WATER SCARCITY PERCEPTIONS OF FARMERS AND ADOPTION OF DRIP IRRIGATION: A CASE STUDY ON KÜÇÜK MENDERES RIVER BASIN

by
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ABSTRACT

WATER SCARCITY PERCEPTIONS OF FARMERS AND ADOPTION OF DRIP IRRIGATION: A CASE STUDY ON KÜÇÜK MENDERES RIVER BASIN

This thesis examines the factors explaining the limited uptake of drip irrigation among farmers in the Küçük Menderes River Basin, specifically in the districts of Tire, Ödemiş, and Bayındır. Despite the basin's vulnerability to water scarcity and climate change, drip irrigation has not been widely embraced, particularly for silage maize. The objective of this study was to understand which individual and contextual/institutional factors are contributing to the unwillingness of farmers towards adopting drip irrigation for silage maize production in the basin. To answer this question, I conducted face-to-face surveys and follow-up in-depth interviews with 43 farmers in the basin (36 small-scale and seven medium to large-scale), as well as six in-depth interviews with the representatives of the relevant government authorities responsible for agriculture. Findings indicate that small, medium, and large-scale farmers do not prefer drip irrigation for silage maize production irrespective of their individual characteristics in the basin. This reluctance can be attributed to their belief that drip irrigation technology is not effective especially for silage maize, insufficiency of government support and/or their inability to benefit from these supports, and high costs of labor associated with drip irrigation. Moreover, biophysical factors such as precipitation and soil characteristics, as well as traditional agricultural knowledge (e.g. crop rotation) enable farmers to address water scarcity in the basin. The study suggests that a one-size-fits-all-approach for the adoption of drip irrigation may hinder a deeper understanding of local needs and knowledge and may be unproductive for coping with water scarcity.

ÖZET

ÇİFTÇİLERİN SU KITLIĞI ALGISI VE DAMLA SULAMANIN BENİMSENMESİ: KÜÇÜK MENDERES HAVZASI ÜZERİNE BİR VAKA ÇALIŞMASI

Bu tez çalışması, Küçük Menderes Havzası'nda özellikle Tire, Ödemiş ve Bayındır ilçelerinde çiftçiler arasında damla sulama teknolojisinin sınırlı kullanımını açıklayan belirleyicilere odaklanmaktadır. Bölgenin su kıtlığına karşı savunmasızlığı ve iklim değişikliğine karşı yüksek duyarlılığına rağmen, özellikle silajlık mısır üretiminde damla sulamanın geniş çapta benimsenmediği gözlemlenmektedir. Bu çalışmanın temel amacı, çiftçilerin havzada silajlık mısır üretimi için damla sulamayı benimsemeye karşı gösterdikleri direncin arkasındaki bireysel ve bağlamsal/kurumsal faktörleri anlamaktır. Bu soruyu yanıtlamak için, havzadaki 43 çiftçiyle (36 küçük ölçekli ve yedi orta/büyük ölçekli) yüz yüze anketler yapıldı ve derinlemesine görüşmeler gerçekleştirildi. Ayrıca, bölgede tarımsal üretimden sorumlu 6 ilgili devlet kurumunun temsilcileri ile derinlemesine görüşmeler yapıldı. Bulgular, havzadaki küçük, orta ve büyük ölçekli çiftçilerin, bireysel özelliklerine bakılmaksızın silajlık mısır üretimi için damla sulamayı tercih etmediklerini ortaya koymaktadır. Bu isteksizlik, çiftçilerin damla sulama teknolojisinin özellikle silajlık mısır için etkili olmadığı inancına, devlet desteğinin yetersizliğine ve/veya bu desteklerden faydalanamamalarına, ayrıca damla sulama ile ilişkilendirilen yüksek işgücü maliyetlerine bağlanabilir. Ayrıca, yağış ve toprak özellikleri gibi biyofiziksel faktörler ile geleneksel tarım bilgisi (örneğin, ekim nöbeti), çiftçilere havzadaki su kıtlığıyla başa çıkma konusunda yardımcı olmaktadır. Çalışma, damla sulamanın benimsenmesi için tek bir yaklaşımın, yerel ihtiyaçlar ve bilgiye daha derin bir anlayış kazanmayı engelleyebileceğini ve su kıtlığıyla başa çıkma konusunda etkisiz olabileceğini öne sürmektedir.

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LIST OF SYMBOLS/ABBREVIATIONS

DSİ	General Directorate of State Hydraulic Works
FAO	Food and Agriculture Organization
IPCC	International Panel on Climate Change
SKD Türkiye	İş Dünyası ve Sürdürülebilir Kalkınma Derneği
TAGEM	General Directorate of Agricultural Research and Policies
TBB	Türkiye Bankalar Birliği
TEMA	The Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats
TURKSTAT	Turkish Statistical Institute
UNESCO	United Nations Educational, Scientific and Cultural Organization
WWF	World Wild Foundation

1. INTRODUCTION

Increasing consumption and uneven distribution of water resources, industrialization, climate change, water quality problems and inefficient usage patterns increase global and local water-related problems (Cassardo and Jones, 2011). Groundwater depletion, for instance, has been accelerating since the early 2000s and this depletion is mostly caused by the extraction of groundwater for irrigation purposes in agricultural regions located in arid areas (IPCC, 2023). Moreover, forecasts based on climate change projections suggest that global water scarcity problems will affect most of the human population by 2025 (Ungureanu et al., 2020). Climate change exacerbates this problem, significantly inducing changes in the water cycle, contributing to extreme weather events such as floods and droughts (SKD Türkiye and Ankara Üniversitesi Su Yönetimi Enstitüsü, 2023). However, water scarcity does not solely stem from environmental impacts but also emerges from socio-cultural and institutional factors (Leroy, 2019).

In this context, water scarcity and water-efficient agriculture practices are receiving scientific attention with significant implications for the economy, the environment, and the society (Hertel and Liu, 2016). The pressing need to address water scarcity and ensure the long-term sustainability of agricultural output has led to the increased use of more efficient new technologies such as drip irrigation (Taylor and Zilberman, 2017). Drip irrigation has several benefits such as supporting plant growth, crop yield, and water use efficiency (Liu et al., 2023). Nevertheless, these benefits do not always imply that drip irrigation is widely adopted by farmers. Globally, drip irrigation is adopted by only a small share of farmers, and this is especially true for the developing countries of the Global South (Garb and Friedlander, 2014). Socio-economic, institutional, technological, and cultural factors do have an important impact regarding the farmers' decision whether to adopt drip irrigation.

The Küçük Menderes River Basin, located in the Aegean Region of Turkey, primarily encompassing the provinces of İzmir, Aydın and Manisa, presents a significant example of an agricultural landscape with increasing rates of water scarcity and climate change vulnerability (Su Yönetimi Genel Müdürlüğü, 2018a). Agriculture is the most important source of income in the basin and the main agricultural products grown in the basin are silage maize, tomatoes, and seedless grapes, irrigated mainly by ground water as a general practice in the region. Livestock production is also rising (Ödemiş Belediyesi, 2022), and this is mainly done in combination with silage maize production in the region (Pilevneli et al., 2023). However, drip irrigation is not widespread in the

basin, especially, it is rarely used for growing silage maize, even though drip irrigation is said to improve water use efficiency, potentially saving costs for farmers (SKD Türkiye and Ankara Üniversitesi Su Yönetimi Enstitüsü, 2023). As such, the Küçük Menderes River Basin presents an interesting case for investigating the individual as well as the broader contextual and institutional factors regarding the (non) adoption of drip irrigation and farmers' perceptions of water scarcity.

Recognizing the specific conditions faced by local farmers is of greatest importance for facilitating the adoption of new irrigation methods and enhancing farmers' understanding of potential climate change risks (Pilevneli et al., 2023). Therefore, the main objective of this thesis is to explore the water scarcity perceptions and individual and institutional factors affecting the adoption of drip irrigation among farmers in the Küçük Menderes River Basin, especially in the villages of Ödemiş, Tire and Bayındır located in İzmir, where silage maize production for livestock activities is widespread. The shift to drip irrigation is also seen as a must by policymakers to address water scarcity in the basin to save water for the future of agriculture in the basin. More specifically, I aim to understand why drip irrigation is not widely adopted in the basin for growing silage maize, despite its proposed benefits in the literature. I hypothesized that this may be related with farmers' individual-level characteristics such age and education as suggested by the Diffusion of Innovation literature (Rogers, 2003), as well as broader structural and contextual factors such as agricultural support systems, infrastructure, governmental subsidies, the structure of the social system and communication channels, the availability of information and advisory services and agricultural policies, that is implied by the Technology Translation concept suggested by Garb and Friedlander (2014). I investigated this question by carrying out surveys and in-depth interviews with a total of 43 farmers (36 small-scale, two medium scale and five industrial farmers) and six representatives from local governmental authorities responsible for agriculture in the basin. I analyzed the responses both qualitatively and quantitatively, first by categorizing the responses provided to the in-depth interviews into key themes and then analyzing the survey responses using exploratory descriptive statistics. This enabled me to uncover and identify individual and institutional/contextual factors shaping farmers' decisions regarding the complexities surrounding drip irrigation technology adoption in the Küçük Menderes River Basin, offering insights for future interventions and policies to enhance drip irrigation uptake. The findings revealed that for the small-scale farmers in the basin, non-adoption of drip irrigation may be in fact more feasible and even desirable, given that small-scale farmers are already adopting other types of drought management techniques such as crop rotation, thanks to their traditional agricultural knowledge transmitted across generations. As such, farmers are aware that water scarcity may be a problem in the future, however, currently they cannot afford

switching to any new types of technology, as drip irrigation is often associated with higher initial and maintenance costs and require a lot of labor input. The traditional way of doing agriculture integrated with livestock breeding and crop rotation which basically provides at least three different crops per year just enables the small-scale farmers to make ends meet in these marginal areas that they do agriculture on. As such, this study suggests that biophysical characteristics of the agricultural land (fertile lands and sufficient precipitation to enable rain-fed farming and growing of field crops) as well as type of agriculture (mainly small-scale, traditional, and resilient to climate change and other shocks) need to be considered by policymakers, tailoring irrigation-related decisions and planning to the local needs and conditions. Therefore, the study contributes to the Diffusion of Innovation and Technology Translation literatures by demonstrating that low-input, small-scale agriculture carried out in specific regions of the Global South relying on traditional knowledge may be innovative enough for addressing water scarcity and climate change, and therefore, a top-down, one-size-fits-all type of adoption may not be productive at all from the perspective of both farmers and water conservation. Therefore, there must be more nuanced ways of including small-scale, low-input farmers into decision-making regarding which types of irrigation techniques to be supported by governmental subsidies, for instance. Furthermore, this study highlights the need for site/basin specific local policies, tailored to the physical, social, and political background and specific needs of the region.

The following section (Section 2) discusses the relevant literature on water scarcity in agriculture and the relevance of drip irrigation as a water saving technology, the theoretical frameworks explaining technology adoption and dissemination as well as the different determinants of drip irrigation for saving water. Section 3 provides a detailed summary regarding the characteristics of the study area, namely, the Küçük Menderes River Basin, after which, Section 4 presents the findings of the surveys with farmers and in-depth interviews. Section 5 discusses these findings considering the technology adoption literature, more specifically, in terms of diffusion of innovation versus technology translation approaches, and Section 6 concludes the study and provides some avenues for future research.

2. LITERATURE REVIEW

2.1. Water Scarcity and Agriculture

The issue of water scarcity has become a significant burden for local communities worldwide, especially considering climate change (Leroy, 2019). Water scarcity refers to a situation when there is not enough water available to meet the demands of a certain location, such as a country, region, watershed, or irrigation scheme (Johnson et al., 2023). This occurs when the available water resources are not able to sustain the continuous and average needs and is worsened by demands that exceed the natural capacity of the system (Łabędzki, 2016).

Based on climate change forecasts, it is projected that most of the human population will experience water scarcity by the year 2025 (Ungureanu et al., 2020). Water scarcity has been characterised as an outcome that arises not solely from environmental factors, such as decreased precipitation, but also from socio-cultural and institutional factors (Leroy, 2019). The primary characteristics of water scarcity encompass water demand that cannot be met, competition for water resources, conflicts among water users, excessive groundwater extraction, and reduced water flow (Johnson et al., 2023).

Water scarcity is closely related with the issues of accessibility, distribution, and supply of water resources (Łabędzki, 2016). It is frequently attributed to various factors such as population growth, climate change, water contamination and inadequacies in water management. Water scarcity is a challenging global issue that carries significant consequences across multiple sectors. Especially in the agricultural sector, predicting plant water needs and development potential is crucial for predicting irrigation water requirements, preventing overuse, and promoting plant growth (Liu et al., 2023).

Over the past four decades, there has been a consistent yearly growth rate of around 1% in worldwide water use, and this trend is expected to continue until 2050 (UNESCO World Water Assessment Program, 2023). The main drivers of this increase are population growth, socio-economic progress, and changes in consumer patterns. Agriculture is the primary sector consuming water. Water withdrawal rates around the world are 69% for agriculture, 12% for cities, and 19% for industry (FAO, n.d.). However, in certain underdeveloped countries, this percentage can be as high as 95%

(FAO, 2017). Groundwater depletion has been rising since the early 2000s and this depletion is mostly caused by the extraction of groundwater for irrigation purposes in agricultural regions located in arid areas (IPCC, 2023).

Irrigation is an efficient way of supplying plants with the necessary water for their growth. The productivity of plants is greatly influenced by the quantity of water accessible and can be utilized during specific time intervals (Süheri et al., 2019). Hence, it is evident that agriculture is the most water-intensive industry, thereby making a significant contribution to the scarcity of freshwater (Ingrao et al., 2023).

Agricultural activities can be broadly classified into two primary categories: irrigated agriculture, which entails the regulated supply of water via artificial methods, and rainfed agriculture, which relies primarily on natural rainfall for crop irrigation. Irrigated agriculture relies on the utilization of both groundwater and surface water sourced from streams and rivers (Taft, 2015). Rainfed agriculture depends only on natural precipitation, which has a big impact on when and how much water is available for irrigation of crops during the growing season. Irrigated agriculture is typically more resistant to temporary drought compared to rainfed agriculture; however, it is also especially vulnerable due to its dependence on an external water supply (Winter et al., 2017). Per unit of land, irrigated agriculture is at least twice as efficient as rain-fed agriculture on average (Kibele Projekt, 2021). In irrigated agriculture, water sources can be obtained from surface water such as lakes, rivers, and reservoirs, as well as from underground sources like wells and aquifers. In numerous significant agricultural regions, groundwater is the primary source of freshwater once surface water sources have been exhausted (Siebert et al., 2010).

Agriculture is especially sensitive to and deeply affected by water scarcity and is unique in that it is both a major contributor to water scarcity and a sector that is sensitive to its worst consequences. Agriculture necessitates water for the purpose of irrigation, livestock, and conducting other agricultural activities. Water scarcity greatly restricts production of crops in terms of agriculture; it is crucial to address the issue of water availability and accessibility in places affected by this problem (Mancosu et al., 2015).

The balance between the increasing need for water and the adequacy of water resources has become increasingly critical in many regions worldwide, underscoring the undeniable importance of effective and sustainable management of water resources in agriculture (Mancosu et al., 2015).

Utilising water for irrigation depends on many important factors, such as the simplicity to get water for irrigation, changes in temperature, population density, the local economy, and the quality of the groundwater (Taft, 2015).

To effectively deal with water scarcity related with agriculture, it is important to understand how farmers make decisions regarding employing efficient irrigation methods like drip irrigation and how they are responding to water scarcity. In this respect, farmers' perceptions for water availability play a crucial role. According to the study of Sarku (2023) in Ghana, for instance, the perceived severity of water availability influences farmers' response methods, including crop selection, timing of planting, irrigation strategies, and other agricultural activities, highlighting the importance of diverse methods for implementing sustainable water management solutions. Similarly studying the rural perceptions of water scarcity, Singh et al. (2018) found that geographical factors such as location, farmers' income, access to wells and communal water bodies, and demographic factors including age, gender, and caste, interact to influence the perception of water scarcity.

2.2. Water Scarcity and Agriculture in Turkey

The relation between agriculture and water scarcity has become a major problem because of the need to ensure to the effects of climate change and the growth of the population. According to data presented by the World Bank in 2020, 87% of the total fresh water used in Turkey is allocated for agricultural purposes. Turkey receives an annual average precipitation of 643 mm, equivalent to a yearly water volume of 501 billion m³ (Bobat, 2019). Turkey's yearly water potential is 234 billion m³, however, technological and economic constraints limit its useable capacity to 112 billion m³: 95 billion m³ is extracted from surface water resources, 3 billion m³ from neighboring countries, and 14 billion m³ from groundwater (Bobat, 2019). With the population increase, availability of water resources decreased from 4000 m^3 per capita in 1960 to 1640 m^3 in 2020 (Bobat, 2019; Kibele Projekt, 2021), which implies that Turkey is becoming a water-stressed country, as its per capita water supply is below 1700 m^3 (Kibele Projekt, 2021).

Long-term averages of the the mean temperature is 13,5°C and evaporation is 1173 mm in Turkey (Topçu et al., 2019). In addition to the scarcity of rainfall, evapotranspiration rates are elevated as a result of the prevalent high temperatures experienced during the summer months (ibid). The Marmara, Kücük Menderes, and Asi Basins have a per-capita water availability of less than 1000

m^3, and these basins are facing significant water stress in terms of both the amount and quality of water (ibid).

Around 54% of Turkey's land is made up of natural areas, mainly transitional woodland and shrubs, with the remaining 42% being used for agriculture. The agricultural areas encompass a variety of land types, including non-irrigated and irrigated arable land, agriculture with natural vegetation, and intricate cultivation patterns. The total cultivable land is approximately 28 million hectares, with 25.85 million hectares being suitable for irrigation (Topçu et al., 2019).

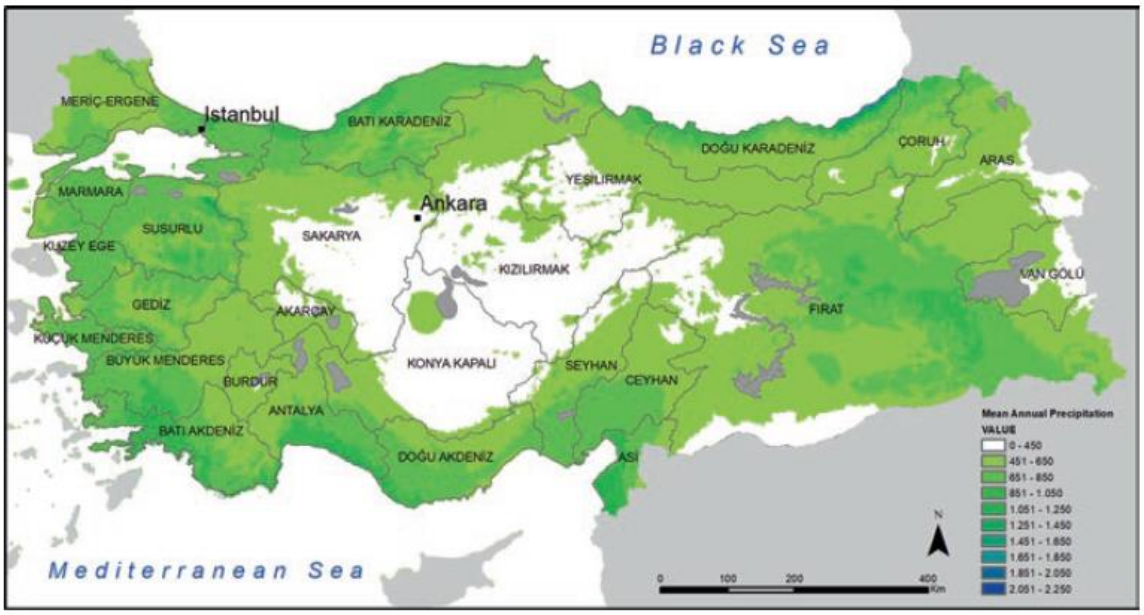


Figure 2.1. Mean annual precipitation across Turkey's river basins (Topçu et al., 2019)

Due to the unpredictable and inconsistent pattern of rainfall, Turkey mostly relies on irrigated agriculture with the Eastern Black Sea Region being the only exception (Topçu, 2011). Approximately 70% of the country's annual rainfall takes place during the period from October to March, nevertheless, the precipitation throughout the summer months is inadequate to sustain agricultural cultivation (ibid). Presently, around 75 to 80% of Turkey's cultivable land is being irrigated through the utilization of surface water, while the remaining 20 to 25% is being irrigated utilizing groundwater. Although Turkey does not have abundant water resources, the cost of irrigation water is comparatively low, resulting in the overuse of water in agriculture (Büyükcangaz et al., 2007). Government subsidies for pressurized irrigation (such as drip irrigation and sprinkler systems) and micro irrigation systems are therefore seen as crucial for improving water efficiency (ibid). However, irrigation practices in Turkey typically rely on surface irrigation techniques, employing

traditional open channel systems or elevated canals (ibid). Open canals, which comprise the majority of Turkey's irrigation infrastructure, are unsuitable for drip or sprinkler systems due to the pressure required to convey water from the canals to the fields (Kibaroğlu, 2022).

2.3. Adaptation to Climate Change and Water Scarcity

With the decrease in water availability, agricultural adaptation to climate change started to come to the fore more among farmers, including smallholders. Agricultural climate change adaptation refers to adjustments made to the agricultural system in response to the existing or future climate change effects, with the goal of reducing climate change vulnerability (Gramig et al., 2013). Adaptation alternatives at the farm level, such as better irrigation scheduling, crop mix changes, new crop varieties, and improved irrigation efficiency through pressurized irrigation systems, appear to play a key role in adaptation (Leclère et al., 2013). However, in addition to technological investments into effective irrigation strategies (e.g drip, sprinkler, micro-irrigation), ecosystem-based techniques, which integrate biodiversity, sustainable land management and ecosystem services, can help mitigate and adapt to climate change by restoring ecosystem functioning in farmlands (Munroe et al., 2012, UNEP, 2019). This approach aims to replace external and inorganic inputs with natural ecosystem processes like prolonged fallow periods, green manures, crop rotations, intercropping, increased crop and animal diversity, and pest control by natural predators to address water scarcity as well as climate change (Chappell and LaValle, 2011). Benefits of ecosystem-based adaptation strategies include the storage of carbon, the preservation of biodiversity, the assurance of water availability, the prevention of erosion, the rehabilitation of land, and improvements in food provision (Shah et al., 2019).

