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# Key Agricultural Product Risk Assessment (KAPRA)


## Report on the Financial Resilience of Key Agricultural Products to Climate Change

2018

İZKA İzmir Kalkınma Ajansı Development Agency

THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

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## Abbreviations

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|---|---|
| AFD | The Agence Française de Développement |
| ARIP | Agricultural Report Implementation Project |
| BDDK | Banking Regulation and Supervision Agency |
| BGK | Regional Development Committee |
| BGYK | High Council for Regional Development |
| BIST | Istanbul Stock Exchange |
| BKK | Council of Ministers' Decree |
| BMRB | Great Meander Basin |
| CAP | Common Agricultural Policy |
| CBS | Geographical Information Systems |
| CCAMCC | Climate Change and Air Management Coordination Council |
| CCCC | Climate Change Coordination Council |
| CF | Compliance Fund |
| CGF | Credit Guarantee Fund |
| COP 21 | 2015 United Nations Climate Change Conference |
| ÇATAK | Environmental Based Agricultural Land Protection Program |
| ÇSY | Environmental and Social Management |
| DPT | State Planning Organization |
| DSI | General Directorate of State Hydraulic Works |
| EAFRD | European Agricultural Fund for Rural Development |
| EBRD | European Bank for Reconstruction and Development |
| EIB | European Investment Bank |
| EMFF | European Maritime and Fisheries Fund |
| ERDF | European Regional Development Fund |
| E-S-E | Economic-Social-Environmetal (impact) |
| ESF | European Social Fund |
| ESI Fund | European Structural and Investment Funds |
| ETAE | Aegean Agricultural Research Institute |
| EU | European Union |
| EUROSTAT | Statistical Office of the European Union |
| FAO | United Nations Food and Agriculture Organization |
| FSFM | Frankfurt School of Finance & Management |
| GAP | Good Agricultural Practice |
| GDP | Gross Domestic Product |
| GIP | Emerging Companies Market |
| GNP | Gross National Product |
| GVA | Gross Value Added |
| HMB | Ministry of Treasury and Finance |
| IBB | Izmir Metropolitan Municipality |
| IBBS | Statistical Regional Unit Classification |
| IFDA | International Financing and Development Agencies |
| IFOAM | International Federation of Organic Agriculture Movements |
| ILO | International Labor Organization |

| | |
|---|---|
| IMKB | Istanbul Stock Exchange |
| IPARD | Instrument for Pre-Accession Assistance for Rural Development |
| IPCC | Intergovernmental Panel on Climate Change |
| ISIC | International Standard Industrial Classification |
| IZKA | Izmir Development Agency |
| JBIC | Japan Bank for International Cooperation |
| KAPRA | Key Agricultural Product Risk Assessment |
| KBKYP | Village-Based Participant Investment Program |
| Kc | Crop transpiration coefficient |
| KDP | Clustering Support Program |
| KfW | German Bank for Reconstruction (Kreditanstalt für Wiederaufbau) |
| KKYDP | Program for Supporting Rural Development Investments |
| KMRB | Kucuk Menderes River Basin |
| KOSGEB | Small and Medium Enterprises Development Organization |
| KÖYDES | Project Supporting Village Infrastructure |
| MDP | Financial Support Programs |
| MGM | General Directorate of Meteorology |
| ÇŞB | Ministry of Environment and Urbanism |
| NACE | The Statistical Classification of Economic Activities in the European Community |
| NRDS | National Rural Development Strategy |
| OECD | The Organization for Economic Cooperation and Development |
| OTP | Common Agricultural Policy |
| PPP | Public-Private Partnership |
| RDP | Rural Development Project |
| SME | Small or Medium Enterprise |
| STB | Ministry of Industry and Technology |
| TARSIM | Agricultural Insurance Pool |
| TB | Ministry of Trade |
| TKB | Development and Investment Bank of Turkey |
| TKDK | Agency for Supporting Agriculture and Rural Development |
| TOB | Ministry of Agriculture and Forestry |
| TOBB | The Union of Chambers and Commodity Exchanges of Turkey |
| TTGV | Technology Development Foundation of Turkey |
| TurEEFF | Turkey Residential Energy Efficiency Financing Facility |
| TURKSTAT | Turkish Statistical Institute |
| TurSEFF | Turkey Sustainable Energy Financing Facility |
| TÜBITAK MAM | The Scientific And Technological Research Council Of Turkey, Marmara Research Center |
| TÜRKONFED | Turkish Enterprise and Business Confederation |
| UHT | Ultra High Temperature |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UR-GE | Supporting the Development of International Competitiveness Programme |
| VAT | Value Added Tax |
| WWF | World Wide Fund for Nature |

# Definitions and Concepts

**Blue water footprint:** Volume of surface and groundwater consumed as a result of the production of a product; traditionally refers to freshwater (WWF).

