mayor in Beypazarı. I got contacts from associations and cooperatives in the region to conduct interviews. I interviewed the mukhtar of the Yeşilöz neighborhood and the head of the Chamber of Agriculture in Güdül. The head of the Chamber of Agriculture is also a farmer and interviewing him gave me insights about the picture of agricultural production in Güdül along with his personal experiences and problems in agricultural production. After central Güdül, I visited Yeşilöz neighborhood to conduct one more interview with a farmer who is the former mayor of the region.

On the next day (July 14, 2021), I visited Beypazarı Municipality, Beypazarı Horticulture Producers Cooperative, Beypazarı District Directorate of Agriculture. An interview with the Horticulture Cooperative was conducted in their office in central Beypazarı. A farmer and board member of the cooperative joined the interview. It was an informative interview on the problems of producers in
Beypazarı. On the same day, I interviewed the directors of both Akkaya Cooperative and Akkaya Tomato Paste Factory. This case represents a women-oriented chain of initiatives and represents one of the best practices in the study region.

**Online or phone interviews during July 29–30 and August 1, 2021**

Three interviews were held by phone with the directors of Ilıca Cooperative/Farmer, director Cooperative/Mukhtar, and Boyalı Women Cooperative/Mukhtar. A Zoom interview was conducted with the Güdül Local Action Group Association on August 1, 2021.

**6–9 September, 2021**

The second part of the field study started at METU. I held two interviews here. Ceyhan Temürcü, as the representative of the Four Seasons Ecological Life Association and Tahtacıörencek Natural Life Collective Both initiatives are based in the Tahtacıörencek neighborhood or village in Güdül. The interview was held in the house of Ceyhan and Nihal Temürcü in METU housing estates. We tried to fit the schedule for an interview during the day. The interview lasted almost an hour, more in an idea-sharing way. Afterwards, I visited an officer in the Faculty of Architecture at METU who is from Güdül and whose contact information I got through personal contact. I got an appointment from him through a personal contact, and we agreed on a date. On the interview date, after not receiving an answer from his phone, I visited his office directly. I found him in the office, and he agreed to the interview. Rather than starting in some unpleasant way, the interview was very informative, and the interviewee enjoyed narrating his agricultural production experiences. The interview lasted almost an hour. He offered the grapes he produced in his village in Güdül, and he was very proud of them. At the end of the interview, he gave me the contact information of his relative, who is the director of the District Directorate of Agriculture and Forestry in Güdül.

On the second day, on September 7, 2021, in the morning, I met with the head of the Ankara City Council Rural Working Group in the Gençlik Park in central Ankara,
where City Council is based. This working group was established in 2019 after the local elections and aims to be an umbrella initiative among people, mukhtars, civil society organizations, and cooperatives working for rural Ankara. I am a member of the working group through my civil society background and my research activities. The aim of the interview is to reveal the problems of the rural part of Ankara, where this present study focuses, from the perspective of a municipal-level actor and intermediary between local government and civil society. He shared the contact information of the head of Mukhtar Associations in Beypazarı and an officer in the Rural Services department of Ankara Metropolitan Municipality. In the afternoon, I visited Güdül for an interview with the director of the district Directorate of Agriculture and Forestry, Hüseyin Tanrıseven in this office in Central Güdül. He was helpful with the questions and explained the context of the district clearly. After Güdül, I visited Beypazarı District Directorate of Agriculture and Forestry. I received the director’s number from Beypazarı Municipality. However, due to time limitations, I could not visit her in the office. During August 2021, I tried to get an appointment for an online or phone interview after sending research permits and information on the research and research questions. At the end, the director suggested an officer and gave his contact details. The phone interview with the officer was awkward. Several times, he stated that the questions I asked were confidential, and he refused to answer on the phone. He suggested meeting face-to-face. Thus, on September 7, I visited his office. He still refused to give a voice recording but allowed me to take notes. He was also coming from a farmer family that still produces, and his insights on the context and problems of Beypazarı was very helpful.

On the third day, September 8th, I revisited Beypazarı for a meeting with the Director of the Association of Mukhtars in Beypazarı. He left agriculture and is currently dealing with trading. He gives information about different neighborhoods in Beypazarı. In the afternoon, I visited the farmers market and central bazaar in Beypazarı. I interviewed a small-scale farmer in the bazaar.
On September 9th, I visited Ayaş to meet with the head of the Chamber of Agriculture. By change, the Director of the District Directorate of Agriculture and Forestry and another person whose personal details do not exist were in the office. They answered the questions together, and the interview lasted 75 minutes. It was a very informative interview in the context of Ayaş. In the afternoon, I visited a farmer and also the mukhtar of Güneyce Neighbourhood of Güdül, which is very close to Ayaş Center geographically. It was an interview on the corn farm, where Afghan workers were preparing the land for cultivation. It was not an effective interview in general. On the last day, September 10th, I visited the Rural Services Department of Ankara Metropolitan Municipality. The officer was helpful in explaining municipal schemes in rural areas, a project about agricultural production and marketing of local products, and the activities of the agriculture campus of the municipality established in Gölbaşı. The interview was not recorded, but notes were taken.

A meeting was requested with the Directorate of Urban Planning of the Ankara Metropolitan Municipality. This interview was intended to grasp the approaches of the metropolitan municipality towards the planning and management of rural areas and agricultural resources. However, the municipality declined the interview request but provided answers to some of the interview questions along with the requested data. In addition, an interview with the urban planner in Beypazarı Municipality was intended. However, the only urban planner in the municipality resigned during the period of field study, and as a result, an interview was not realized.

During field visits in the region, I traveled across several village and district centers, followed river streams, visited fields and valleys, and camped in the region during the nights. The taste of the water flowing in the river, the taste of tomatoes, peppers, and fruits collected directly from the fields, the sound of the weasels during the evening, the warmth of the fire, and tea cooked in the farmer’s black tea pot over the fire enabled me to understand the producer’s life and productive landscape with their natural and productive dimensions. Out of interview periods, I visited the region during the winter several times for association purposes, visited village halls, producer houses, and villager houses, but did not conduct interviews.
CURRICULUM VITAE

PERSONAL INFORMATION

EDUCATION

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<tr>
<th>Degree</th>
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<th>Year of Graduation</th>
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<tr>
<td>MS</td>
<td>Cardiff University, European Spatial Planning and Environmental Policy</td>
<td>2014</td>
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<tr>
<td>MS</td>
<td>Radboud University, Social and Political Sciences of the Environment</td>
<td>2014</td>
</tr>
<tr>
<td>BS</td>
<td>METU, City and Regional Planning</td>
<td>2011</td>
</tr>
<tr>
<td>High School</td>
<td>Buca Anadolu High School, İzmir</td>
<td>2004</td>
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WORK EXPERIENCE

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<tr>
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<tr>
<td>2022-Present</td>
<td>Parabol Software</td>
<td>Urban Planner/Project Expert</td>
</tr>
<tr>
<td>2020-2022</td>
<td>Izmir Institute of Technology</td>
<td>Research Assistant</td>
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<tr>
<td>2019-2020</td>
<td>EPRA Energy</td>
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<td>2017-2018</td>
<td>Ecology Collective Association</td>
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<tr>
<td>2013-2014</td>
<td>Sustaianble Places Research Institute</td>
<td>Researcher</td>
</tr>
<tr>
<td>2011-2012</td>
<td>Hilmi Oğuz Aldan Planning Bureau</td>
<td>Urban Planner</td>
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FOREIGN LANGUAGES

Advanced English, Beginner German

PUBLICATIONS / PROCEEDINGS


480