Agroecological strategies are closely linked to ecosystem-based approaches. These include integrated pest control, organic farming, conservation agriculture (crop rotations, composting, cover cropping), regenerative agriculture, and sustainable intensification (Nicholls et al., 2016; Melece and Shena, 2020). Moreover, the presence of a wide range of agricultural varieties and the associated traditional agricultural knowledge are essential in strengthening the ability to adapt to climate change. For example, Altieri et al. (2015) suggest that farmers facing harsh environmental conditions have developed intricate farming systems over centuries to adapt to extreme weather events and climatic variations.

2.4. Drip Irrigation in Turkey

Adoption of drip irrigation receives a lot of public attention worlwide. Governmental policies in developing countries emphasize that there is need to shift to this technology to conserve water, often without a reference to other agroecological practices that could be equally important and perhaps even more practical and profitable for smallholders, the main producer type in develoing countries.

Drip irrigation is seen as one of the promising technologies offering advantages such as enhancements in plant growth measures, crop yield, and water use efficiency (Liu et al., 2023). For example, in terms of efficiency, furrow irrigation has an application rate of around 60-80%, while micro-irrigation methods such as drip irrigation exhibit a substantially greater efficiency of 80-95% (Hillel and Hatfield, 2004). For instance, Chadran and Surendan (2016) found that drip irrigation brought about yield improvements for arecanut, coconut, and nutmeg ranging from 13% to 47% compared to surface irrigation in Kerala, India. However, despite its advantages, drip irrigation method is implemented at a mere 4% globally (Friedlander et al., 2013). In Turkey, its adoption rate has increased from 1% in 2006 to 17% in 2021(Tarım ve Orman Dergisi, 2021).

The implementation of drip irrigation requires the examination of numerous biophysical factors such as the temperature, water sources, pH, salinity, presence of sunlight, land slope, and soil characteristics. The soil type determines wetting patterns, affecting the depth, and spacing of drip tapes, as well as determining the duration and frequency of irrigation. Comprehending the soil wetting pattern and its movement is crucial for determining the optimal depth and spacing of pipes, formulating irrigation schedules, and improving the overall effectiveness of the drip irrigation system (Kareem et al., 2013). In water scarce areas, it is crucial to understand soil charactertics and water levels to achieve higher crop yields (Tüfekçi and Kuşçu, 2021). The sole application of drip irrigation may not contribute to an increase in yield; correct implementation, as with all other technologies, is a crucial factor in drip irrigation.

The results of several studies regarding the efficiency of drip irrigation for cultivating maize are inconclusive. Due to its high initial installation costs, Bozkurt et al. (2006) suggested that drip irrigation may be economically unfeasible for field crops like maize. However, there are other studies stating that improving dripline lateral spacing can lower the high investment costs of drip irrigation, especially for maize (F. R. Lamm et al., 1997; Bozkurt et al., 2006). A recent research project carried out in Kırıkkale province, Turkey, found that implementing drip irrigation in the cultivation of wheat

and silage maize led to conservation of water and enhanced crop productivity. The drip irrigation system yielded a 20% to 23% higher crop output in comparison to conventional irrigation techniques such as furrow or flood irrigation (SKD Türkiye and Ankara Üniversitesi Su Yönetimi Enstitüsü, 2023). The Sustainable Land Management and Climate-Friendly Agriculture Project, implemented by FAO and the Ministry of Agriculture and Forestry of the Republic of Turkey, implemented drip irrigation systems in 28 locations in the Konya and Karaman regions between 2019 and 2020 (FAO and Tarım ve Orman Bakanlığı, 2021). These systems were specifically introduced for the cultivation of sugar beet and maize. Specifically, they resulted in a 25.5% of reduction in water use and 20.1% reduction in the electricity usage in silage maize. Additionally, drip irrigation led to significant yield improvements of 32.9% in silage maize. The study also found that the adoption decisions of farmers about agricultural technology depended on their socio-economic conditions and the effectiveness of institutions.

Aydın et al., (2020) studied the effects of drip irrigation supports on silage maize production in Edirne. The producers in Edirne province who were receiving drip irrigation subsidies built their irrigation systems in accordance with the plan created by authorized technical personnel and this allowed them to use the water sources more efficiently. Therefore, the study argued that a correctly configured drip irrigation system can be much more effective. Because of that, the yield of the producers who received assistance in growing silage maize was higher than the yield of the producers who did not. Similarly, Yaman and Karataş (2021) conducted a study with 52 farmers who are members of the Turkey Agricultural Credit Cooperatives İzmir Regional Union. The study examined the difficulties faced when operating drip irrigation systems that were set up using cooperative loans. The findings suggested that the main issues faced during the operation of irrigation systems are predominantly attributed to physical deterioration and blockages. Furthermore, the study unveiled that poor water quality and failure to maintain filters might cause obstructions, ultimately leading to water depletion. The study demonstrated the necessity to audit these systems post-installation in terms of the proper utilization of drip irrigation support provided by cooperatives or the government. However, public and private institutions, such as agriculture and water ministries, watershed authorities, irrigation organizations, water users and farmer associations often lack the necessary environment and capacity for effective functioning (Kibele Projekt, 2021). Therefore, the study highlighted that the implementation of drip irrigation alone cannot always ensure improved yields and water consumption reduction; it is also crucial to consider the conditions regarding how farmers implement this practice.

Another study conducted by Yılmaz et al. (2022) investigated the farmers' knowledge levels and opinions regarding drip irrigation subsidies within the scope of *Supporting Individual Irrigation Systems within the Scope of Rural Development Supports* in the provinces of Adana and Niğde. The study included 26 farmers who implemented drip irrigation techniques with subsidies and a comparative analysis was performed by surveying an equal number of farmers who did not get subsidies. The study found that an increased number of household size, a greater amount of irrigated land, and a higher level of education considerably enhanced the probability of favorable outcomes arising from subsidies. The study by İpekçioğlu et al. (2022) examined the perspectives of 50 farmers in Şanlıurfa and Mardin provinces who received drip irrigation subsidies under Rural Development Supports. Accordingly, while participants expressed their desire for an increase in subsidy amounts and the expansion of support topics, they acknowledged bureaucratic challenges such as the difficulty of paperwork. Finally, a study specifically on the Aegean region by Öcalan (2009) found that 16.8% of producers utilizing pressurized irrigation systems suggest that the government should provide these systems for free due to their high costs and 70.6% proposed that the government should offer credit incentives for acquiring the system, reduce energy costs, or cover half of the expenses.

2.5. Technology Transfer, Diffusion and Translation Literature

How new technologies and innovations emerge and are transferred to different actors and regions has received substantial attention in the literature such as Science and Technology Studies and agricultural systems. Initially, this literature mainly referred to “technology transfer”, in form of a linear and rather passive process, where the recipients were to be educated about the benefits and technical details of a new technology, upon which they would become willing to adopt this technology. This tradition also gave rise to the “Diffusion of Innovation” theory by Rogers which was quite popular in the 1960s and 70s (Rogers, 2003). The main factors considered in this strand of literature was individual costs and benefits of adoption, adoption channels and networks, and barriers of adoption (Garb and Friedlander, 2014). However, the theory of diffusion of innovation was criticized later, due to its disregard for historical, contextual, and political context. The theory also was seen as weak, as it only considered technology as a static concept emerging in the core of the developed countries, and to be adopted by the countries in the periphery, that is by the “grateful adopters” who had not been aware about the benefits of this technology or were unable to adopt it because of some market-related barriers (ibid). In terms of agricultural research, diffusion of innovation was mainly conceptualized as a passive and linear transmission of new innovations from

public research organizations via extension workers to the end users, namely, the farmers and peasants.

The Innovation Systems approach, on the other hand, gave rise to a bidirectional understanding of the technology creation and dissemination between the developers and the end users, with a specific emphasis on the dynamics of the socio-economic and cultural context. This approach therefore did not only pay attention to the individual level factors of adoption or non-adoption but started to address the more systemic factors of adoption and migration of a new technology, by considering the technology as something dynamic, changing and evolving when migrating among contexts. Technology in this perspective is therefore seen as receiving “new meanings, advantages, costs and applications” in different contexts (Garb and Friedlander, 2014).

Diffusion of Innovation theory defined diffusion as “the process by which an innovation is communicated through certain channels over time among the members of a social system” (Rogers 2003, p5) by identifying four essential components in the diffusion process: innovation, channels of communication, time, and social systems. Within this perspective, Alcon et al. (2019) defined "adoption" as an individual's acceptance of an innovation, whereas "diffusion" referred to the process of technology acceptance by the members of a social system. Accordingly, farmers' adoption or rejection of a new technology depended on the duration of the decision-making process, uncertainties surrounding the proposed innovation, formal and informal information gathered about its effectiveness, the credibility of the information sources, as well as the characteristics and background of the farmers (Alcon et al., 2019). However, most of these factors are related with the individual characteristics of the farmers. For drip irrigation, this implies that agricultural professionals or innovative leading farmers aiming at water savings and improved productivity would be the first ones the adopt drip irrigation. As they use this technology, other farmers would see its success, and the adoption level would eventually rise. After then, drip irrigation technology would spread throughout multiple user groups in time.

Yet, in many instances, especially in case studies on farmers in developing countries, we observe that this linear understanding is not sufficient to understand the non-adoption of drip irrigation. One specific study comparing the cases of Israel and Africa therefore suggests that there is spectrum between these two approaches of transfer/diffusion and what they call “technology translation” (Garb and Friedlander, 2014). They emphasize that the technology needs to be “reinvented” and highlight the importance of local language and needs, emphasizing the technical and institutional fluidity, and

support for local innovation systems, in the case where institutions are weak, infrastructure is not evenly distributed among farmers and is of lower quality, and access to credit, insurance and markets is limited. In such contexts, leading innovative farmers themselves may come up with simpler inventions that are nevertheless effective for addressing water scarcity and irrigation problems that they often cannot communicate back to the extension workers or the drip irrigation companies, for instance (ibid).

While both diffusion of innovation and technology transfer theories take technology and adopters as fixed and analyze the process of diffusion over time (Ruttan and Hayami, 1973), technology translation views technology as an evolving part of a socio-technical network. It emphasizes adapting technology to fit into new environments by understanding local languages and dynamics, not just moving it as it is. It emphasizes the need to make technology more flexible and responsive to local needs, acknowledging the intricate relationship between technology and culture. Therefore, it highlights that for an innovation to gain widespread acceptance, it is necessary to modify the technology to cater to the numerous and varied needs of local users (Taylor and Zilberman, 2017).

The study conducted by Garb and Friedlander (2014) explores the difficulties and restricted effectiveness encountered by drip irrigation technology, which is enthusiastically embraced in Israel but has limited adoption in Sub-Saharan Africa. This underscores the insufficiency of exclusively "transferring" technology and underscores the need to adjust to local circumstances and promote local innovation processes. Similarly, the research conducted by Mirhanoğlu et al. (2023) in the the village of Ağlasun, Burdur, Turkey highlights the potential adverse outcomes that can arise from ignoring the compatibility of drip irrigation technology with the current infrastructure and institutions. Both studies emphasize the significance of understanding the interplay between technical breakthroughs and social, institutional, and geographical aspects to accurately predict potential impacts and achieve successful implementation of innovations.

Given this context, below I summarize the main individual-level and systemic factors affecting the adoption of drip irrigation in the literature by differentiating between technological, economic, institutional, and farmer characteristics.

2.6. Factors affecting the adoption of drip irrigation

As discussed in the previous section, having adequate financial resources, presence of agronomists and extension workers, adopter awareness and other concerns such as access to innovation do not automatically guarantee adoption of new technologies in agriculture (Tomas-Simin and Jankovic, 2014). Technology adoption is also largely tied to cultural, contextual, and policy-related factors (Ruzzante et al., 2021). In this section, I will give a brief overview of the past literature on the different determinants of the adoption of drip irrigation by farmers.

Adoption rates of drip irrigation varies greatly, it has been adopted with substantial success in certain places such as Israel, while facing failures in others such as in Sub-Saharan Africa, making its overall adoption unpredictable (Garb and Friedlander, 2014). It has been argued that the adoption of a new technology is dependent upon the interaction between the fundamental characteristics of the technology and the other socio-environmental circumstances (Loevinsohn et al., 2012). There is a variety of factors that can farmers' adoption of drip irrigation, and these factors can differ from country to country and region to region (Pannell et al., 2006; Akudugu et al., 2012; Garb and Friedlander, 2014; Mwangi and Kariuki, 2015; Madhava Chandran and Surendran, 2016; Alcon et al., 2019; Ruzzante et al., 2021; Serote et al., 2021; Yazdanpanah et al., 2022). For instance, while Alcon et al. (2019) classifies these determinants as farmer characteristics, economic characteristics, farm characteristics, innovation characteristics and environmental factors; Serote et al. (2021) focuses on demographic factors, farm characteristics, formal and informal training, and irrigation-related factors. On the other hand, Akudugu et al. (2012) differentiates between social, economic, and institutional factors. Similarly, Parmar and Thorat (2016) discuss economic, technological, administrative, and socio -psychological factors for the adoption of drip irrigation. Yazdanpanah et al. (2022) divides these determinants as social capital, socio-economic and technology characteristics. Based on this literature and on my field work, I decided to categorize these factors as technological, economic, institutional, and farmer-specific factors in this research.

2.6.1. Technological factors

Technological factors include the effectiveness, suitability and accessibility of a given technology from the perspective of farmers (Serote et al., 2021). Technological factors such as access to irrigation equipment have been found to have a positive impact on the adoption of new irrigation technologies (Sinyolo et al., 2014). For example, according to Serote et al. (2021) there exists a strong

and favorable correlation between possessing specific irrigation equipment such as pumps and farmers' inclination to embrace novel agricultural technology, as well as the degree to which they implement the technology (Serote et al., 2021). The potential benefits of the technology (Akudugu et al., 2012; Alcon et al., 2019) as well as farmer's perceptions about the performance of the technology are also important for successful adoption process. Trialability (Alcon et al. 2019) and compatibility (Yazdanpanah et al., 2022) of drip irrigation technology have also been shown to have a positive impact the adoption. These two factors refer the probability of adopting a new technology grows as farmers' capacity to experiment and evaluate it in real-world scenarios improves.

However, there are also several constraints regarding the adoption of drip irrigation that is related with the technological factors. The most common technical concerns are non-availability of drip irrigation components in the market (Chadran and Surendan, 2016), installation and maintenance difficulties of drip irrigation system (Greenland et al., 2017), complexity of the technology (Yazdanpanah et al., 2022) clogging of laterals and emitters (Chadran and Surendan, 2016; Parmar and Thorat, 2016) , difficulty of folding the pipes during rainy seasons (Chadran and Surendan, 2016), high cost for replacement of irrigation components (Parmar and Thorat, 2016), requiring occasional care for small repairs and a lack of technical expertise (Parmar and Thorat, 2016), inadequate and unreliable power supply, non-availability of spare parts at reasonable prices (Parmar and Thorat, 2016) and difficulty to do inter cultivation when drip irrigation system exists (Chadran and Surendan, 2016).

2.6.2. Economic factors

Economic factors are one of the crucial determinants of the adoption of drip irrigation. Access to water, net gain of adoption, access to financial resources (Akudugu et al.,2012; Serote et. al., 2021), availability of and access to credit (Mohamed and Temu, 2008; Mwangi and Kariuki, 2015; Alcon et. al., 2019;), association and business size (Alcon et al., 2019) have been found to have a positive effect on the adoption of drip irrigation. However, high initial costs (Chadran and Surendan, 2016; Parmar and Thorat, 2016), insufficient subsidies and difficulty in obtaining subsidies (Chadran and Surendan, 2016), high costs of spare parts and equipment (Parmar and Thorat, 2016; Greenland et al. 2017) negatively affect adoption of drip irrigation. On the other hand, if drip irrigation enables the the production of high-yielding products these can compensate the farmers for the higher costs related with drip irrigation, and as a result, farmers may embrace this system despite its high costs (Chadran and Surendan, 2016). This implies that when farmers believe in the effectiveness of irrigation

methods and the economic benefits associated with these crops, it positively influences their decision to adopt these methods.

Studies indicate that off-farm income also serves as a determinant in technology adoption (Mwangi and Kariuki, 2015; Akudugu et al., 2019). There are studies suggesting that off-farm income has a positive influence on technology adoption (Mwangi and Kariuki, 2015). However, there is also evidence to the contrary; according to Akudugu et al. (2019), engaging in non-agricultural activities might decrease farmers' willingness to adopt new agricultural technologies. The correlation between off-farm income and technology adoption is closely related with the technology itself. For instance, Mwangi and Kariuki (2015) found a positive correlation between off-farm income and the use of labor-intensive technologies. Another economic factor is related with the number of the animal farmers owns. Yazdanpanah et al. (2022) found that this impacts acceptance of the drip irrigation systems positively, as bigger livestock farmers have more financial resources than who do not.

2.6.3. Institutional and contextual factors

The allocation of water resources and the adoption of water conservation technologies are significantly influenced by institutional and contextual factors. One critical institutional factor impacting the adoption of drip irrigation is closely linked with agricultural policies implemented by central and local governments (Avella and Garcia Molla, 2008). Political dynamics and agricultural policies within a country play a substantial role in the adoption of innovative irrigation technologies (Greenland et al. 2017; Ganesan et al., 2018). Additionally, Garb and Friedlander (2014) emphasize that the establishment of policies, organizational structures, and communication systems that facilitate the adaptation of technology to local contexts is a crucial determinant for technology adoption. Ortega-Reig et al. (2017), for instance, underline the role of Water Users' Associations (WUA) in Spain for facilitating public policies to promote drip irrigation as a response to water scarcity. Accordingly, the active participation of the government in state-led projects and the involvement of Water User Associations in securing funding for drip irrigation initiatives have established a mutually beneficial partnership, proving effective in enhancing the use of drip irrigation (ibid). Further, WUAs play an essential role in conveying policymakers' goals to farmers, recognizing the strategic importance of drip irrigation in mitigating water demands during basin-scale water deficits (ibid). Public administration agencies are crucial as they often initiate water conservation projects, provide funding, and offer subsidies for the adoption of water conservation technology, particularly in surface-water irrigation systems (Avella and Garcia Molla, 2008).

Social networks can be considered an important contextual factor. The structure of the social system and communication channels play a key role in the diffusion of an idea (Mvangi and Kariuki, 2015). Farmers depend on social networks for making individual decisions, interchanging shared information within their community to acquire knowledge about the advantages and implementation of new agricultural technologies (Mvangi and Kariuki, 2015). Similarly, Alcon et al. (2019), Ruzzante et al. (2021), and Serote et al. (2021) imply that membership in a farmer organization provides a convenient platform for farmers to acquire knowledge about the advantages and utilization of a new technology. However, to the contrary, Yazdanpanah et al., (2022) found that spending more time in social settings decreases the time farmers dedicate to fieldwork, resulting in a negative impact regarding their acceptance of new technologies.

In addition to social systems, the availability of information and advisory services for farmers (such as extension services, irrigation associations and media) can positively affect the adoption process (Akudugu et al., 2012; Mvangi and Kariuki, 2015; Alcon et al., 2019; Serote et al., 2021). The uncertainty surrounding the proposed innovation, the formal and informal knowledge obtained about its efficacy, the authority and credibility of the informants all affect how long it takes for the farmer to decide and adopt an innovation (Alcon et al., 2019). Gaining information on a technology plays a vital role in its acceptance and adoption among farmers (Mvangi and Kariuki, 2015). Extension services play a crucial role in raising awareness about the use of a new technology; farmers with access to extension services are more likely to adopt new irrigation technologies (Akudugu et al., 2012; Ruzzante et al., 2021; Serote et al., 2021). However, simply having access to knowledge is not enough; the adoption process is also influenced by the quality of the knowledge (Mvangi and Kariuki, 2015). Farmers can adapt to a new technology if reliable, consistent, and accurate information is available, and there is strong institutional infrastructure support.

2.6.4. Individual-level farmer characteristics

Agricultural technology adoption literature emphasizes the importance of age in adopting new technologies. Several researchers found that younger and less experienced farmers pioneer and influence new technology adoption (Chadran and Surendan, 2016; Alcon et al., 2019; Serote et al., 2021; Yazdanpanah et al., 2022). According to Mvangi and Kariuki (2015), older farmers are more risk-averse and less interested in long-term farm investments, whereas younger farmers are more likely to accept new technologies. To the contrary, other studies (Kariyasa and Devi, 2011; Mignouna et al., 2011; Yazdanpanah et al., 2022) suggest that older farmers have more expertise and can better

evaluate technical information than younger farmers, therefore age is negatively correlated with technology adoption. On the other hand, by evaluating various agricultural practices, Akudugu et al. (2012) stated that they either did not find a relationship between age and adoption or found it to be an insignificant, small effect.

In terms of education, several studies found that there is a high correlation between technology adoption and the level of education of farmers (Akudugu et al., 2012; Chadran and Surendan, 2016; Alcon et al., 2019; Serote et al. 2021; Yazdanpanah et al., 2022). This is since education helps promote a positive attitude toward knowledge-based and management-focused methods (Akudugu et al., 2012). According to Chadran and Surendan (2016), education not only enhances awareness, but also instills the confidence to embrace a new technology. Although, in general, education is found to have a positive impact on the adoption of new technologies in agriculture, it is also noted that the level of education can have a negative effect for more controversial technologies such as the adoption of genetically modified products (Mvangi and Kariuki, 2015). This highlights that these determinants and the adoption of technology are largely related to the technology itself and the perceptions of farmers.