**Climate change adaptation** includes adjustments and arrangements made in advance in order to ensure readiness for anticipated climate change and climate variability with a view to mitigating the potential harmful effects of climate change and to seizing opportunities (IPCC, 2007).

**Climate change mitigation:** Actions aimed at reducing or preventing greenhouse emissions (UNEP).

**Climate-smart agriculture (CSA):** Climate-smart agriculture according to the FAO (and the World Bank): An approach aimed at ensuring (1) a sustainable increase in agricultural yield and revenue, (2) the development of resilience against climate change and adaptation, and (3) the reduction and/or elimination of greenhouse emissions, if possible (FAO & World Bank).

**Cooling Need:** The period that plants need to spend at low temperatures in a specific period in order to enable them to grow buds and to give a high yield (TrAgLor, 2008).

**Fallowing:** Plowing an area of land and leaving it to rest without sowing anything

**Farm gate value:** The market value of a product minus the sales costs (transport costs, marketing costs) (Agricultural Marketing Guide).

**Global climate change:** An increase in the average surface temperatures of the globe and changes observed in the climate as a result of a heightened natural greenhouse effect triggered by a rapid increase in accumulated greenhouse gases (H2O(b), CO2, CH4, O3, N2O, CFC–11, HFC, PFC, SF6) released to the atmosphere as a result of human activities, such as the use of fossil fuels, changes in land use, deforestation and industrial processes (Ministry of Energy and Natural Resources).

**Good agricultural practices:** A production method that is free of any chemical, microbiological or physical residue that may be harmful to human health, where crops are grown without polluting the environment or inflicting harm on the natural equilibrium and without negatively affecting the welfare of human beings involved in production or other living creatures, and carried out in accordance with the agricultural regulations of the country in which the product is grown and the country in which the consumers are located subject to registration, control and certification (FAO COAG 2003 GAP paper).

**Green water footprint:** Total rainwater used for the production of a product (WWF).

**Grey water footprint:** Amount of fresh water used for the elimination or reduction of pollution load based on existing water quality standards (WWF).

**Harvest:** All agricultural products harvested in a specific year.

**In vitro:** (Latin for within the glass) the technique of performing a given procedure in a controlled environment outside of a living organism mostly in in laboratory or artificial conditions (MPKB Autoimmunity Research Foundation).

**Organic agricultural practices:** Refers to the production or growing of organic products or inputs using soil, water, plants, animals and natural resources; picking crops from natural areas and resources; harvesting, cutting, processing, sorting, packaging, labeling, preservation, storage, transportation, marketing, importation and exportation, and other activities undertaken until the delivery of the product or input to the consumer (Information Legislation System, Prime Minister's Office).

**Organic agriculture:** Organic agriculture is a holistic production management system that promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity (FAO / WHO Codex Alimentarius Commission, 1999).

**Periodicity:** The fact that the tree giving fruit every two years (especially olive trees)

**Phenology:** A science examining various phases within the development periods of living creatures (MGM).

**Resilience:** Capacity of a social-ecological system to absorb perturbations while maintaining its main structure, functions, self-organization and capacity to adjust to stress and change.

**Slow Food:** An organization promoting local and traditional food. The organization was founded in Italy in 1986 and has since expanded to other countries. Promoted as an alternative to "Fast Food," Slow Food makes efforts to preserve traditional and local cuisines and promotes the plant, seed, and livestock characteristics of the local ecosystem. Three products in Turkey (Divle Obruk Cheese, Boğatepe Gruyere and Siyez Bulgur) that have such characteristics, have been produced for centuries (Slow Food Foundation for Biodiversity).

**Sustainable development:** A development model that is capable of meeting the needs of the current generations without compromising on the potential to meet the needs of future generations (Ministry of Development).

**Vulnerability:** The extent to which a system is exposed to the negative effects of climate change and is unable to cope (IPCC, 2007).

**Xerophilous:** (of a plant or animal) adapted to a very dry climate or habitat, or to conditions where moisture is scarce.