Several studies in the literature state that farm characteristics such as farm size is an important determinant of the adoption of irrigation technologies (Akudugu et al.,2012; Chadran and Surendan, 2016; Alcon et al., 2019; Serote et al. 2021; Yazdanpanah et al., 2022). Large-scale producers are more likely to use new equipment than small-scale farmers because bigger landowners can set aside some of their land to test out new technologies due to their greater financial resources (Mwangi and Kariuki, 2015). However, according to Fischer (2016), a technology might be equally effective or suitable when adapted on a large- or small-scale and factors influencing the adoption of agricultural technology are mostly associated with the social and biological influences of the technology at hand, rather than the scale of the farmed land.

The awareness regarding the new technology by the farmer is an important factor for its adoption, yet the level of this awareness also matters. For instance, the level of knowledge plays a positive role (Parmar and Thorat, 2016; Serote et al., 2021). The importance of accurate guidance and technical education for farmers regarding the effectiveness of this technology is therefore crucial. For instance, although drip irrigation methods are seen as suitable for certain crops cultivated by farmers, possessing sufficient technical knowledge about the correct irrigation methods for their other products stands as a pivotal determinant for implementing this technology. This situation indicates that farmers'

specific perceptions of certain products or their lack of knowledge about irrigation techniques play a significant role in the acceptance of new technologies (Serote et al., 2021).

The adoption process is influenced by the size of a household as well. Larger families could overcome labor limitations that are essential when introducing a new technology to their farm (Mignouna et al, 2011; Mwangi and Kariuki, 2015; Ruzzante et al., 2021). However, another study indicates that, to the contrary, the irrigation technology adoption may be hindered by a larger family-farm, as the larger number of individuals in a household can increases the total expenses of a family farm (Serote et al., 2019).

Location of the water source that is used for irrigation also plays an important role. Farmers located closer to viable water sources are less motivated to adopt drip irrigation technology as they have relatively less water transportation costs and the time they need for irrigation is also reduced through their proximity to the water source (Yazdanpanah et al., 2022). Moreover, water scarcity plays an important role as well. If farmers face water scarcity, they are more motivated to adopt water efficient technologies such as drip irrigation (Chadran and Surendan, 2016). To the contrary, there are studies stating that water availability has a positive impact on drip irrigation adoption (Alcon et al. 2011; Alcon et al., 2019).

3. STUDY AREA

Water used for irrigation has a very important share in the total water consumption in Turkey, with a share of 74% used for irrigation, 13% for household and domestic use, and another 13% for industrial production (Su Yönetimi Genel Müdürlüğü, 2019a). Located in the Mediterranean region, Turkey has a semi-arid climate (Yerli et al., 2023). Mediterranean countries, especially those located in the southern and eastern parts, face difficulties in terms of access to sufficient freshwater resources (Yerli et al., 2023), and Turkey is no exception to this trend.

Agriculture is a fundamental and integral part of Turkey's economy, closely intertwined with its cultural and historical heritage. Agriculture is carried out in a varied range of climatic zones and different soil types, resulting in a unique mosaic of cultivation processes (TBB, 2013). Small-scale, family farms dominate the agricultural production (TBB, 2013); almost 80% of farmers have a farm size smaller than 10 hectares (TURKSTAT, 2016). The share of agriculture in the Gross Domestic Product of the country has fallen down from 51% in 1960 down to 6.5% in 2022 (The World Bank, 2023). This is related to several problems regarding the current trends in agriculture: the agricultural workforce is aging, migration from rural areas to cities is continuing, leading to a shift of farmers away from agriculture to other income sources in urban or peri-urban centers (Sav and Sayın, 2018). About 17% of the total workforce is employed in the agricultural sector (FAO, 2021),

Küçük Menderes River Basin is in the Aegean region of Turkey and is an important region for agricultural production. The basin spans about 702,931 hectares, of which about half is used for agricultural production. İzmir, Aydın, and Manisa provinces fall within the boundaries of the Küçük Menderes River Basin (Tarım ve Orman Bakanlığı, 2023). The sub-basins of the Küçük Menderes are Aşağı Menderes, Çeşme- Karaburun, İzmir Bay, Kuşadası, Tahtalı-Seferihisar and Yukarı Menderes as shown in Figure 3.1 and 3.2 below.

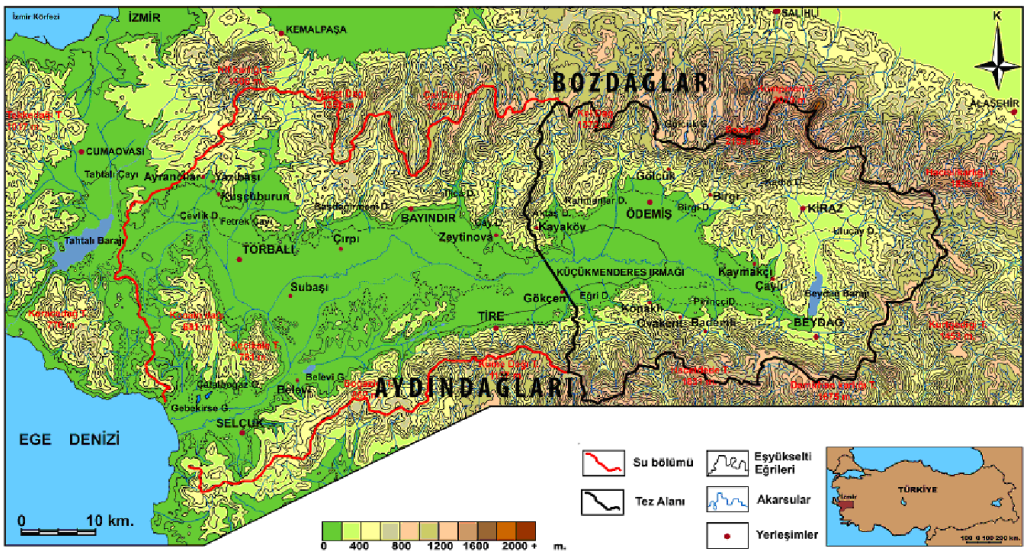


Figure 3.1. Küçük Menderes River Basin (Şahin et al., 2020).

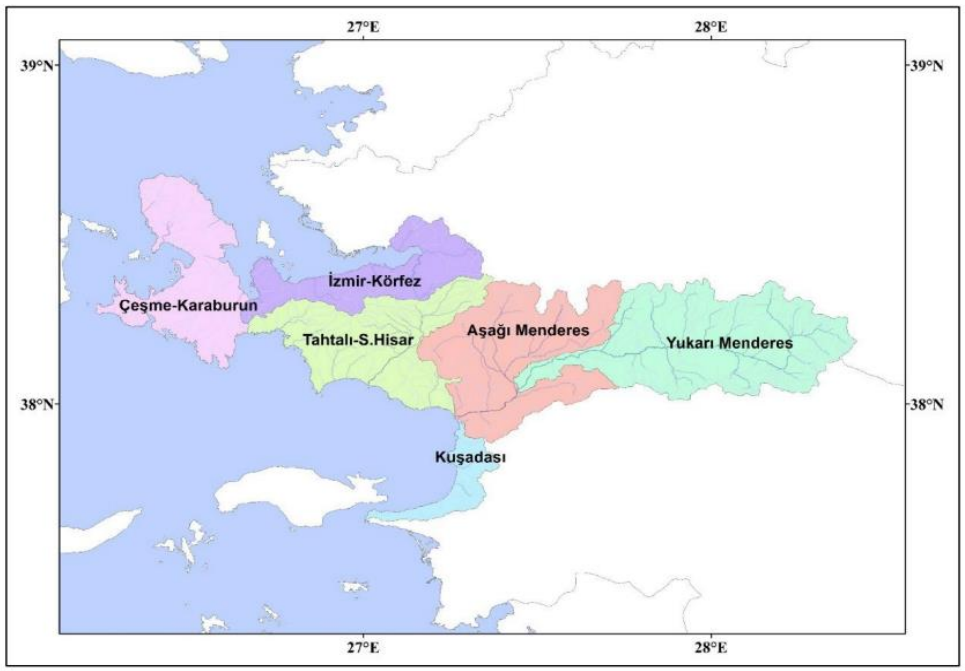


Figure 3.2. Küçük Menderes River Basin Sub-basins (Su Yönetimi Genel Müdürlüğü, 2018a).

Küçük Menderes River Basin is predominantly affected by the Mediterranean climate with average annual temperatures between 16-18°C, precipitation between 600-850 mm, and relative humidity between 55-70% (Gülersoy et al., 2015). The basin experiences dry and sunny weather during the summer season, characterized by elevated temperatures and minimal precipitation. Winters are characterized by warm temperatures and increased precipitation. The environment in this region is conducive to agricultural activity; nonetheless, the dependence on irrigation systems is substantial due to the seasonal pattern of rainfall. Winter averages 141.06 mm of precipitation, the month

receiving the least rainfall in the basin is 3.8 mm in August, while the month with the highest rainfall is 185.2 mm in December (Su Yönetimi Genel Müdürlüğü, 2016). The central region of the area is characterized by a flat plain that is mostly utilized for intensive agricultural operations, mainly owing to the presence of fertile soil and a wide range of agricultural products (Hepaksoy et al., 2018). In the region, the productivity is quite high, and in several districts, more than one crop can be grown annually (ibid).

According to the Ministry of Agriculture and Forestry's climate change projections for the period between 2015 and 2100, a continuous increase in average temperatures is expected in the basin (Tarım ve Orman Bakanlığı, 2023). The mean temperature in the basin was measured as 16.7°C between 1971 to 2000, however, between 2071 and 2100, average temperatures are projected to rise by a minimum of 1.6°C and a maximum of approximately 4.7°C (Tarım ve Orman Bakanlığı, 2023). Ödemiş is projected to experience a more significant increase in temperature and decrease in precipitation compared to other areas, resulting in diminished underground and surface water resources, along with a potential exacerbation of soil salinity due to reduced winter rainfall (Hepaksoy et al., 2018). Increased soil salinity from rising maximum temperatures, reduced total precipitation (threatening drought), and precipitation irregularity is projected to threaten agriculture in the basin (ibid).

The basin has a precipitation area of 6907 km^2, with around 39% of it being dedicated to agriculture (Hepaksoy et al., 2018). Total agricultural land in the basin amounts to 314,017 hectares, of which 52% is used for irrigated farming, and 48% is dedicated to rainfed farming (Su Yönetimi Genel Müdürlüğü, 2018a). 50.5% of the agricultural land is devoted to cultivating fruits-beverages-spice plants, with vegetables occupying 10.5% of the cultivated area. Fallow land is scarce; most of the remaining lands are used for growing grains and other crops (Su Yönetimi Genel Müdürlüğü, 2018a). Barley, wheat, oat, and rye are classified as winter crops whereas potato, maize, alfalfa, cotton, tobacco, and sorghum are classified as summer crops (Hepaksoy et al., 2018).

In the Küçük Menderes River Basin, silage maize is the most widely produced agricultural product, amounting to 5,640,004 tons in 2022 in the region (TURKSTAT, 2023). Maize production is followed by tomatoes with 3,355,518 tons and seedless grapes with 1,630,422 tons. Other widely produced products in the region were clover and olive for oil. While the production patterns have changed over the last 10 years, silage maize was the product with the highest production volume over the last decade due to rising level of intensive livestock activities (Su Yönetimi Genel Müdürlüğü,

2018b). Overall, cereal crops, which serve as raw materials for staple food products and contribute to the feed industry, have the highest share in total agricultural production in the basin (TOB, 2013).

The production of silage maize has increased by 376% from the year 2004 to the year 2022. Silage maize production is carried out in 95 percent of the farmland in the basin in terms of its area. Over the recent decades, the intensification of maize farming has been driven by a combination of livestock subsidies and rising prices for meat (Esetlili et al., 2022). Livestock production is a prominent industry in the basin, with İzmir Province accounting for 75.3% of the cattle, 37.7% of the sheep, 24.3% of the goats, 35.5% of the poultry, and 36.8% of the beehives in the region. Significant contributions are made to both big and small-scale animal husbandry, as well as dairy processing, particularly in the Ödemiş and Tire regions. Furthermore, the Tire Milk Cooperative plays a vital role in the processing of milk and its associated products. Torbalı and Tire districts excel in chicken farming, Menderes specializes in goat farming, and Ödemiş district is known for its apiculture. The animals raised in İzmir constitute approximately 4% of the country's large cattle population and approximately 2% of the small cattle population (İzmir Tarım ve Orman İl Müdürlüğü, 2021). According to 2021 data provided by İzmir Tarım ve Orman İl Müdürlüğü, there are 781,070 cattle in İzmir. In cattle farming, Ödemiş leads with 182,028 cattles, followed by Tire with 115,824 cattles, Kiraz with 104,685 heads, and Bayındır with 94,330 cattles. The close relationship between the livestock and silage maize production in the basin has been explained as follows by the Ödemiş Kaymakçı Agricultural Development Cooperative Head Raşit Tatlı (Habertürk, 2018):

> "Livestock farming is not possible in the region without silage maize production. Farmers have shifted their focus from products like watermelon and potatoes, which face price instability, to maize production. The instability in plum prices has also directed the producers towards maize. Now, we can say that maize covers about 70% of the fields in the plain." Head of Kaymakçı Agricultural Development Cooperative, Raşit Tatlı (Habertürk, 2018).

In the present study, I selected the following three districts in İzmir to narrow down the scope of the study, where silage maize is predominantly produced with a rising trend, namely Ödemiş, Tire and Bayındır districts. Silage maize production trends in these three districts are provided in the below figure (Figure 3.3). The next three figures (Figure 3.4, Figure 3.5 and Figure 3.6) provide a brief overview of production patterns separately in each district. Accordingly, silage maize has the highest share in each district.

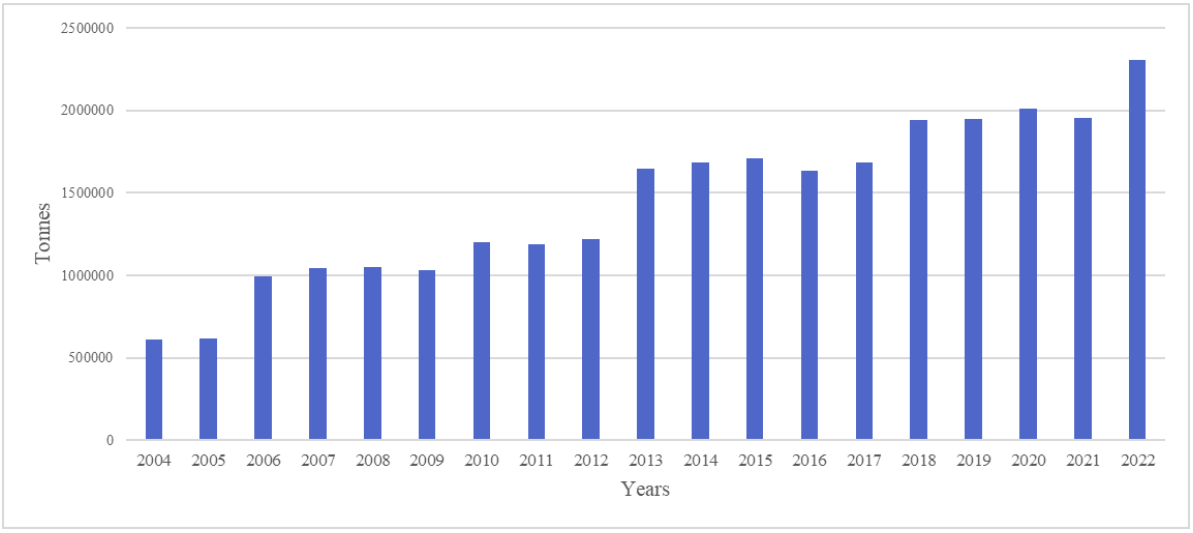


Figure 3.3. Silage maize production between 2004-2022 in Ödemiş, Tire and Bayındır in total (TURKSTAT, 2023).

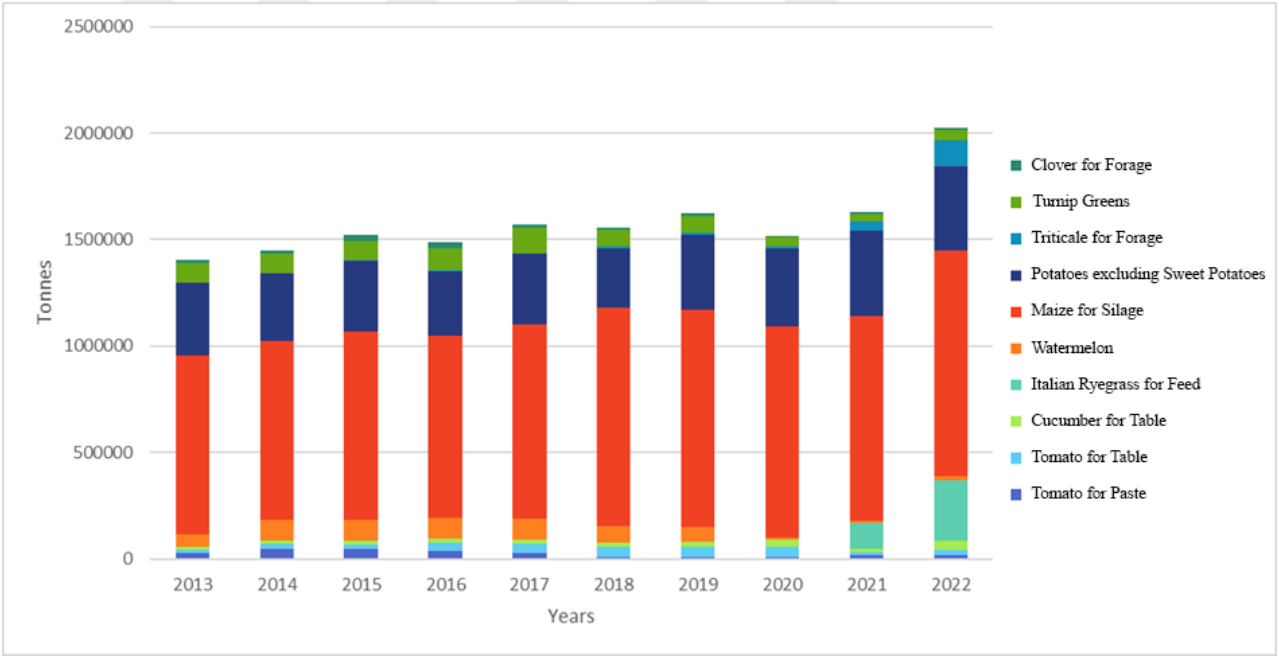


Figure 3.4. 2013-2022 production amounts of products in Ödemiş (TURKSTAT, 2023).

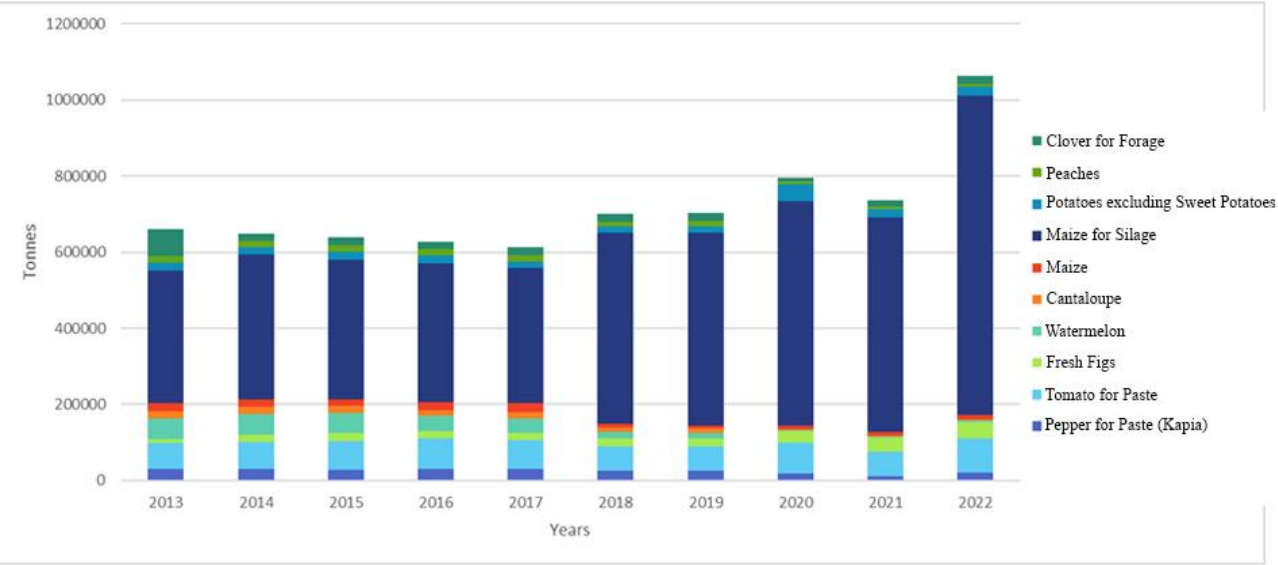


Figure 3.5. 2013-2022 production amounts of products in Tire (TURKSAT, 2023).

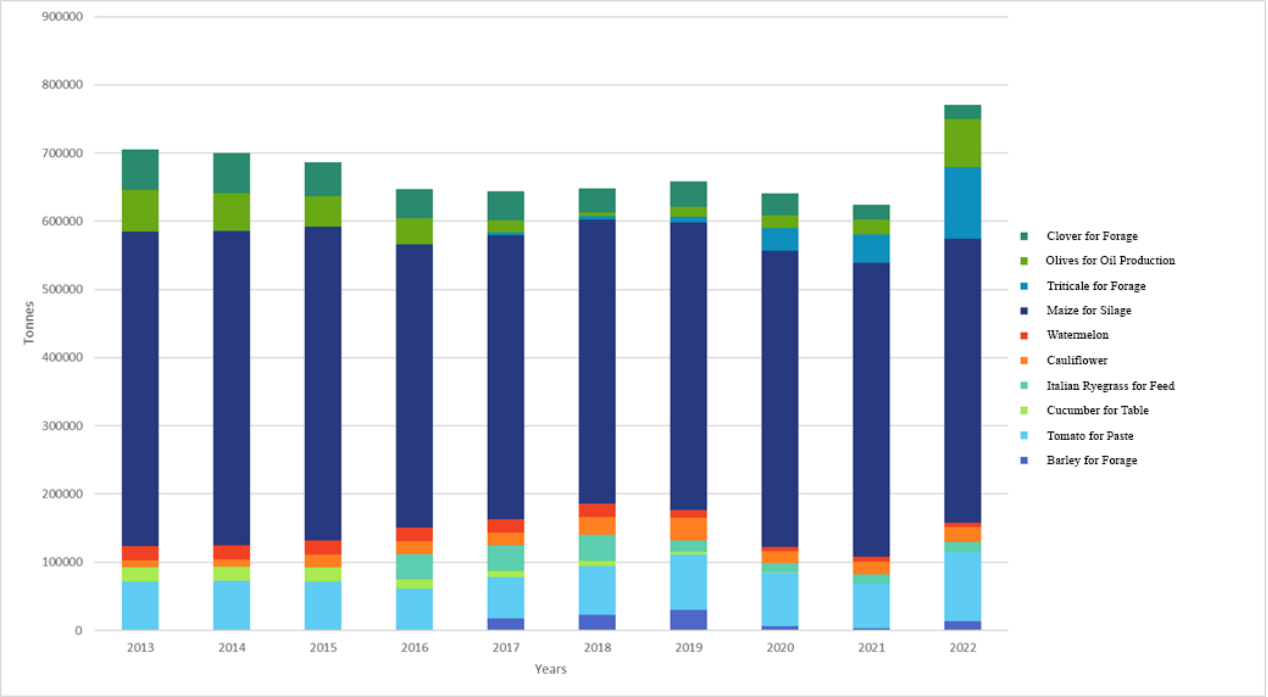


Figure 3.6. 2013-2022 production amounts of products in Bayındır (TURKSTAT, 2023)

The data highlight the important role and extensive cultivation of silage maize in the agricultural landscape of the region. Due to its great nutritional value and ability to grow in a wide range of climates, silage maize is one of the most important feed crops (Çakmakçı and Şahin, 2021). The significant yield of silage maize exceeds that of traditional crops such as wheat and cotton, indicating the crucial importance of silage maize as the main agricultural product in the Küçük Menderes River Basin. Due to intensive livestock activities, farmers produce maize for silage to feed their animals in

the region. Especially Ödemiş and Tire districts have an important share in cattle breeding and dairy products processing (Şahin et al., 2020).

"Evapotranspiration", commonly referred to as "ET" in numerous national and international sources, is terminologically accepted in Turkish as the definition of "Plant Water Consumption." (DSİ and TAGEM, 2017). ET refers to the amount of water that a plant consumes within a specific period, assuming ideal conditions with no negative impact from diseases, nutritional deficiencies, or water scarcity (ibid). While the water consumption per unit is indeed crucial, the total water consumption is also greatly influenced by the output amounts in each region. With the rise in production quantities, there is typically a proportional increase in overall water use. The given ET values are derived under the assumption of ideal conditions, where there are no adverse effects from diseases, deficiencies in nutrients, or water scarcity. Additionally, the state of the field, soil requirements, and the farmer's irrigation practices are directly associated with the water consumption of the crops grown in the region. The following table presents the water consumption of different crops for the 10 mostly cultivated products in Ödemiş, Tire, and Bayındır over a 10-year period from 2013 to 2022, derived from data provided by TURKSTAT.

Table 3.1. Agricultural crop water consumption (ET, mm) (DSİ and TAGEM, 2017).

	Product	Station	1st product
Bayındır	Wheat for Forage	Ödemiş	
	Tomato for Paste	Ödemiş	640
	Cucumber for Table	Ödemiş	579
	Italian Ryegrass for Feed	-	-
	Cauliflower	Bergama	266
	Watermelon	Ödemiş	400
	Maize for Silage	Ödemiş	615
	Triticale for Forage	Ödemiş	305
	Olives for Oil Production	Seferihisar	706
	Clover for Forage	Ödemiş	1010
Tire	Pepper for Paste (Kapya)	Ödemiş	846
	Tomato for Paste	Ödemiş	640
	Fresh Figs	Bornova	588
	Watermelon	Ödemiş	400
	Cantaloupe	Ödemiş	565
	Maize	Ödemiş	736
	Maize for Silage	Ödemiş	615
	Potatoes excluding Sweet Potatoes	Ödemiş	546
	Peaches	Ödemiş	917
	Clover for Forage	Ödemiş	1010
Ödemiş	Tomato for Paste	Ödemiş	640
	Tomato for Table	Ödemiş	844
	Cucumber for Pickling	Ödemiş	579
	Italian Ryegrass for Feed	-	-
	Watermelon	Ödemiş	400
	Maize for Silage	Ödemiş	615
	Potatoes excluding Sweet Potatoes	Ödemiş	546
	Triticale for Forage	Ödemiş	305
	Turnip Greens	-	-
	Clover for Forage	Ödemiş	1010

The table confirms that water consumption per unit of maize production is indeed quite high and in combination with high production amounts, this translates to a very high total consumption of water, especially because traditional irrigation methods such as furrow irrigation are used for irrigating maize, rather than drip irrigation, in the region. The prevalent irrigation techniques employed for growing maize in Küçük Menderes River Basin are mostly flood and furrow irrigation, and rarely drip irrigation and sprinkler irrigation (Su Yönetimi Genel Müdürlüğü, 2019a).

In Turkey, the water footprint of cereal crops (wheat, rice, maize) is reported to account for approximately 38% of the total water footprint of agriculture (SKD Türkiye and Ankara Üniversitesi Su Yönetimi Enstitüsü, 2024). Indeed, Pilevneli et al. (2023) projected the future water scarcity to be caused by climate change in Turkey's 25 river basins in the near, intermediate, and long run and found that maize has the highest water footprint among these products.

Yoldaş (2011) study stated that approximately 97% of the population in this basin is engaged in agriculture. In terms of agricultural enterprise sizes, 71% in the Küçük Menderes Basin are small-scale operations with sizes ranging from 0 to 19 hectares, particularly suitable for family-operated vegetable farming (Yoldaş, 2011).

The research published by Akyüz (2019) assessed environmental attitudes of farmers in the Küçük Menderes River Basin within the framework of adaptation to climate change. Although the study was actually carried out for understanding the climate change awareness of the farmers in the region, it provided important information about the characteristics of the farmers in this region. The research was carried out with farmers in the villages of Bayındır, Beydağ, Ödemiş and Tire districts. Accordingly, the average age of the producers included in the study was 49. The agricultural experience of the producers was found to be 25 years. The average education period was 6 years and there were on average 4 people living in each family. Almost half of the producers (41%) were engaged in animal husbandry as well as growing agricultural products. In addition to this, 22% of the farmes were having another job 40% had a non-agricultural income. At the same time, the average size of the lands cultivated by the farmers was found to be 38.57 decares, 52% of these lands were irrigated and 45% were non-irrigated lands. This land size, which is almost half of the Turkey's average of 71 decares, emphasized the common occurrence of small and fragmented farms in the basin. According to the study, farmers were proactively adjusting their farming methods and crop selections in response to perceived climate-related fluctuations.

The large amount of agricultural land in the Küçük Menderes River Basin, along with the significant livestock activities, increases the need for water use. Nevertheless, uncontrolled water extraction, unplanned urbanization, intensive livestock production, and unsustainable agricultural practices have negative effects on water sources in the area (Şahin et al., 2020). A substantial portion of agricultural water in the region depends on groundwater use, resulting in notable reductions in groundwater levels (Şahin, 2018). Due to excessive use of groundwater for agricultural activites, the basin has seen a significant fall in groundwater levels over the past 30 years (Şahin et al., 2020). In

the Küçük Menderes Basin and its sub-basins, the total groundwater recharge amounts to 716.5 million tonnes, whereas the total actual withdrawal measures as 1.2 billion tonnes (Su Yönetimi Genel Müdürlüğü, 2019b). As per these figures, more water is being extracted from the groundwater through wells than what is being recharged. Hence, there is a need to prioritize the implementation of modern irrigation techniques such as drip irrigation and optimal crop patterns due to water scarcity in the region (Pilevneli et al., 2023). Research shows that Küçük Menderes (shown by number 6 in Figure 3.7) and Burdur river basins exhibit the lowest irrigation water availability among Turkey's 25 river basins (ibid). The same scholars also highlight that there is a high risk of experiencing a substantial reduction in water availability for irrigation, starting from 2040 onwards. Moreover, climate change scenarios used for the study suggest that both the overall production and incomes in the Aegean Region, including the Küçük Menderes River Basin, could experience a significant decline ranging from 78% to 100% (ibid).

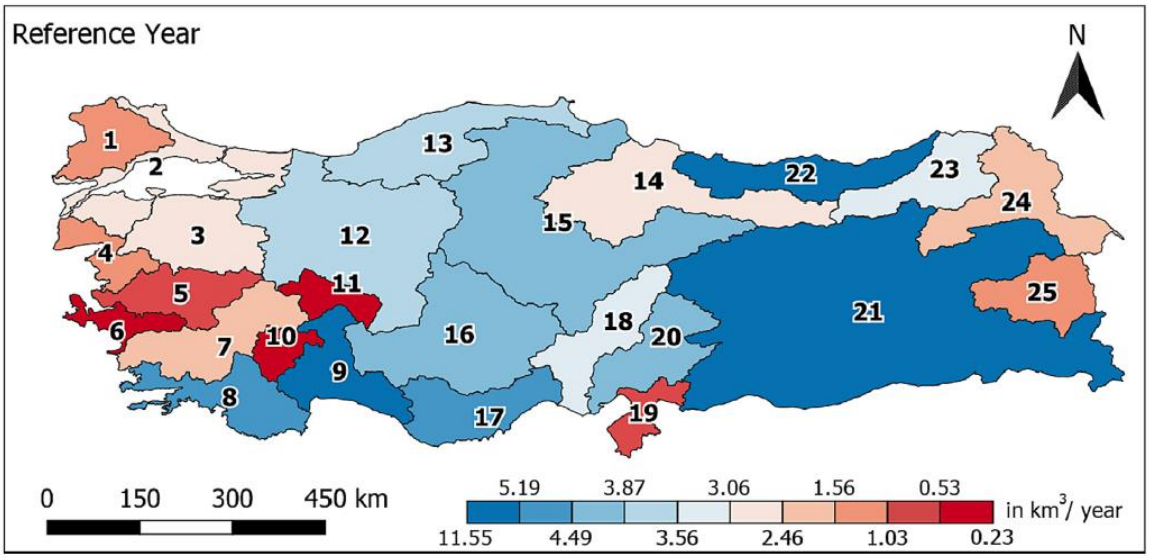


Figure 3.7. Water supply for irrigation purposes in river basins during the reference year of 2015 (Pilevneli et al., 2023).

Drought risk maps prepared for the Küçük Menderes Basin produced by Turkish State Meteorological Service show that the eastern parts of the basin are prone to severe drought, the more continental northern parts of the İzmir-Gulf and Kuşadası sub-basins are prone to moderate drought, and the Aşağı Menderes sub-basin has a more moderate drought trend (Meteoroloji Genel Müdürlüğü). The agriculture sector in the basin is expected to be hardest hit by the drought conditions. The mostly affected sub-basins of Küçük Menderes will be Aşağı Menderes and Yukarı Menderes. In comparison to other sub-basins of the Küçük Menderes Basin, irrigation water use is substantially

higher in these two sub-basins, which have the highest agricultural area (Su Yönetimi Genel Müdürlüğü, 2018a).

Given this context, the present thesis focuses on the Küçük Menderes River Basin because it is highly vulnerable to the effects of climate change, which are further exacerbated by the heavy dependence on agriculture for livelihood (Su Yönetimi Genel Müdürlüğü, 2019b). The region has experienced a significant decrease in groundwater levels over the last thirty years (Şahin et al., 2020). This decrease is mainly caused by the combined impacts of extensive agricultural irrigation, intensive livestock husbandry, and rapid industrialization (ibid). The depletion of the basin's groundwater reservoirs is a significant and imminent threat, affecting both the quality and quantity of the water. This depletion is mostly caused by intensive agricultural practices, uncontrolled animal breeding, and unregulated developmental activities (ibid). In recent years, there has been a significant decrease in the water levels in wells. This is mostly due to excessive extraction and the additional effects of climate change (ibid). Therefore, it is crucial to prioritize the use of more effective irrigation technologies, such as microsprays, mini-sprinklers, surface drip, and subsurface drip irrigation systems (Nikolaou et al., 2020) in the region. Technological changes could play a vital role in climate change adaptation strategies by providing a means to reduce the constraints on water supplies and enhance resilience in response to changing climatic conditions in the Küçük Menderes River Basin. The next section gives a brief overview of the agricultural subsidies provided to farmers with a specific focus on livestock production incentives and support for the implementation of drip irrigation.

3.1. Agricultural Subsidies Related with the Adoption of Drip Irrigation and Livestock Production

The above analysis demonstrated that livestock production is going hand in hand with increasing silage maize production in the basin, which lead to higher water consumption and decreasing groundwater sources. This is why in this section I concentrate on the subsidies supporting livestock production and drip irrigation, which have counteracting effects in terms of water use, as the former increases water consumption and the latter, in theory at least, should decrease irrigation water use.

The Rural Development Investments Support Program is a grant-funded effort designed to promote economic and social progress in rural regions. This initiative aids farmers in improving their economic activities by providing financing for agricultural infrastructure projects, including pressurized irrigation systems, such as in-field drip irrigation, sprinkler irrigation, micro-sprinkler

irrigation, in-field subsurface drip irrigation, linear or center pivot irrigation, drum irrigation, solar-powered irrigation, and smart irrigation systems. This support is provided at a 50% grant rate, up to a maximum of 500,000 TL over the 2021-2025 period (Mevzuat Bilgi Sistemi, n.d., Yılmaz et al. 2022).

In 2021, the Ministry of Agriculture and Forestry started a project called "Damla Sulama Yöntemi İle Tarımda Verimi Artırıyoruz Tarımsal Girdileri Azaltıyoruz" (*Increasing Agricultural Yield with Drip Irrigation Method, Reducing Agricultural Inputs*) in İzmir. Within this project, approximately 410 kilometers of drip irrigation main lines and lateral pipes were installed in an area of 510 hectares irrigated using the furrow irrigation method within the 4,000-hectare irrigation field in Tire. The aim of the implemented system was to promote the widespread adoption of modern irrigation methods to address problems arising from incorrect and excessive water use due to climatic conditions in the Küçük Menderes Basin, where silage maize, requiring substantial water, is grown. The project aims to achieve water conservation, resolve issues stemming from climate-based conditions, and enhance agricultural productivity and quality per unit area (Tire'de Su Kaynaklarının Doğru Kullanımı İçin Önemli Bir Proje Daha Hayata Geçti, n.d.). This was explained by the Former Director of İzmir Provincial Directorate of Agriculture and Forestry as follows:

> "We have a livestock population of nearly 600,000 in this region. Ensuring the sustenance of these animals is essential. We could introduce modern irrigation systems to the entire plain where silage maize is grown. However, there seems to be a tendency in our society to not grasp the seriousness of the situation until it directly affects us. Yes, we might not feel the drought significantly compared to 2020. However, our groundwater, which used to be extracted from 30-40 meters below the surface 10-15 years ago, are now drawn from depths of 200-300 meters. We cannot increase the quantity of this water, but we can use the existing water resources more efficiently. Indeed, the investment required for these systems might be high, and it can be a challenging endeavor. Considering the substantial increase in agricultural inputs, one might say, 'Let's not invest in this.' But if we aim to sustain this agriculture, we have no choice but to make such investments. We have no other option". Former Director of İzmir Provincial Directorate of Agriculture and Forestry, Mustafa Özen (Tire'de Su Kaynaklarının Doğru Kullanımı İçin Önemli Bir Proje Daha Hayata Geçti, n.d.).

In terms of support for cattle breeding, calves born to cows that have completed scheduled vaccinations, aged 4 months and above, with the first calving at a maximum of 960 days old or a maximum interval of 600 days between the last two calvings are eligible for a payment of 500 TL per head. In terms of support for small ruminants, farms with over 100 breeding sheep or goats receive

12,000 TL, supporting the employment of herd managers. In addition, for sheep and goats, farmers receive 50 TL per head for registered breeding sheep and goats. An additional 20 TL per head is provided for registered breeding (Decision on Agricultural Support to be Provided in 2022 and Certified Seed Use Support to be Implemented in 2023, n.d.). Table 3.2 below shows the plant production and animal husbandry supports provided in İzmir. Accordingly, barley, wheat, cotton, triticale, fodder crops, olive oil, and potatoes receive governmental support in Bayındır, Tire, and Ödemiş, while maize receives support in Bayındır and Tire.

Table 3.2. Plant production and animal husbandry supports in İzmir (T.C. İzmir Valiliği İl Tarım ve Orman Müdürlüğü, 2020).

Area based supports	**Differential payment supports**	**Livestock supports**	**Animal husbandry supports**
1. Fuel and fertilizer support. 2. Organic production support 3. Good agricultural practices support 4. Support for small family farms engaged in crop production. 5. Area-based income support for hazelnuts 6. Biological pest control support 7. Soil analysis support 8. Solid organic-organomineral fertilizer support 9. Support for the protection of agricultural areas for environmental purposes	1. Sunflower oilseed support 2. Baled cotton support 3. Soybean support 4. Canola support 5. Rapeseed support 6. Grain maize support 7. Cereal support (Wheat, Barley, Oat, Rye, Triticale) 8. Paddy rice support 9. Dry legumes support (kidney beans, chickpeas, lentils) 10. Olive oil support 11. Olive grain support 12. Fresh tea support	1. Feed crop supports	1. Calf support 2. Buffalo and malak support 3. Breeding sheep and goat support 4. Fattening male cattle support 5. Purchase support for 500 head and above breeding heifers 6. Disease-Free farm support 7.Beekeeping support 8. Milk support 9.Additional support for milk quality 10.Ear tag application support 11. Livestock disease compensation

In 2022, Izmir Metropolitan Municipality initiated a new vision with the title "Başka Bir Tarım Mümkün" (*Another Agriculture is Possible*). This vision entailed in practice a set of measures for

processing all dairy, meat, and plant products by İzTarım A.Ş. and presenting them to consumers under the brand name "İzmirli". The Mera İzmir initiative facilitated export prospects for producers operating on a medium scale, while also devising a "Shepherd Map" to enhance pastoral farming. The Metropolitan Municipality supported agricultural production by providing farmers with machinery and processing facilities (İzmir Büyükşehir Belediyesi, 2023). The collaboration of the Izmir Metropolitan Municipality with Tire Milk Cooperative is another factor supporting livestock production in the region. This collaboration dates to the period of Aziz Kocaoğlu[1], who was the mayor of İzmir Metropolitan Municipality between 2004-2019. As of 2022, the milk provided to children between the ages of 1-5 within the "Süt Kuzusu" Project, for instance, was supplied by the Tire Milk Cooperative.[2] Overall, therefore, the basin and the surrounding agricultural areas in Izmir receive financial and other types of indirect support by both central and local governments for dairy and livestock production, which makes maize and silage maize an attractive and profitable crop option for farmers. Simultaneously, there are also support schemes for the adoption of drip irrigation. How these different types of support shape farmers' decisions regarding maize production and adoption of drip irrigation will be further elaborated in the next sections of this thesis. But before that, in the following section, I briefly summarize the methodology I used in this study.

[1] https://www.egeyebakis.com/izmir-modeli-yikildi-eskiyoruk-ten-sut-kuzusu-cikisi-dislandik/62774/
[2] https://www.izmir.bel.tr/tr/Haberler/dagitilan-sutun-yarisi-tire-sut-ten-tedarik-ediliyor/46313/156

4. METHOLODOLOGY

The data collection method was divided into two separate phases. In the first phase, face-to-face interviews were conducted with the local authorities of different public institutions responsible for agriculture in the basin, such as provincial agriculture directorate, district agriculture directorates, chambers of agricultural engineers, and irrigation unions. Following that, in the second stage, I visited and conducted surveys and follow-up interviews with the farmers based on a snowball-sampling method described below in this section. This enabled me to collect insights from both decision-makers as well as learn about the individual experiences of the farmers.

The field research was conducted with 6 representatives from the public authorities and 43 small- and large-scale farmers aged 18 and above (36 of them small-scale with agricultural land smaller than 101 da), two of them medium-scale (with agricultural land between 101 and 250 da) and five of them large-scale (with agricultural land greater than 250 da), residing in selected villages within Ödemiş, Tire, and Bayındır, regions known for their intensive agricultural activities in the Küçük Menderes Basin located in İzmir. The survey aimed to identify and comprehend farmers' perceptions regarding water scarcity, their water conservation practices, irrigation methods, and decision-making processes associated with drip irrigation. Participants were selected through a snowball sampling method from the farming communities located in the ten villages of Ödemiş, Tire, and Bayındır. The sampling process started in the village of Birgi, Ödemiş, where I visited a village coffee house and asked the farmers spending time there for permission and consent to conduct a scientific survey on water scarcity and drip irrigation. I conducted the surveys with farmers who were willing to participate and then asked them for other potential farmers that they know who would be willing to participate. This process was replicated in nearby villages of Ödemiş and was then extended to Tire and Bayındır. While many of the surveys were conducted in coffee houses, I also visited four farmers in their own farms. Two of those four farmers were adopting drip irrigation, one for maize (in the village of Karateke where the water user association requires farmers to use drip irrigation) and one for vegetables. In each coffee house that I visited, on average, five out of twenty individuals were willing to take part in the study, making up an average response rate of about 25 percent. Most individuals who did not want to take part stated that they are not conducting any agricultural activities anymore. This process continued until I reached a minimum number of forty participants in the study who took part in the survey. This process did not entail any risks for the farmers, as I did not collect any data on their individual identity such as their names and addresses. None of their responses were shared

with any third party, either. I analysed farmers' responses in an aggregate, anonymous way, without any reference to their personal information. All participants were informed that they have the option to skip questions or discontinue the survey at any point without facing any consequences. The specific survey questions and in-depth interview questions that were used with representatives from public institutions presented in the Appendix. Below I present the details regarding the face-to-face in-depth interviews and surveys conducted with farmers.

In June 2022, face-to-face, in-depth interviews were conducted with six representatives of public institutions in the basin, in the districts of Tire, Ödemiş, and Bayındır and İzmir. The interviews were conducted to explore crop production, farmer decision-making, and irrigation systems in the region, including the choice of crops, methods of planting, techniques of irrigation, and patterns of water utilization over the last 5-10 years. As such, the responses provided me with an understanding of the general agricultural characteristics in the study area.

Table 4.1.Representatives from the state institutions and public organisations interviewed.

Region	**Number of respondent(s)**	**Institution**
İzmir	1	İzmir Provincial Directorate of Agriculture and Forestry
Tire	2	Tire District Directorate of Agriculture
		Tire Chamber of Agricultural Engineers
Ödemiş	1	Ödemiş District Directorate of Agriculture
Bayındır	2	Bayındır District Directorate of Agriculture
		Bayındır Irrigation Association

The research also entailed a series of face-to-face questionnaires followed by informal interviews conducted with a total of 43 farmers in the Küçük Menderes River Basin region in August 2023, specifically in five villages of Ödemiş (Beyazıtlar, Birgi, Hacıhasan, Kızılcaavlu, Küçükavulcuk, İlkkurşun), two in Tire (Çeşteman Kavağı, Karateke) and two in Bayındır (Yalıkavak Mevkii,

Karapınar). The surveys were conducted by visiting village coffeehouses in each village and/or the farms of the participants. Turkish coffeehouses are integral to local culture and social life, especially in villages. These places frequently form a substantial part of the social structure in villages, providing a setting where people gather to socialize, participate in conversations, and share thoughts. The survey was conducted on a voluntary basis. Participants were not asked for any kind of specific personal data. I took notes of the comments made by the farmers and the details they provided without any specific names of participants.

The surveys aimed to identify and understand the perceptions of farmers on water scarcity, their practices on water conservation and irrigation, and decision mechanisms related to drip irrigation. Additionally, follow-up interviews were conducted for understanding farmers' water use and adoption and non-adoption of drip irrigation practices in depth. In the survey, each farmer was presented with a set of 45 questions, which are available in Appendix B. Questions were categorized into four modules, designed to cover a wide array of aspects related to the research.

Survey Module 1: General Questions

This module focuses on general information about the farmer characteristics such as their income sources, agricultural and non-agricultural activities, presence of livestock farming, their agricultural cooperative and association memberships, land size they own and/or operate, primary crops they cultivate, decision-making factors for crop selection, presence of government incentives, water sources and drip irrigation usage.

Survey Module 2: Farmers' Perceptions of Water Scarcity

This module gathers basic information related to the perception of farmers regarding water scarcity in the region. This module also covers sources of irrigation water, drought experiences in the region, water quantity issues in wells, rivers and irrigation dams and the impact on agricultural production.

Survey Module 3: Water Conservation and Irrigation-Related Questions

This module aims to collect information about farmers' perceptions regarding water sources for irrigation and the adoption of drip irrigation. This module also assesses the changes in livestock farming and maize cultivation in the region over the past five years. Additionally, there are questions

about the perceived cost and necessity of transitioning to drip irrigation and the factors influencing irrigation-related decisions.

Survey Module 4: Socio-Economic Information

This module collects data on the socio-economic background of the farmers, encompassing factors such as age, income, education level and number of people living in the household.

15 open-ended questions were drafted to be used with the representatives from public institutions shown in Table 4.1. I categorized their responses and compared them across three districts to understand regional subtleties and institutional perspectives. This first stage provided the basis for the second stage of the project. Based on the insights from the first stage, I then prepared the 45 questionnaire items to be used in the survey with farmers. I used both open-ended and closed-ended questions. Closed-end questions were formulated as agreement with statements on a 5-point Likert-scale ranging from Strongly Disagree to Strongly Agree. The questionnaire results were analyzed in an exploratory way, based on the descriptive statistics gathered. Responses were later summarized as follows: 5-4: Agree, 3: Undecided, 2-1: Disagree. Basic descriptive statistics such as max, min, and mean were used to summarize the overall results.

5. RESULTS

5.1. In-depth Interviews with Public Institutions

This section presents the findings of the in-depth interviews conducted with public institutions, irrigation associations and the chamber of agricultural engineers presented in Table 4.1. The conversations were essential in obtaining valuable insights regarding many aspects of agricultural practices and irrigation methods in the region. The prominent practices in the agricultural landscape of Bayındır, Ödemiş and Tire regions in İzmir provide crucial information for understanding the relationship of factors influencing crop selection and irrigation methods.

Ödemiş

According to the Ödemiş District Directorate of Agriculture, the prevalent crops in the region are silage maize, Italian ryegrass, and potatoes. The widespread ownership of livestock farming in villages results in virtually everyone having animals. Consequently, farmers predominantly cultivate feed crops to feed their animals and sell any surplus produce. According to the representatives from this public authority, water availability is not currently a cause for concern. In the region, 80% of farming involves dairy cattle, while 20% is dedicated to beef cattle, with livestock farming being the primary source of livelihood. Farmers engage in livestock farming; hence they grow feed crops, not merely because of the incentives provided by the government but out of necessity to earn their livelihood. Fields remain cultivated throughout the year, with Italian ryegrass and maize planted in April as the first crop and harvested in July and August. Subsequently, they are replanted as a second crop, with maize following Italian ryegrass, and wheat is planted in June after the harvest.

Fallow practices are not applied, and the fields are consistently being cultivated year-round. Crop rotation is practiced between Italian ryegrass, wheat, and maize. Furrow irrigation is used in maize production, while drip irrigation is primarily employed for growing fruits.

Farmers are familiar with drip irrigation, but its usage is minimal, accounting for approximately 10% of farmers. According to the public institution representatives, the overall perception of farmers is that drip irrigation is more effective in fruit and vegetable cultivation rather than in maize production. Farmers believe that the crops are not adequately irrigated using drip irrigation and that

the effort required does not justify the benefits. Additionally, they consider drip irrigation unnecessary for the crops they cultivate.

Water is mainly drawn from wells, with some areas utilizing water from dams and some farmers drawing water from ponds. Around 70% of the water is sourced from wells and those without artesian wells purchase water externally. The depth of water extraction varies, ranging from 50 meters in streambed areas to 350 meters in the inland regions. Water-sharing practices depend on the relationship between farmers, including both shared and individually owned wells, as well as purchases from others. There are also farmers sourcing their irrigation water from irrigation associations.

Tire

Representatives from the Tire District Directorate of Agriculture state that the primary crops in the region include tomatoes, figs, olives, peaches, silage maize, wheat, and olives. Olive and peach orchards are traditionally being passed down through generations. Due to the prevalence of livestock farming and the productivity of silage maize, which can be harvested 2-3 times a year without fallow periods, farmers prioritize its cultivation. Wheat is sown in November and harvested in May or June. Tomatoes and figs are also widely grown due to their high profitability and farmers tend to focus on these most lucrative crops. Farmers cultivate silage maize after wheat is harvested in June.

The government provides support for feed crops here, incentivizing farmers to prefer to grow these crops. Farmers register their choice of crops and harvests on the Farmer Registry System (ÇKS). Crops are planted throughout the year and fallow practices are not common. Wheat and Italian ryegrass are typically planted in October and November, followed by the harvest in June, after which silage maize is sown. In addition, Tire Agricultural Engineers Chamber notes that maize, Italian ryegrass, and tomatoes are the main crops in the region. The shift from cotton and tobacco to maize cultivation, according to TURKSTAT data, occurred before 2004 and was primarily driven by profitability perspectives. Farmers made this transition based on the most lucrative crops available, where financial gain stood as the primary motive. Crop rotation occurs between Italian ryegrass, wheat, and maize.

In Tire, flood and furrow irrigation remains the prevalent method, despite farmers having knowledge about drip irrigation. However, the latter is sparingly used, mainly in fruit and vegetable

cultivation due to its perceived high cost and complex maintenance. Water sources predominantly rely on wells, some reaching depths of 200 meters, while a few villages utilize water cooperatives drawing from ponds.

Farmers in the region exhibit diverse practices concerning well water usage. Some share wells, while others maintain individual access. Despite their awareness of drip irrigation, farmers hesitate to adopt it universally due to costs, labor requirements, and concerns regarding adequate water supply for their crops. This hesitation particularly affects maize cultivation, where farmers perceive drip irrigation as less efficient.

Bayındır

According to the Bayındır District Directorate of Agriculture, the primary crops in the region include silage maize, Italian ryegrass, forage turnip and clover. The cultivation of feed crops is attributed to the prevalence of livestock farming in the region and the availability of zero-interest loans for livestock-related activities for those who own (officially) wells. However, most farmers cannot benefit from agricultural loans due to the majority having unauthorized wells (Haber Tire, 2022), lacking the necessary permits.

In terms of incentives, the focus is on livestock-related support. Farmers are informed about more productive crops through training and announcements. Silage maize is planted in two periods: spring (April-May) and fall (September-October). Italian ryegrass is sown before New Year's, and forage turnip is planted around September-October. Fields are not left fallow; instead, a continuous cycle of planting new crops is maintained. For example, after harvesting one crop, another is planted on the same day.

According to the representatives from this district-level public authority, there are ongoing endeavors to enhance the adoption of drip irrigation, however its efficacy in the context of maize farming remains constrained in the region. The close spacing of crops and frequent tillage practices render drip irrigation less feasible, hence leading farmers to favor the utilization of furrow irrigation methods. Farmers tend to avoid using drip irrigation, mostly due to the complex installation procedures. Moreover, the implementation of this technique becomes burdensome when sourcing water from a dam, as it may contain soil or particles that have the potential to obstruct the pipes used

in drip irrigation. Whenever individual farmers possess their own wells, this approach is not commonly favored.

Farmers acquire knowledge regarding drip irrigation through the dissemination of information by the district agricultural directorate, as well as through the exchange of experiences with their neighbours involved in agricultural activities. Nevertheless, the utilisation of this approach is not widely adopted in Bayındır, either. This may be attributed primarily to the perceived lack of efficacy, as well as the substantial height of maize plants, which typically reach approximately three meters.

According to officials, most farmers possess their own wells, whereas a subset of farmers relies on water sourced from a dam. The utilisation of municipal water is absent. Water is commonly extracted at depths that vary between 100 and 150 metres. Farmers engage in the practise of well-sharing due to the absence of personal wells or the presence of strong relationships with neighbouring farmers.

Bayındır Irrigation Association emphasizes the cultivation of feed crops in the region is widespread such as silage maize, Italian ryegrass, and wheat. In the region, where livestock farming is the predominant agricultural activity, farmers commonly opt to cultivate feed crops. Drip irrigation is commonly employed by individuals engaged in fruit and vegetable agriculture, but traditional furrow irrigation is favoured by producers of feed crops. Farmers get knowledge on irrigation techniques from two primary sources, namely the irrigation association and agricultural cooperatives. The primary water source predominantly consists of wells, with a portion of farmers extracting water from the dams.Table 5.1 below provides a summary of insights from interviews with public officials in three regions.

Table 5.1. Summary of agricultural characteristics across Ödemiş, Tire, and Bayındır.

Features	Ödemiş	Tire	Bayındır
Main Crops	Silage maize, Italian ryegrass, potatoes	Tomatoes, figs, olives, peaches, silage maize, wheat	Silage maize, Italian ryegrass, forage turnip, clover
Irrigation Methods	Furrow irrigation for maize, drip irrigation for fruits. About 10% usage of drip irrigation	Primarily flood and furrow irrigation, minimal drip irrigation for fruits/vegetables	Preference for furrow irrigation, drip irrigation minimal only for fruits/vegetables
Water Sources	Mostly from wells (around 70%), some from dams and ponds	From privately owned wells, a few villages use pond water	Mostly privately owned wells, limited use of dam water
Investment & Knowledge	Government support directed towards livestock, knowledge of drip irrigation but not widely adopted	Government support mostly for livestock, knowledge of drip irrigation but not widely adopted	Focus on livestock support, knowledge of drip irrigation but limited adoption

Overall, farmers in each district seem to have a strong focus on animal husbandry, resulting in an expansion of the cultivation of feed crops. Public authorities imply that the adoption of drip irrigation is often met with reluctance on the side of farmers, especially, in the context of maize agriculture due to its perceived ineffectiveness, perceived high costs and other complications. The findings of the questionnaires with farmers and the follow-up interviews seem to confirm this, as discussed in the following section.

5.2. Surveys and Follow-up In-depth Interviews with Farmers

This section presents a complete overview of the insights derived from the surveys and follow-up interviews conducted among farmers located in the villages of Ödemiş, Tire and Bayındır. Surveys were conducted in a total of 10 villages, namely in Beyazıtlar, Birgi, Hacıhasan, Kızılcaavlu, Küçükavulcuk, İlkkurşun, Çeşteman Kavağı, Karateke, Yalıkavak Mevkii, Karapınar across Ödemiş, Tire, and Bayındır with 43 farmers in total, 36 of them small-scale (with agricultural land smaller than 101 da), two of them medium-scale (with agricultural land between 101 and 250 da) and five of them large-scale (with agricultural land greater than 250 da). After the surveys, I often continued with informal in-depth interviews, as the farmers were often eager to talk more about their perceptions,

concerns and needs in terms of water use and irrigation. The regions and total number of surveyed/interviewed producers are presented in the Table 5.2 below.

Table 5.2. Survey numbers allocated across villages.

City	District	Total answer	Village	Total number of surveyed producers
İzmir	Bayındır	8	Yalıkavak Mevkii	7
			Karapınar	1
	Ödemiş	25	Beyazıtlar	4
			Birgi	11
			Hacıhasan	5
			Kızılcaavlu	1
			Küçükavulcuk	3
			İlkkurşun	1
	Tire	10	Çeşteman Kavağı Mevkii	1
			Karateke	9

Module 1: General Questions

The purpose of this module was to gain insights into farming experiences and livelihoods of farmers in the basin. Among 43 farmers who participated in the study, the average number of years engaged in agriculture was 37 years with a median value of 38. The most experienced farmer had 77 years of farming experience, while the least experienced farmer had been involved in agriculture for 6 years. Out of 43 farmers surveyed, only 5 relied solely on agriculture as their main source of income. 4 farmers were engaged in agriculture along with gardening, horticulture, shepherding, or sales of food (*gözleme*, traditional Turkish dish usually sold in street markets). The number of farmers engaged in animal husbandry alongside agriculture was 30.

Out of the 30 livestock farmers, 22 were engaged in cattle breeding, while one farmer was involved in the breeding of sheep. The remaining 7 farmers indicated involvement in both cattle and

sheep breeding. Farmers maintained varying numbers of animals, ranging from 5 to 350, with an average of 74 animals.

A total of 19 of the surveyed farmers stated that they are members of an agricultural production cooperative. 12 farmers who gave an answer to the question on how many years they have been members of a cooperative, the average was 26 years, indicating that they have been a cooperative member for a considerably long period. The remaining 7 farmers stated that they do not remember for how many years they have been members. The distribution of memberships in agricultural cooperatives are shown in Figure 5.1. Two farmers mentioned that they are members of both the agricultural credit cooperative and the livestock associations in their region. Membership in the Tire Milk Cooperative was important, as this cooperative strongly supports dairy production and cattle breeding in the İzmir region. Seven of the surveyed farmers indicated that they are a member of this cooperative. The Tire Milk Cooperative acquires a daily supply of 150 metric tons of milk from a total of 50,000 cows distributed across its 68 milk collection locations. The cooperative offers substantial assistance to farmers operating in rural areas. Villagers who are involved in the cooperative deliver their daily milk production to the milk collecting centers. Additionally, farmers can take advantage of the cooperative's resources to obtain the agricultural tools, feeds, and fuel needed for their tractors (Sabancı Vakfı, n.d.).

In line with its "Başka Bir Tarım Mümkün" vision, the İzmir Metropolitan Municipality has been implementing various projects which are designed around local production, efficient water usage, support for livestock farming, assistance to beekeeping activities, local producer markets, seedling support, vegetable, and fruit markets, and supporting farrmers through soil analyses (İzmir Büyükşehir Belediyesi). For livestock farming, İzmir Metropolitan Municipality organized breeding training programs with the aim of supporting and promoting small ruminant farming. A total of 14,359 small ruminant grants were provided to 3,687 producers in the districts of Aliağa, Bayındır, Bergama, Beydağ, Dikili, Güzelbahçe, Karaburun, Kemalpaşa, Kınık, Kiraz, Menderes, Ödemiş, Seferihisar, Selçuk, Tire, and Urla in 2023. Additionally, water buffalo (*manda,* in Turkish) breeding education sessions were conducted between 2020 and 2023 in the districts of Selçuk, Bergama, Kınık, Tire, Menemen, and Aliağa. During this period, 302 water buffalos were granted to 88 producers (İzmir Büyükşehir Belediyesi, 2023).

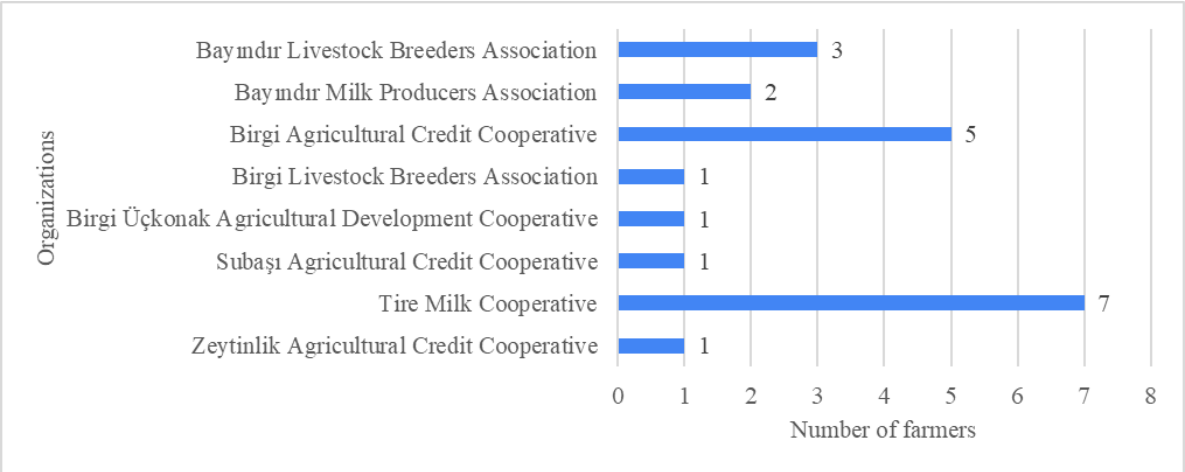


Figure 5.1. Membership in agricultural cooperatives and associations among farmers.

The following figure (Figure 5.2) summarizes membership in irrigation cooperatives or associations among the farmers surveyed. There were 21 farmers who indicated that they are registered with an irrigation association or irrigation cooperative. These farmers mentioned that they do not have their own well and therefore obtain water from irrigation associations.

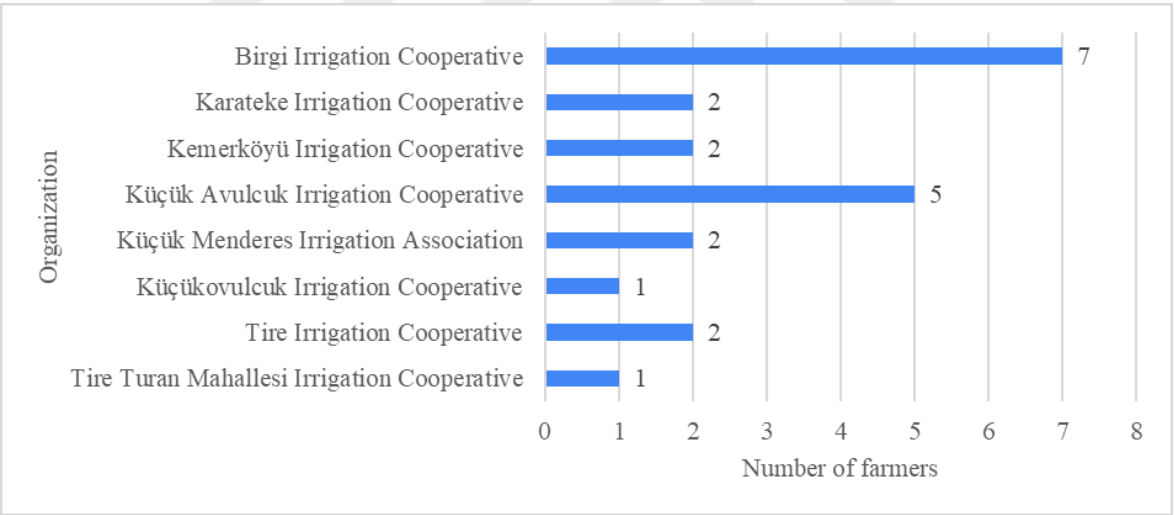


Figure 5.2. Membership among farmers in irrigation cooperatives and associations.

Farmers were asked about the size of the land they operate and/or own. The lands owned and/or operated by farmers varied from 6 decares to 1000 decares, with an average land size of 95 decares where median value was 55 decares. Of the interviewed farmers, five operate on a large scale (agricultural lands greater than 250 da), two on a medium scale (agricultural lands between101-250 da), and 36 on a small scale (agricultural lands smaller than 100 da). So, most of the farmers (83.7%) I surveyed were small-scale farmers.

Table 5.3 below shows the characteristics of the five large-scale farmers I surveyed and interviewed and their drip irrigation preferences and the products they cultivate. As revealed in Table 5.3, even large-scale farmers did not prefer drip irrigation for maize due to several constraints: They stated that their large farm size would increase additional workload; they believed that the yield will be limited in larger fields; placing and assembling the pipes is costly, and finding a sufficient number of workers to perform this task is difficult. However, for products other than maize, large-scale farmers indicated that drip irrigation has several advantages such as an even amount of irrigation for crops, regular application of fertilizers and pesticides, and the ease of taking preventive measures against diseases. Additionally, a shared characteristic among large producers was that they all had their own wells.

Table 5.3. Characteristics of large-scale farmers.

Age of farmer	**Level of Education**	**Cultivated products**	**Drip irrigation preference**	**Drip irrigated product**
60	Elementary school	Maize, peach	Yes	Peach
80	Elementary school	Maize, fodder crops, wheat, alfalfa, potatoes, cotton	No	-
44	Elementary school	Maize, alfalfa, pepper	No	-
36	Secondary school	Tomatoes, cauliflower, broccoli, cabbage	Yes	Tomatoes, cauliflower, broccoli, cabbage
31	University	Maize, potatoes, wheat, pepper	Yes	Potatoes, wheat, pepper

Figure 5.3 below illustrates each product along with the number of producers cultivating these products.

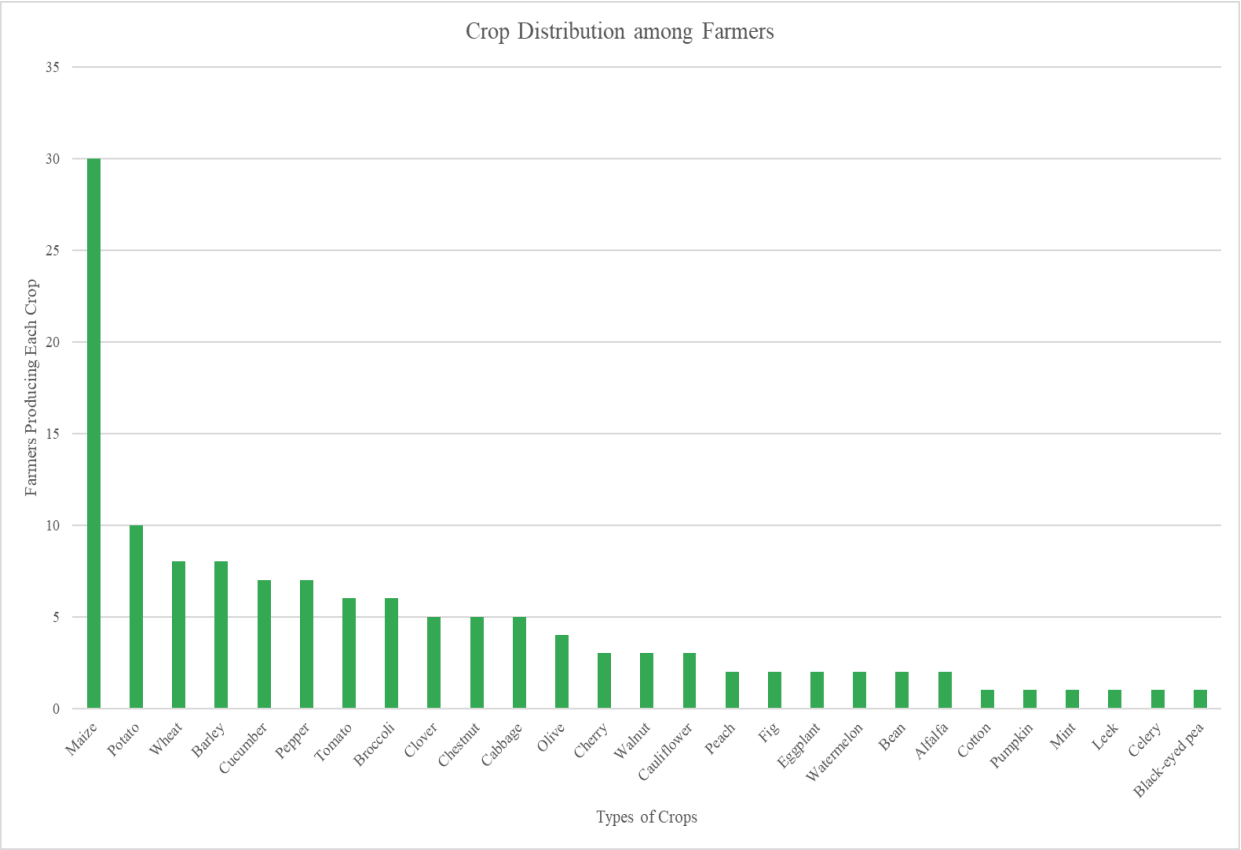


Figure 5.3. Main crops produced among surveyed farmers.

Among the surveyed farmers, most (70%) were engaged in silage maize cultivation. The product profile varied according to the villages surveyed in the region. Among these farmers, there were 4 who solely cultivated maize to feed their animals, 30 farmers in total grow maize, and 26 of them cultivated other crops alongside maize. All farmers who grow maize were also involved in livestock farming. There were 6 farmers who do not grow maize but engage in livestock farming. Among them, 3 cultivated crops such as barley and wheat as animal feed, while the other 3 purchase animal feed. 3 farmers mentioned that they receive a retirement pension in addition to their farming and livestock incomes, while 3 others stated that they are also involved in trade activities. In the villages of higher altitudes (for instance, Hacıhasan, Ödemiş), there is a predominant focus on fruit orchards such as chestnut, peach, cherry, fig, and olives. Rest of the farmers stated that they cultivate potato, wheat, barley, cucumber, pepper, tomato, broccoli, clover, cabbage, cherry, walnut, cauliflower, eggplant, watermelon, bean, alfalfa, cotton, pumpkin, mint, leek, celery, black-eyed pea in addition to maize.

Farmers were asked about how they decide on the crops they produce each year. According to the survey, farmers' decisions regarding crop selection are primarily driven by market conditions, including prevailing market factors, such as prices and demand. This is particularly evident among livestock farmers, who prioritize feed crops like maize and triticale to ensure their animals' nutritional

needs are met. Some farmers also consider their personal needs and experiences when making crop choices, while others prioritize meeting the demands of market. This reflects their desire for certainty and stability in their product selection. A few farmers actively seek knowledge about new crops and experiment with them, often guided by information obtained through media like the internet and television. Additionally, two indicated that they utilized soil analysis services provided by agricultural engineers to gain insights into their soil conditions to decide on which crop they will produce. Figure 5.4 illustrates factors influencing farmers' product choice.

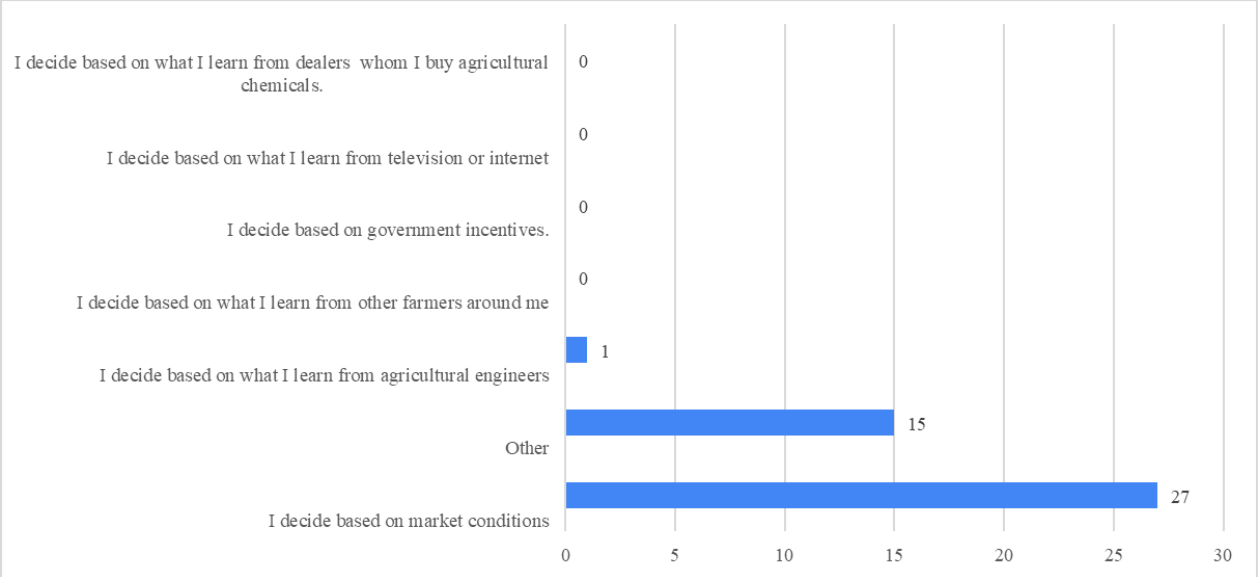


Figure 5.4. Factors influencing product choice.

Producers who receive support and/or incentives for their products or animals stated that 32% of them receive support specifically for maize. Additionally, 21% of those who receive support and/or incentives mentioned receiving diesel and fertilizer support. Farmers indicating calf and milk support constituted 16%, while those stating that they do not receive any support or incentives due to various reasons make up 32%. Farmers who indicated not receiving any support mentioned that the absence of support/incentives for the products they cultivate, and they do not receive support due to their small field sizes. This is mainly because some supports are given based on a minimum land size, as stated by the farmers and by Mirhanoğlu et al. (2023).

> "I'm growing my crops based on chance. Agricultural policies in the region are not functioning effectively, the government is not providing incentives to the producers." (Interviewee 31, small scale farmer, Ödemiş)

Figure 5.5 summarizes the answers of farmers on agricultural support and incentives by the government.

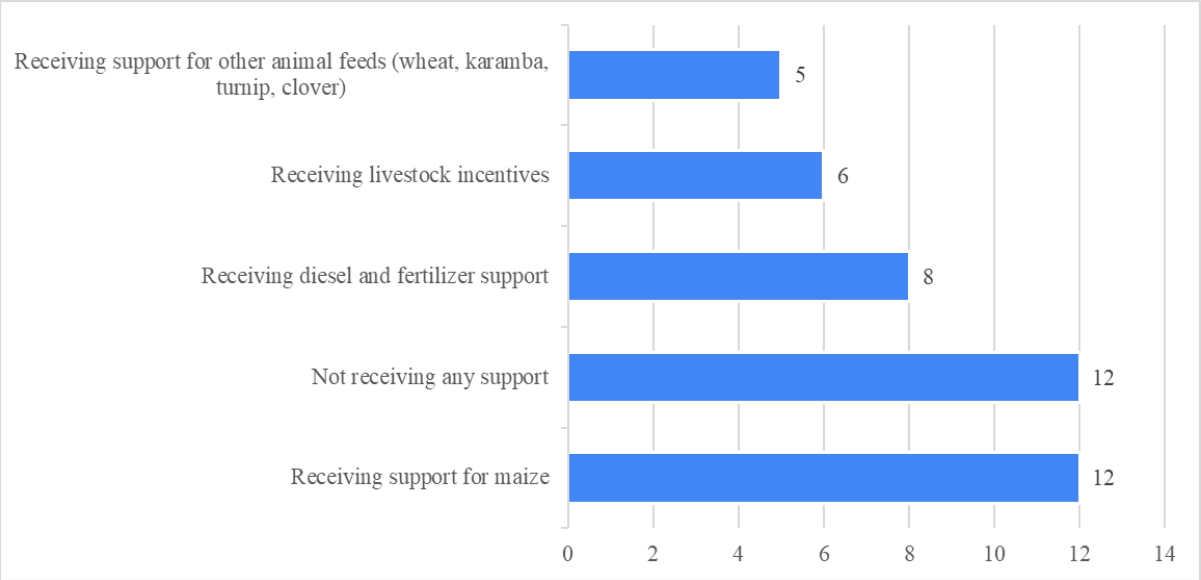


Figure 5.5. Agricultural supports and incentives.

A great majority of the farmers surveyed (40 out of 43) mentioned using irrigation wells, while one indicated practicing rain-fed irrigation as shown in Figure 5.6. Additionally, one farmer stated that he combines both irrigation wells and streams, and another one noted that he uses both an irrigation well and an irrigation dam. Average yearly precipitation in the basin is 695,6 mm (Su Yönetimi Genel Müdürlüğü, 2019). This precipitation rate is higher compared to the Central Anatolian Region, which is the least rainy region in Turkey with an average rainfall of around 400 mm (Tarım ve Orman Bakanlığı, 2021). According to the interviews with farmers that I conducted, the first round of silage maize planted in April requires on average 7 irrigations, and the first harvest is carried out in July. Subsequently, the second round of silage maize planted in August, is harvested in November, with three irrigations being sufficient during this period due to the influence of seasonal rains. Between November and April, crops such as barley and wheat are cultivated in the region. In the region, crop rotation is widely adopted, enhancing soil fertility, and preventing the spread of harmful organisms. Additionally, between November and April, production is carried out without the need for irrigation, relying on natural seasonal rainfall.

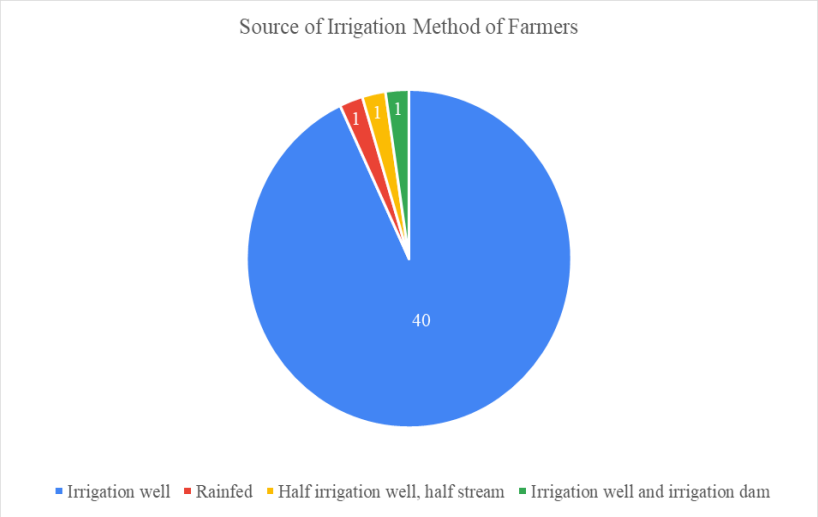


Figure 5.6. Source of irrigation methods of farmers.

Almost half of the surveyed farmers (20 out of 43) stated that they had previously used drip irrigation methods, whereas 23 farmers never used it before. Out of the initial group of 20 farmers that attempted drip irrigation, 4 of them discontinued the practice. The reasons for this were related with their perception of inadequate/insufficient level of watering, the failure to achieve the anticipated yield, and the difficulty encountered in maintaining the equipment as also stated by the public institutions discussed in In-depth Interviews with Public Institutions of section.

> "Drip irrigation is very inefficient for maize; maize demands excessive water and drip irrigation doesn't provide adequate water through the drip system." (Interviewee number 24, small scale farmer, Ödemiş)

The 4 farmers who abandoned drip irrigation were planting maize in addition to barley, wheat, cucumber, and potato. 16 of the producers who continued drip irrigation state to use it for vegetables and fruit orchards such as tomato, cauliflower, broccoli, cabbage, peach, potato, cucumber, pepper, wheat, barley, kidney beans, cherry, chestnut, walnut, olive fresh fava beans and eggplants. Only one farmer stated to utilize drip irrigation for maize, due by the requirement imposed by the Karateke Irrigation Union in the district of Tire on its members to source water from this union's facilities.

> "The Karateke Irrigation Union mandates drip irrigation to access water. I don't have my own well, so I get water from the irrigation union, which is why I irrigate maize using drip irrigation, but it becomes very laborious." (Interviewee number 16, small scale farmer, Tire)

According to the 16 farmers, who stated that they use drip irrigation, the reasons indicated were to facilitate water conservation, promote uniform dispersion of fertilisers and pesticides, enable

proactive disease management, lower expenses, minimise labour requirements and offer practicality and time efficiency.

The farmers list the advantages of drip irrigation as shown in Figure 5.7 below.

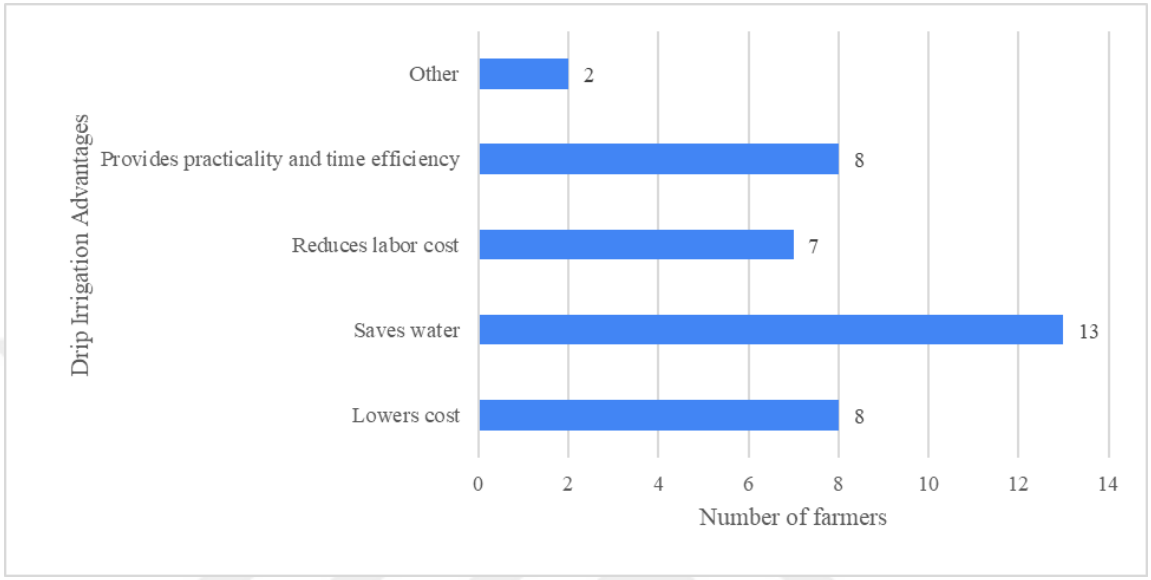


Figure 5.7. Drip irrigation advantages reported by farmers.

According to the survey findings, farmers only use drip irrigation if they are cultivating maize alongside fruits and vegetables, and they do not prefer drip irrigation for planting silage maize. This situation is in line with the Climate Change Impact on Water Resources Project Final Report prepared by the General Directorate of Water Management, which indicates the use of drip irrigation for all crops except silage maize in the region (Su Yönetimi Genel Müdürlüğü, 2018b). Despite indications in the literature that the drip irrigation method is practical for other crops, saves time, reduces labor costs, increases yields, and is cost-effective (SKD Türkiye and Ankara Üniversitesi Su Yönetimi Enstitüsü, 2023; FAO and Tarım ve Orman Bakanlığı, 2021), farmers specifically express reluctance to use it for silage maize. This reluctance is attributed to both the inadequacy of watering maize sufficiently and the challenges associated with using this equipment on large maize fields. Farmers state that the labor-intensive process of assembling the equipment every year and difficulty in finding labor, and the risk of animals, such as moles, damaging the pipes as reasons for not favoring drip irrigation for maize cultivation.

"Drip irrigation can be very productive if managed well. But it's a challenge to use it for every crop. It requires careful handling." (Interviewee number 15, Ödemiş, small scale farmer).

Although farmers do acknowledge a decrease in water levels in their wells and experience drought conditions, they prefer not to switch to drip irrigation, citing the high profits from maize cultivation (for which they are not willing to use drip irrigation) and the perceived labor intensity as reasons.

In the survey, approximately 70% of farmers indicated maize as their primary product. Following maize, the second mostly cultivated crop was potatoes, with around 24% of the surveyed farmers engaging in potato cultivation. Among potato-producing farmers, 89% operate in Ödemiş, while the remaining 11% operate in Tire. Wheat, barley, and cucumber followed potatoes. Pepper, tomato for paste, and broccoli also ranked among the mostly cultivated crops in the region, following cucumber.

The intensive cultivation of crops such as maize and barley, used in animal feed, is commonly associated with livestock farming practices prevalent in the region. Farmers in the region associate the changing production patterns with the risk of their vegetables remaining unsold, market fluctuations, and low profits. Therefore, they mostly mentioned that they rely on livestock farming for their livelihoods.



Figure 5.8. Drip irrigated maize field in Tire, Karateke.



Figure 5.9. Drip irrigation in Bayındır.

Diverse perspectives exist among farmers with regards to the adoption of drip irrigation, given each product. For example, some farmers stated that the utilisation of this technique is suitable on peach trees or cucumber, but not suitable for potatoes.

> "I switched to drip irrigation due to water scarcity, but it doesn't work for potatoes. I use it for cucumber. Not every crop is suitable for drip irrigation." (Interviewee number 8, Ödemiş, small scale farmer)

But there is a common perception among the farmers surveyed that drip irrigation does not fit maize production, even though the literature suggests otherwise (FAO and Tarım ve Orman Bakanlığı, 2021; SKD Turkey and Ankara Üniversitesi Su Yönetimi Enstitüsü, 2023). Those cultivating maize in the basin therefore had a clear preference for furrow irrigation. Moreover, drip irrigation is perceived to be advantageous only in farms where the terrain is flat because this facilitates the process of irrigation. However, Climate Change Impact on Water Resources Project Final Report prepared by the General Directorate of Water Management states that the conditions of the Küçük Menderes Basin are suitable for pressurized irrigation methods for all crops (Su Yönetimi Genel Müdürlüğü, 2018b). Farmers also stated that they face challenges during the installation phase of drip

irrigation systems. The following statements summarize these negative contextual factors of non-adoption of drip irrigation:

> "It saves water and time. Not very advantageous though, requires flat land, it's a lazy man's job, easy during watering but difficult during installation." (Interviewee number 22, Ödemiş, large scale farmer)

> "The drip irrigation system isn't expensive, but finding hired labor to assemble and disassemble every year is challenging. There is a scarcity of labor in the region, and their wages are very high." (Interviewee number 11, small scale farmer, Bayındır)



Figure 5.10. Furrow irrigation used for maize production in Tire.

Module 2: Farmers' Perceptions of Water Scarcity

In Module 2, 13 statements were posed to farmers to understand their perceptions of water scarcity, requesting them to rate each question on a scale of 1 to 5: 1) Strongly Disagree, 2) Disagree, 3) Undecided, 4) Agree, and 5) Strongly Agree. The results were then organized into Agree (4-5), Undecided (3), and Disagree (1-2) categories for the analysis, and the findings for each question are presented in the Table 5.4 below.

Table 5.4. Water scarcity perceptions of farmers.

Statements	Response	Agree	Undecided	Disagree
Agricultural irrigation in our region is mainly done from wells.	43	93.02%	6.98%	0.00%
There is a drought in our region.	43	79.07%	6.98%	13.95%
There are problems related with the amount of irrigation water in our region.	43	62.79%	4.65%	32.56%
The scarcity of irrigation water negatively affects agricultural production.	43	72.09%	2.33%	25.58%
There is a sufficient amount of water for agricultural irrigation in wells.	43	34.88%	11.63%	53.49%
There is a sufficient amount of water for agricultural irrigation in rivers and irrigation dams.*	11	27.27%	63.64%	9.11%
The quantity of irrigation water is less than five years ago.	43	69.77%	16.28%	13.95%
The quantity of irrigation water will be more in the next 5 years than it is now.	43	0.63%	23.26%	65.12%
I believe the current levels of rivers and irrigation dams are lower than five years ago.*	11	72.73%	9.11%	18,18%
I believe the current levels of irrigation wells are lower than five years ago.	43	62.79%	20.93%	16.28%
I believe the levels of rivers and irrigation dams will not change much in the next 5 years.*	11	45.45%	9.11%	45.45%
I believe the water levels of irrigation wells will not change much in the next 5 years.	43	13.95%	34.88%	51.16%
My crops are not significantly damaged by water scarcity.	43	37.21%	6.98%	55.81%

**Farmers mentioned the absence of irrigation canals, dams, or rivers in their region, that is why the number of respondents for the questions with an asterisk are low. There are 11 farmers who responded.*

The consensus among most respondents is that wells serve as the primary source of agricultural irrigation in the region. This observation suggests a significant dependence on groundwater for the purpose of irrigation. A considerable proportion of farmers indicated that they think their region is prone to droughts. Furthermore, most respondents acknowledged the presence of challenges pertaining to the quantity of irrigation water within the region. The consensus among farmers is that water scarcity has a significant impact on agricultural production, with a particular emphasis on the negative consequences it has on farming activities. The sufficiency of water sources is a matter of concern, as a considerably smaller proportion of farmers express agreement regarding the sufficiency of water for agricultural irrigation in wells, rivers, and irrigation dams.

There was a significant number of farmers who held the belief that the amount of irrigation water has decreased in comparison to the last five years. However, many respondents were quite optimistic about the availability of irrigation water for the upcoming five-year period. And a notable proportion of farmers were of the view that water scarcity does not have a substantial detrimental effect on the crops they grow. These two points highlight, quite surprisingly, that the perceived damage of water scarcity for current production and for the future is currently quite limited.

Module 3: Water Conservation and Irrigation-Related Questions

In Module 3, eight statements were formulated to understand farmers' water conservation practices and perceptions of irrigation practices, again on a five-point Likert scale.

Table 5.5. Water conservation and irrigation practices of surveyed farmers.

Statements	Response	Agree	Undecided	Disagree
In my agricultural region, groundwater is used more than surface water.	43	90.70%	6.98%	2.33%
My relatives and other farmers in my region use irrigation methods that save water.	43	55.81%	13.95%	30.23%
Livestock farming has increased in my agricultural region within the last 5 years.	43	60.47%	2.33%	37.21%
Maize cultivation has increased in the agricultural region I operate within the last 5 years.	43	72.09%	11.63%	16.28%
The transition to drip irrigation is very costly in the agricultural region I operate.	43	46.51%	20.93%	32.56%
Maintenance costs for drip irrigation are very high in the agricultural region I operate.	43	44.19%	25.58%	30.23%
There is no need for drip irrigation in the agricultural region I operate.	43	48.84%	13.95%	37.21%

A significant consensus exists among surveyed farmers, indicating a prevailing belief that groundwater serves as the predominant source of irrigation within the agricultural region in which they are actively engaged. This observation underscores the widespread dependence on groundwater

for agricultural irrigation in the region. However, most of the respondents acknowledged that their family and fellow farmers in the area employ irrigation practices with the objective of water conservation, even though they are in general not very willing to switch to drip irrigation for their own production. Yet, there was also a wide-spread awareness that maize production and livestock farming has increased in the region, possibly with negative consequences for water use. The following statement confirmed this:

> "There's drought in the region, and it will worsen as long as maize is being planted." (Interviewee number 43, large scale farmer, Ödemiş)

Farmers surveyed were asked about the main crop that they cultivated before they switched to maize. A significant proportion of participants, 26 farmers, expressed that they were mainly growing cotton before they switched to maize, 8 farmers indicated that maize had replaced potato production, 7 farmers stated that they grew wheat and tobacco before, and 6 farmers indicated that watermelon and barley replaced maize as their chosen crops.

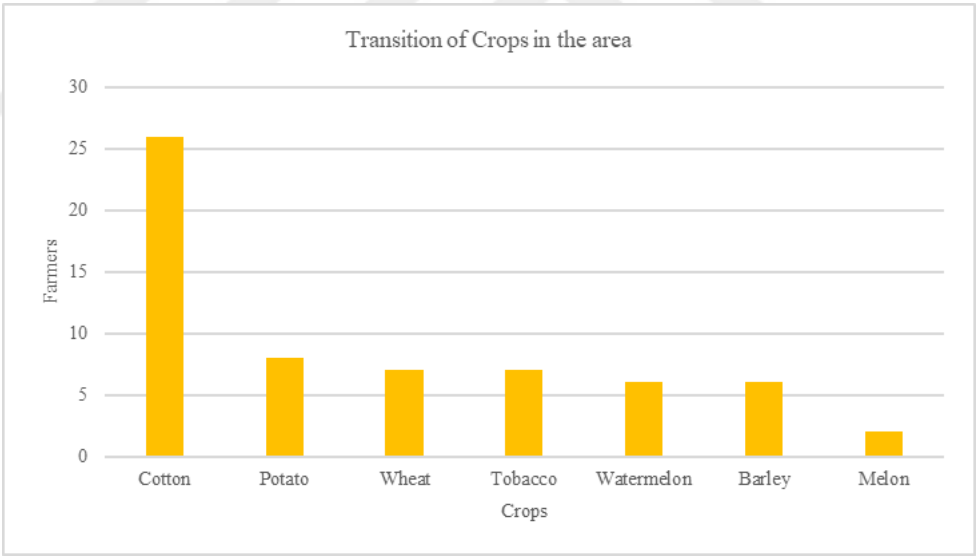


Figure 5.11. The main product cultivated by surveyed farmers before switching to maize.

When asked about how they decide on which crops to cultivate each year, approximately 35% of farmers surveyed placed considerable emphasis on environmental issues including climatic conditions and soil quality. A minority of farmers, comprising 2% of the total, recognized the importance of specialised knowledge and influence of agricultural engineers in informing their choices about crop selection.

When farmers were asked about how they decide on the irrigation method they use, approximately 26% of respondents indicated that the influence of relatives and neighbours is significant in determining the irrigation method. Farmers influenced by agricultural engineers in the region and agricultural extension and consultancy services constituted 7.41% among respondents. Factors such as television and the internet, salespersons from whom agricultural pesticides are purchased, and agricultural provincial or district organizations did not play a significant role in farmers' irrigation decisions. “Other” category mostly indicated personal experience and personal decisions. Figure 5.12 below summarizes these findings.

> "I make the decision regarding irrigation myself; not even a single agricultural engineer has come to inform us in Birgi." (Interviewee number 31, small scale farmer, Ödemiş)

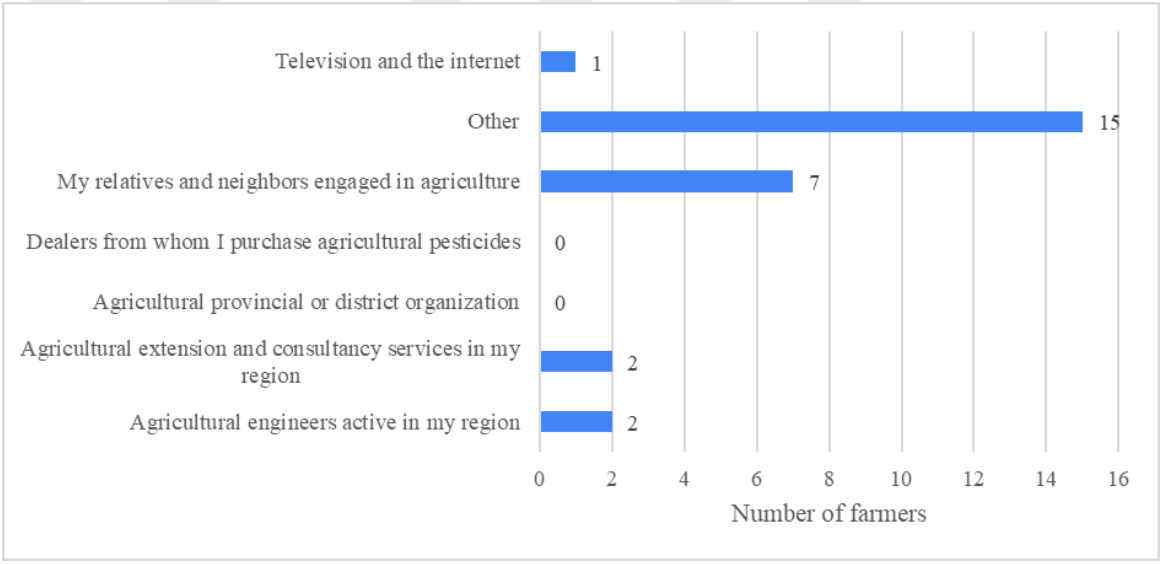


Figure 5.12. Main sources for irrigation type selection.

Module 4: Socio-Economic Information

The age distribution of participants in this study, who were actively involved in farming within the study area, ranged from 31 to 83 years old, with an average age of approximately 56 and median value of 55. This is mainly in line with the general finding in practice and in the literature, due to diminishing interest in agriculture among younger generations within farming families, who often opt for pursuing careers in other sectors, such as industry.

The number of individuals living in the same household varies between 1 and 14 among farmers, with an average of approximately 4 individuals per household with a median value of 4. Regarding

the educational levels of the producers, it was observed that there was a wide range from elementary school to university degree: 34 farmers were elementary school graduates, 7 farmers had graduated from the secondary school, one farmer was a high school graduate, and one farmer was a university graduate. So, a great majority of the farmers surveyed had a rather lower level of education, as in line with the general trends in the country.

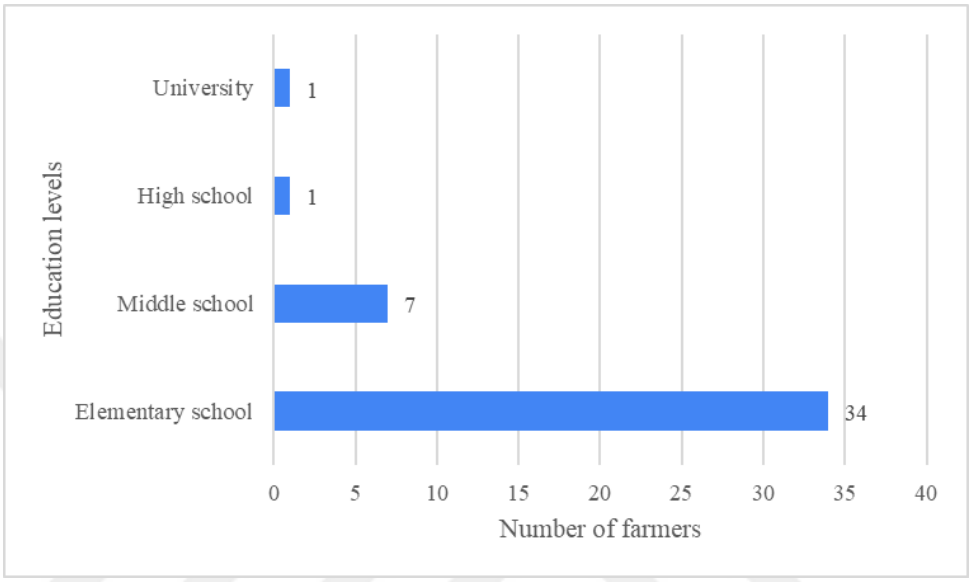


Figure 5.13. Education levels of surveyed farmers.

Lastly, regarding farmers' monthly income, one farmer reported an agricultural income between 0-5000 TL, 24 farmers incomes ranging from 5000-15000 TL, 15 farmers with incomes between 15000-50000 TL, and 4 producers with agricultural incomes exceeding 50000 TL. So, on average, farmers were earning below the minimum wage in the country, even though exceptions existed.

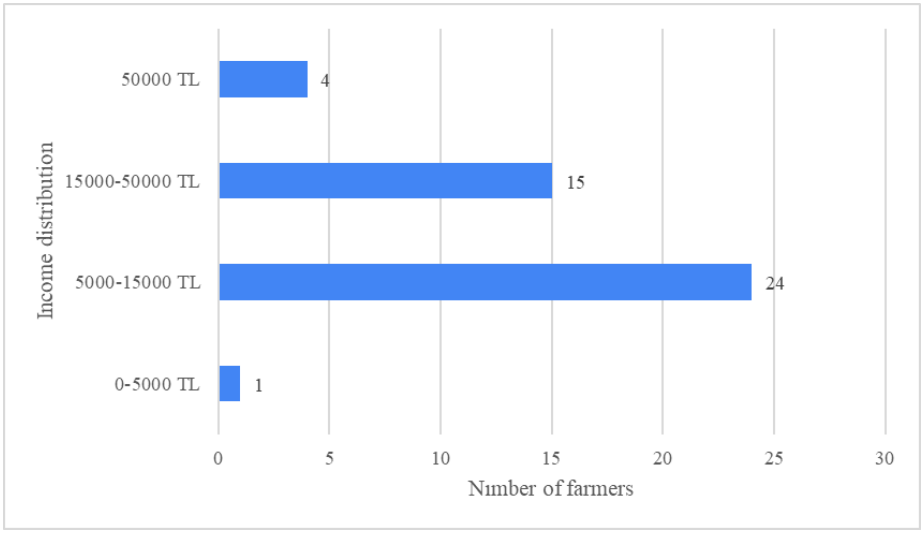


Figure 5.14. Income distribution of farmers.

6. DISCUSSION

In the Küçük Menderes Basin, the agricultural landscape is notably dominated by small-scale agriculture and livestock farming, which plays a pivotal role in determining the crop pattern. Particularly, there is a distinct emphasis on cultivating feed crops that are specifically intended to serve as feed for the animals, especially silage maize. The cultivation decisions in the three districts are mostly driven by the necessity of feeding the animals owned for livestock production, where incentives provided by the government are not the dominant driver.

Many producers are small-scale farmers gorwing silage maize for feeding their animals rather than providing feed crops to the market. The use of a triannual crop rotation can address both pest and drought management. Additionally, triannual crop rotation restores essential plant nutrients and diminishes the need on chemical fertilizers. Crop rotation is one form of traditional agricultural knowledge essential for small-scale farmers for sustaining their livelihoods as well as their farming practices (Aksoy and Öz, 2020). With diversified crop rotation, the soil conditions can be improved, and productivity can be increased, leading to increased soil water uptake and drought tolerance of the soil (Shah et al., 2021).

Smal-scale farmers in the basin are reluctant to invest in new irrigation technologies such as drip irrigation because of the substantial expenses associated with installation and operation. The farming population in the region (especially livestock farmers) typically seek to maintain their livelihoods by following conventional agricultural methods inherited from previous generations. Although drip irrigation is known in the area, several constraints hinder its adoption, such as the need to achieve two harvests each year from silage maize fields and the need to rotate crops every third cycle. This is mainly because every crop has different raw spacings and it is hard and infeasible for small-scale farmers to rearrange drip irrigation system every 4 months. The farmers therefore perceive drip irrigation as an ineffective technology for silage maize. Although there are several studies stating that drip irrigation increases yield and decreases water use especially for maize production (FAO and Tarım ve Orman Bakanlığı, 2021; Fikadu and Teshome, 2021; SKD Türkiye and Ankara Üniversitesi Su Yönetimi Enstitüsü, 2023), farmers in the basin do not believe that this will be feasible for growing rain-fed field crops and silage maize. This reseonates with the study of Aksoy and Öz (2022) in which the authors suggest that it is crucial for policymakers to make efforts towards combining farmers' traditional knowledge and scientific expertise when making decision regarding the introduction of

and support to any new agricultural technology. This emphasizes the crucial significance of traditional knowledge in advancing and maintaining agricultural sustainability.

This implies that although water consumption can be reduced in practice with the drip irrigation system, the efficiency of the system is highly dependent on how this technology is perceived by farmers. This is in line with the general findings in the literature that irrigation preferences are not only shaped by the technical specifications of irrigation equipment, but also heavily influenced by farmer perceptions regarding the technology, as well as costs of initiation and equipment maintenance (Luquet et al., 2005). When farmers believe in the effectiveness of irrigation methods and the economic benefits associated with it, it positively influences their decision to adopt these methods despite its high costs (Chadran and Surendan, 2016). In the Küçük Menderes Basin, the economic benefits of livestock farming dominate, and fluctuating market prices, low returns, and perceived high risks for growing crops (other than feed crops) lead producers to lean towards livestock production, and therefore growing maize, for which farmers believe that drip irrigation is not effective. While the literature highlights the importance of government support for the use of innovative irrigation systems such as drip irrigation (Greenland et al. 2017), this does not resonate much in the Küçük Menderes Basin. Indeed, no farmer surveyed in the study stated that governmental support for drip irrigation is useful for switching to drip irrigation in the basin. Instead, governmental support for agricultural production, in general, was mainly perceived to be low by farmers. The use of unlicenced wells further hinders the appropriate allocation of subsidies for drip irrigation.[3]

Therefore, flood and furrow irrigation remains the dominant method employed in the study area, in line with Bozkurt et al. (2006). According to Bozkurt et al. (2006), drip irrigation may not be economically viable for crops like maize because of the significant upfront costs involved. However, farmers believe that drip irrigation can be effective for other crops like tomatoes, peach, olive, pepper etc. Therefore, cultivated crop type seems to be an influential parameter in the region. Additionally, farmers adopt a crop rotation system, an agricultural strategy commonly used to improve soil fertility and mitigate the impact of pests or harmful organisms as well as the impacts of droughts.

Additionally, while many studies emphasize the potential future challenges of drought in the region, farmers express uncertainty about the variability in rainfall patterns, some of them stating "Only God knows" when referring to what the future holds in terms of water scarcity. This attitude

[3] The presence of unlicensed wells in the basin was indeed supported by the Tire Chamber of Agriculture (Haber Merkezi, 2022).

may be related with the higher levels of precipitation they receive in the basin, compared to Central Anatolia, for instance, as well as their crop rotation practice and fertile lands that they are carrying out agricultural activities on. Therefore, farmers are not very pessimistic regarding their agricultural income and future water scarcity.

In addition to the farmer perceptions, this study reveals that the contextual and institutional factors such as current agricultural policies, initiatives, and legal frameworks play an important role in the acceptance and adoption of drip irrigation among farmers. The literature emphasizes that extension services and membership in farmer organizations play a crucial role in raising awareness about the use of a new technology; accordingly, farmers with access to extension services are more likely to adopt new irrigation technologies (Akudugu et al., 2012; Ruzzante et al., 2021; Serote et al., 2021;) since these provide a convenient platform for farmers to acquire knowledge about the advantages and utilization of the new technology (Akudugu et al., 2012; Mvangi and Kariuki, 2015; Alcon et al., 2019; Ruzzante et al., 2021; Serote et al. 2021). However, the present study demonstrated that although all farmers surveyed were aware of drip irrigation, and almost half of the farmers in the study area were members of irrigation associations and agricultural cooperatives, adoption of drip irrigation was quite limited and only a few farmers confirmed the effectiveness of such associations when implementing new irrigation technologies. This proves that simply having access to knowledge is not enough; the adoption process is also influenced by the type and effectiveness of knowledge, as well as the btraditional agricultural knowledge that farmers have (Mvangi and Kariuki, 2015).

Farmers can adopt a new technology due to the availability of reliable, consistent, and accurate information, as well as strong institutional infrastructure support. In the study area, farmers cultivating maize only preferred drip irrigation if they are legally required to do so (in the case when they do not have any other water sources such as private wells, for instance), but drip irrigation is usually not their favored method if they have their own well. Furthermore, the irrigation union's mandate for drip irrigation to access water underscores the potential influence of systemic factors in the region to define adoption decision of the farmers. While the prevailing opinion in the region is that drip irrigation does not provide sufficient water to crops, particularly in maize, there appears to be a lack of active involvement from agricultural engineers, public institutions, or other informational bodies in the area to inform farmers about the effectiveness of drip irrigation especially in maize production. Despite the fact that, when used properly, drip irrigation evenly distributes the required amount of water to plants, facilitates easy application of fertilizers and agricultural chemicals, is beneficial for disease prevention, improves both crop output and water use efficiency in maize,

making it suitable for places experiencing water constraints (Liu et al., 2023; SKD Turkey & Ankara Üniversitesi Su Yönetimi Enstitüsü, 2023; Fikadu & Teshome, 2021), this was not in line with the general belief and perceptions of farmers in the region. For instance, only two of the interviewed farmers in the region, one being a cooperative head, mentioned acquiring information about drip irrigation from public authorities. The rest of the farmers tended to decide on their irrigation methods based on their own experiences or if they had observed some other farmer who had previously attempted and succeeded with drip irrigation. Moreover, difficulty of obtaining subsidies supporting the adoption of drip irrigation was highlighted in the literature as a negative factor for the adoption of drip irrigation (Chadran and Surendan, 2016). In the study area, farmers seem to be unable to access credit and government support due to their use of unlicensed wells for irrigation. This is in line with the findings by Mirhanoğlu et al. (2023) on Ağlasun village in Burdur. They found that since one of the prerequisites for being eligible for governmental support for drip irrigation is proving that the farmer irrigates a farmland of at least one hectare, most farmers in Ağlasun would not qualify for the subsidy because they have smaller plots. In the present study, farmers with larger field sizes cannot qualify since they do receive irrigation water from illegal wells. Overall, these findings highlight the importance of contextual and institutional factors, in addition to the economic and technological factors. This is like the findings of Akudugu et al. (2012) who found that adoption of agricultural technology depends on their socio-economic circumstances as well as the effectiveness of relevant institutions.

In terms of individual level farmer characteristics, several studies emphasized the importance of education in the transition to drip irrigation, suggesting that educated farmers have higher motivation to adopt innovative technologies (Akudugu et al., 2012; Chadran and Surendan, 2016; Alcon et al., 2019; Serote et al. 2021; Yazdanpanah et al., 2022). However, in the study area, this factor did not seem to predict adoption of drip irrigation, because regardless of the education level, farmers would embrace the drip irrigation method if they believed it to be effective. Being a secondary school or university graduate did not change this perception regarding the ineffectiveness of drip irrigation for maize. This widely held belief seems to be invariant to the education level of farmers in this study.

The literature suggests that younger farmers tend to be more pioneering in adopting new technologies (Alcon et al., 2019; Serote et al., 2021). However, in this study, only 21% of farmers using drip irrigation were below the age of 40, while the remaining 79% were above 40. Yet, the sample size is quite small (and sampling procedure was non-random) to draw a definite conclusion on this. It is interesting to note that the study on Ağlasun, Burdur by Mirhanoğlu et al (2023) found

that older farmers in their study tended to have a similar perception regarding the ineffectiveness of drip irrigation: they believed that not the product they cultivate, but the soil type was not suitable for drip irrigation. In the present study, though, the perceptions regarding the ineffectiveness of drip irrigation were mostly uniformly held.

It has been noted that due to inadequate equipment use, poor maintenance, and suboptimal irrigation techniques, the effectiveness and efficiency of drip irrigation can be even lower than the efficiency of surface irrigation (Benouniche et al., 2014). Hence, the perception of ineffectiveness among farmers in our study might be connected to the practical challenges and implementation issues that impact the overall efficiency of drip irrigation in the region. However, interviewed farmers applying drip irrigation for crops other than maize were mostly satisfied with the system.

In the study area, mostly cited challenges related with drip irrigation were damage by wild animals and difficulties of finding workers to assemble and disassemble the pipes as well as inadequate power supply for implementing drip irrigation system. While almost half of the farmers considered drip irrigation costly, an equal number of farmers regarded this method as “unnecessary”. Hence, costs appear to play a role in the non-adoption, yet farmers seem to be inclined not to prefer changing the currently used irrigation methods. Furthermore, farmers having their own wells are less likely to adopt drip irrigation in the region. This may be in line with the finding that farmers located closer to viable water sources are less motivated to adopt drip irrigation technology due to reduced impact from water transportation costs and time consumption (Yazdanpanah et al., 2022). Despite the rising costs of electicity to be used for pumping water from wells, this is not yet a concern among the farmers in the study area, perhaps because there is still suffcieint precipitation for growing field crops and doing rain-fed agriculture.

The size of farmland has been found to be an important parameter whether a technology is adopted or rejected (Akudugu et al.,2012; Chadran and Surendan, 2016; Alcon et al., 2019; Serote et al. 2021; Yazdanpanah et al., 2022). The fact that large-scale producers in the region, alongside small-scale ones, do not utilize drip irrigation for maize underscores a significant issue in the region. The medium- and large-scale producers employing drip irrigation for crops other than maize mention that this method ensures water conservation, fertilizers and pesticides are consistently administered, enabling quicker disease prevention. Yet, they do not prefer to use it for maize production, so the scale of operations does not seem to play a role here, at least for maize production. This seems to be in line with the finding of Fischer (2016), who argued that a technology might be equally effective or

suitable when adapted on a large or small scale. Rather, the author claimed, social and biological factors are more important, rather than the scale of operations.

All large-scale producers and most small-scale farmers indicated the presence of water scarcity and climate change effects in the region. Despite the large presence of farmers indicating a decrease in water levels in their individual wells, there were also farmers who believed their water levels are sufficient. According to the survey responses and discussions with public institutions, a significant majority in the region relies on groundwater usage for irrigation. The drought conditions in the area are attributed to the decreased rainfall in recent years. There is a widespread belief among farmers about the decrease in water resources in the region, which is also associated with a negative impact on agricultural production. However, the fact that only a small portion of interviewed farmers believes there is sufficient water in groundwater wells suggests a lack of widespread belief in a strong correlation between drought and groundwater sources in the region. Additionally, although more than half of the farmers anticipated a significant decrease in water quantity within wells over the next five years, most farmers tended not to opt for transitioning to drip irrigation for maize unless compelled to do so legally. Although farmers anticipate a significant decrease in water resources in the region in fthe next five years, they remain hesitant to transition to innovative technologies that promote resource efficiency, such as drip irrigation or methods requiring less water. However, they are applying ecosystem-based approaches such as crop rotation for years to increase the soil fertility.

The present study highlighted the limited distribution of drip irrigation in places such as Ödemiş, Tire, and Bayındır could potentially be linked to local contextual and institutional factors. This situation reflects the findings discussed in Garb and Friedlander (2014) study, which emphasizes that the technology's effective spread in Israel did not necessarily lead to comparable success in Sub-Saharan Africa. The difference in adoption highlighted the crucial impact of not only the technical components but also the alignment of technology with local agricultural practices and methods (Benouniche et al., 2014; Garb and Friedlander, 2014). Garb and Friedlander (2014) emphasized the importance of considering local social and regional issues in addition to technical aspects when implementing technological innovations such as drip irrigation. Similarly, research by Mirhanoğlu et al. (2023) on Ağlasun village highlighted the potential negative consequences of disregarding the compatibility of drip irrigation technology with the local infrastructure and institutions. Both studies emphasize the importance of comprehending the interplay between technology advancements and social, institutional, and geographical factors to effectively predict possible effects and successful adoption of technologies.

Lastly, the broader structural factors such as lack of proper agricultural planning and long-term specific targets, aligned with water constraints and changing climatic conditions, in the country seems to create significant challenges for the Küçük Menderes Basin. Both central and local governments support dairy and livestock production, requiring huge amounts of irrigated agriculture for maize and other feed crops in a basin with substantial water scarcity and vulnerability to climate change. While this seems to be improving farmers' livelihoods in the short-term, it can have devastating effects in the long-term both for the farmers and the ecological and agricultural systems in the basin. Faced with substantial challenges for ensuring livelihoods and incomes, farmers are of course acting in their best (short-term) self-interest by cultivating maize and growing livestock which use lot of irrigation water.

Within the scope of this study, while several determinants were discussed regarding why drip irrigation is not utilized specifically for silage maize in this region, the actual understanding of why drip irrigation has not been adopted for maize goes beyond the factors such as age, education, land size, and cooperative membership. Instead, it is crucial to comprehend the value of local agricultural knowledge farmers possess and practices like soil conservation (e.g., crop rotation) that play a role. Providing support in this direction might be more impactful, recognizing the farmers' local knowledge and sustainable practices, rather than imposing a new technology like drip irrigation, regardless of type of farming another biophysical aspect like precipitation levels, soil characteristics, etc.

While agricultural policies often emphasize the need for a widespread adoption of new irrigation systems and greater integration of technology into farming, the existing average rainfall, which farmers seem to perceive as adequate, agricultural practices, livestock management, and farmers' views and beliefs underscore the need for supporting more ecosystem-based approaches in the region, especially for silage maize production. The farmers' deep understanding of the region where they practice agriculture, their continuity of traditional agricultural practices inherited from past generations, and their knowledge about the crops they cultivate highlight the value of local knowledge in the region. To tackle this issue, it is necessary to implement agricultural policies that are both supportive and integrated, and that openly endorse ecosystem-based adaptation as a key component of a comprehensive agricultural adaptation program (Vignola et al.,2015; Shah et al., 2019). By promoting ecosystem-based approaches, policymakers can incentivize practices that align with farmers' preferences and leverage the abundant local knowledge, so enhancing the overall resilience and sustainability of agriculture in the region.

Overall, the findings of this study imply that the adoption (or rather, non-adoption) of drip irrigation in the basin is not only related with the technology's characteristics only, but also with the contextual factors such as farmers perceptions, legal and institutional setting, governmental subsidies, agro-physical conditions, and broader agricultural policies on a macro scale. In line with the "technology translation" concept (Garb and Friedlander, 2014), the farmers were not merely passive recipients of the technology; they were active in trying out the new technology, experimented with it for maize production and found it ineffective, however, they decided to apply it for other crops they grow in the basin such as vegetables and fruits. While the diffusion of innovation theory (Rogers, 2003) considers the technology to be adopted as a static concept, and technology dissemination as a linear process from the dissemination agencies towards farmers, this thesis highlighted that this is not sufficient to understand the ceomplex background regarding the non-adoption of drip irrigation for maize farming in the Küçük Menderes Basin. The study therefore confirms that technology can evolve while it migrates bringing up unforeseen meanings ("*it is a lazy man's job"*), costs (labor costs and difficulty of finding workers), and advantages (beneficial for fruits and vegetables, but not for maize) and applications (illegal well use hinders the adoption of drip irrigation due to absence of subsidies), and attention must be therefore paid to the contextual challenges and difficulties faced by the farmers, and their traditiona ways of doing agriculture, rather than merely looking at their individual-level characteristics such as age, education, farm size, etc. Therefore, this study highlights the need for site/basin specific local policies, tailored to the physical, social, and political background and specific needs of the region.

7. CONCLUSION

This study examined farmers' perceptions for water scarcity and drip irrigation for silage maize and other products and found that regardless of individual level farmer characteristics such as age, income, farm size, and education, farmers were not willing to adopt drip irrigation for silage maize production in the Küçük Menderes River Basin. The most relevant factors with a potential to explain this finding was farmers' perception for the technology's ineffectiveness, absence of suitable governmental subsidies, high labor, and maintenance costs as well as the incompatability of agricultural practices such as crop rotation and rain-fed farming with drip irrigation.

Farmers' water scarcity perceptions seemed to play a role in the non-adoption as well. While the farmers admitted to experience water scarcity related problems in the basin, not all of them had a pessimistic outlook regarding the future water scarcity in the region and seemed to trust on the income they receive for their own products (mainly from growing feed crops and livestock production). However, it must be noted that the sample size of the survey was not large enough to draw any definite cause and effect relationships in this matter. Still, the follow-up interviews with farmers as well as in-depth interviews with public institutions seem to confirm the main findings of the study.

The study revealed that for the dominant form of farming in the basin, namely, small-scale, low-input farming based on feed crops and livestock production, the non-adoption of drip irrigation may be in fact more feasible and even desirable, given that small-scale farmers are already addressing water scarcity through other means such as crop rotation, based on their traditional agricultural knowledge. Farmers in the basin are mostly aware of water scarcity, however, they prefer their traditional ways of doing agriculture and irrigation, given that precipitation levels are not very low, enabling rain-fed farming. Drip irrigation, on the other hand, is quite costly and is often associated with higher initial and maintenance costs, requiring intensive labor inputs. The traditional way of doing agriculture integrated with livestock breeding and crop rotation and the biophysical characteristics of the agricultural land therefore seem to make the adoption of drip irrigation irrelevant for most farmers growing silage maize. The study therefore concludes that a top-down, one-size-fits-all type of adoption for drip irrigation may not be the best strategy to address water scarcity. Rather, support should be provided to other types of of water conservation more in line with the local agricultural practice, for instance, conservation agriculture, ecosystem-based approaches, rainwater harvesting could be potentially more feasible and productive for the given type of agriculture in the

basin. This, however, necessitates the incorpotation of local farmer knowledge into decision-making and long-term planning for agriculture, taking into consideration the biophysical, social, and political background and specific needs of the region. Future studies could compare these findings originating from the Küçük Menderes River Basin with other important maize producing regions like Konya and Thrace, for instance, to provide a more complete view regarding the (non-) adoption of drip irrigation in different basins of Turkey. The present study can be seen as a first step to understand the different needs and perceptions of farmers in the case of drip irrigation, along with the institutional and biophysical factors that shape these specific needs and beliefs.

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APPENDIX A: IN-DEPTH INTERVIEW QUESTIONS WITH PUBLIC INSTITUTIONS

1.Which crops are predominantly cultivated in the region, and how have these crops changed in the last 5-10 years?

2.How do farmers decide on the crops they will plant?

3.Are there incentives for the cultivation of new crops?

4.During which time intervals are specific crops typically planted?

5.Are fields left fallow, and if so, which crops are more commonly left fallow?

6.Is crop rotation practiced in the fields, and if so, which crops are more frequently involved in rotation?

7.What technologies are employed for irrigating crops, and how prevalent is drip irrigation?

8.Are farmers educated about the drip irrigation method?

9.What is the status of drip irrigation in the district?

10.What reservations do farmers have regarding the transition to drip irrigation?

11.What is the water source utilized, and from what depth is the water extracted?

12.If well water is used, is the well shared among other farmers?

13.Can you provide information on the drawdown rates in the wells? How have these rates changed in the last 5-10 years?

APPENDIX B: SURVEY QUESTIONS CARRIED OUT WITH FARMERS

Module 1: General Questions

1.How many years have you been involved in agriculture?

---------- years / since ----------

2.What is your main source of income?

a) Agriculture

b) Livestock

c) Retirement pension

d) Trade

e) Other

3.Do you engage in another profession aside from agriculture? If yes, what is it?

4.Do you also engage in livestock farming?

a)Yes

b)No

5.If yes, do you raise small livestock or large livestock, and how many do you have?

6.Are you a member of an agricultural production cooperative?

a) Yes

b) No

7.If yes, which one and for how long?

8.Are you a member of an irrigation association or irrigation cooperative?

a) Yes

b) No

9.If yes, which one and for how long?

10.What is the size of the agricultural land you work on? (Consider both land you own, and land owned by others but worked by you.)

11.What are the primary crops you cultivate?

12.What factors influence your choice of crops for each growing season?

a) Market conditions

b) Decisions based on what I learn from other farmers in my area

c) Decisions based on government incentives

d) Television or the internet

e) Agricultural engineers

f) Retailers where I purchase agricultural chemicals

g) Other

13.For which of the crops you cultivate do you receive financial incentives from the government?

14.Where do you primarily obtain your irrigation water from?

a) Groundwater (irrigation well)

b) Irrigation reservoirs/dams/rivers

c) Other

15.What is the price per cubic meter of the water you use for irrigation?

16.Have you ever used drip irrigation?

a) Yes

b) No

17.If yes, did you continue to use the system after its installation?

a) Yes

b) No

18.If not, what were the reasons?

a) High installation costs

b) High maintenance costs

c) Difficult to maintain

d) Unsuitable water quality

e) I didn't think it watered the plants sufficiently

f) I didn't receive sufficient technical support

g) Other

19.If you continued to use drip irrigation, what were the reasons/advantages?

a) Cost-effective

b) Water-saving

c) Reduces labor costs

d) Convenient and timesaving

e) Other

Module 2: Farmer Perception of Water Scarcity

Please respond to the following questions considering the region where you conduct agricultural production (Küçük Menderes Basin)

20.In my region, agricultural irrigation is mostly done from irrigation wells.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

21.Drought is experienced in my region.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

22.There are issues with the quantity of irrigation water in my region.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

23.Insufficient irrigation water adversely affects agricultural production.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

24.There is enough water for agricultural irrigation in the irrigation wells.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

25.There is enough water for agricultural irrigation in rivers and irrigation reservoirs.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

26.The quantity of irrigation water is less compared to 5 years ago.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

27.I believe the quantity of irrigation water will be greater in the next 5 years than it is now.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

28.I believe that the current levels of rivers and irrigation reservoirs are lower compared to 5 years ago.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

29.I believe that the current levels of irrigation wells are lower compared to 5 years ago.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

30.I believe that the levels of rivers and irrigation reservoirs will not significantly change in the next 5 years.

Strongly disagree.

Disagree

Undecided

Agree

Strongly agree.

31.I believe that the levels of irrigation wells will not significantly change in the next 5 years.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

32.My crops do not suffer significantly from water scarcity.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

Module 3: Water Conservation and Irrigation-related Questions:

Please answer the following questions considering the agricultural region you work in (Küçük Menderes Basin).

33.In the agricultural area I work in, groundwater is used much more than surface water.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

34.My relatives and other farmers in my region use irrigation methods that save water.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

35.Livestock farming has increased in the agricultural area I work in over the past 5 years.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

36.Maize cultivation has increased in the agricultural area I work in over the past 5 years.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

37.(For those stating that corn production has increased): In your opinion, what crop did corn replace in the past?

38.Transitioning to drip irrigation in the agricultural area I work in is very costly.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

39.Maintenance costs for drip irrigation are very high in the agricultural area I work in.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

40.There is no need for drip irrigation in the agricultural area I work in.

1)Strongly disagree

2)Disagree

3)Undecided

4)Agree

5)Strongly agree

41.Which of the following has the most influence on your decisions regarding irrigation?

a) My relatives and neighbors engaged in agriculture

b) Active agricultural engineers in my region

c) Agricultural extension and advisory services in my region

d) Television and the internet

e) The agricultural supply store where I buy pesticides

f) Agricultural district or county organizations

g) Other

Module 4: Socioeconomic Information

42.How old are you?

43.What is the last level of school you completed?

a. Elementary school

b. Middle school

c.High school

d.University

44.How many people, including yourself, are there in your household?

45.What is your average monthly income (total of agricultural and other income) falling into the following ranges?

a. 0 - 5000 TL

b.5000 - 15000 TL

c.15000 - 50000 TL

d.Above 50000 TL

APPENDIX C: LIST OF SURVEYED/INTERVIEWED FARMERS

ID Number	District	Village	Scale of operation	Age	Education
1	Bayındır	Fatih Mah, Yalıkavak Mevkii	Large scale	36	Secondary school
2	Tire	Karateke Köyü	Small scale	43	Elementary school
3	Tire	Karateke Köyü	Small scale	62	Elementary school
4	Tire	Karateke Köyü	Small scale	65	Elementary school
5	Bayındır	Karapınar Köyü	Large scale	60	Elementary school
6	Ödemiş	Beyazıtlar Köyü	Small scale	47	Secondary school
7	Ödemiş	Beyazıtlar Köyü	Small scale	57	Secondary school
8	Ödemiş	Beyazıtlar Köyü	Small scale	58	Secondary school
9	Bayındır	Fatih Mah. Yalıkavak Mevkii	Small scale	34	Elementary school
10	Bayındır	Fatih Mah. Yalıkavak Mevkii	Small scale	61	Elementary school
11	Bayındır	Fatih Mah. Yalıkavak Mevkii	Small scale	53	Elementary school
12	Bayındır	Fatih Mah. Yalıkavak Mevkii	Small scale	72	Elementary school
13	Bayındır	Fatih Mah. Yalıkavak Mevkii	Small scale	61	Elementary school
14	Bayındır	Fatih Mah. Yalıkavak Mevkii	Medium scale	63	Elementary school
15	Ödemiş	Beyazıtlar Köyü	Small scale	60	Elementary school
16	Tire	Karateke Köyü	Small scale	60	Elementary school
17	Tire	Karateke Köyü	Small scale	48	Elementary school
18	Tire	Karateke Köyü	Small scale	53	Elementary school
19	Tire	Karateke Köyü	Small scale	83	Elementary school
20	Tire	Karateke Köyü	Large scale	80	Elementary school
21	Tire	Karateke Köyü	Large scale	44	Elementary school

22	Ödemiş	Küçükovulcuk Köyü	Small scale	49	Elementary school
23	Ödemiş	Küçükovulcuk Köyü	Small scale	60	Secondary school
24	Ödemiş	Küçükovulcuk Köyü	Small scale	57	Elementary school
25	Tire	Çeşteman Kavağı Mevkii	Small scale	39	High school
26	Ödemiş	Birgi Köyü	Small scale	64	Secondary school
27	Ödemiş	Birgi Kötü	Small scale	53	Elementary school
28	Ödemiş	Birgi Köyü	Small scale	54	Elementary school
29	Ödemiş	Birgi Köyü	Small scale	64	Elementary school
30	Ödemiş	Birgi Köyü	Medium scale	45	Elementary school
31	Ödemiş	Birgi Köyğ	Small scale	54	Elementary school
32	Ödemiş	Birgi Köyü	Small scale	39	Elementary school
33	Ödemiş	Birgi Köyü	Small scale	77	Secondary school
34	Ödemiş	Birgi Köyü	Small scale	50	Elementary school
35	Ödemiş	Birgi Köyü	Small scale	62	Elementary school
36	Ödemiş	Birgi Köyü	Small scale	46	Elementary school
37	Ödemiş	Hacıhasan Köyü	Small scale	43	Elementary school
38	Ödemiş	Hacıhasan Köyü	Small scale	60	Elementary school
39	Ödemiş	Hacıhasan Köyü	Small scale	73	Elementary school
40	Ödemiş	Hacıhasan Köyü	Small scale	76	Elementary school
41	Ödemiş	Hacıhasan Köyü	Small scale	42	Elementary school
42	Ödemiş	Kızılcaavlu Köyü	Small scale	39	Elementary school
43	Ödemiş	İlkkurşun Köyü	Large scale	31	University