**Yield:** A product is the result of anything that is operated and run or grown or it is the quality of that result.

# Executive Summary

The World Bank, in collaboration with Izmir Development Agency (IZKA), has initiated the "**Key Agricultural Product Risk Assessment (KAPRA)**" for the Kucuk Menderes River Basin in order to strengthen the resilience of Izmir's agricultural economy and boost its competitiveness by ensuring the sustainability of natural resources and social factors. The study aims to help understand the effects of climate change on the region's agricultural output and develop appropriate resilience strategies.

**This study is one of the first of its kind for Turkey.** Thus, prioritization projects in various sectors, particularly in the agricultural sector, were reviewed while selecting key agricultural products, in line with similar development guidelines at international scale. Assessments focus on the prioritization of overall results, risks, and trends supported with academic findings. The primary objective of the risk assessment is to inform the relevant stakeholders regarding the risks on the ecosystem, production facilities and capacities, and on impacts beyond the boundaries of the Basin and spreading to other sectors.

**Kucuk Menderes River Basin (KMRB), where a significant part of the population is engaged in farming and has a relatively rich range of agricultural products, is facing serious threats due to climate change.** The frequency of drought cycles and irregular precipitation are already giving rise to concerns, but diversified natural resources also offer opportunities to devise policies for ensuring adaptation to changing climatic conditions.

**The study encompasses four primary themes:** (i) To develop a framework for the concept of "key agricultural product" and to identify existing key agricultural products in the region, (ii) to assess climate change risks in the production chain (from producer to consumer) of five selected key agricultural products, (iii) to identify resilience solutions considering economic, ecological, and social dimensions, and (iv) to develop business cases for these strategies and make recommendations regarding new funding strategies for their implementation.

## i. Identification of Key Agricultural Products in Kucuk Menderes River Basin (KMRB)

- ✓ When forming the basis of the method for selecting key products, principles such as sustainable development, social inclusion, socioeconomic development, and gender-sensitive development were taken as a guide. *Key agricultural products* were defined within this context. For the KMRB, a model encompassing a series of social, economic and environmental indicators that reflect the priorities of regional stakeholders and dynamics was developed.
- ✓ A review was made of the various public agency- and civil society-led development studies and strategy/action plans conducted at the national level and in the project area, and it was ensured that the project goals that guide the key product identification phase are in parallel with and supportive of these plans.
- ✓ In parallel with the project's participatory and multi-stakeholder approach, regular meetings were held with various public and private stakeholders in the region, and the priorities of these stakeholders as well as the problems and opportunities they had observed in the Basin were discussed. Furthermore, a workshop that brought together the stakeholders in the Basin was held, and the outcome of this workshop was utilized for developing the methodology.
- ✓ Statistical data and field observations, surveys, and focus group meetings were used for reflecting these indicators into the model.
- ✓ As a result of the works listed above; **olive (for oil), milk (cow), tomato (industrial), fig (dried), and outdoor ornamental plants were selected as the 5 key agricultural products** in KMRB.

## ii. Assessment of Climate Change Risk in Kucuk Menderes River Basin

- ✓ **It was observed that under current conditions, the counties in the Basin, except for Selçuk and Torbalı, were at medium category/level in terms of exposure to the impact of climate change.** Projections indicate that current annual average temperatures in the Basin will **rise between 2°C and 6°C** toward the end of the century. Temperature rise in the summer will be higher than that in the winter.

- ✓ It is anticipated that the variation in the total annual precipitation within the Basin will be less than 5% until 2050, therefore **a significant change is not expected in total precipitation.** There may, however, be a decline in the number of days with rain. Precipitation estimations indicate that the longest drought period in the Basin will become longer, while the longest rainy period will become shorter and the number of days with excessive precipitation will increase.
- ✓ Indices pertaining to temperature denote that **there will be a decline in the numbers of cold, icy, and frosty days, cool nights and cool days**, whereas **the number of summer days, hot days and hot nights will increase.** The growth season will become longer to some extent, and the daily temperature range will slightly increase.
- ✓ According to the results of the temperature index, **continuous moderate and extreme drought conditions** are anticipated after 2022. In addition, working conditions in the Basin during the months of July-August may reach a level that requires "extreme caution" in terms of workers' health.
- ✓ After 2030, the Basin will generally be affected by **continuous water shortage and severe drought**. A drastic fall in the levels of groundwater, rivers, and lakes is hence expected.
- ✓ There will be a limited rise in the sea level of Selçuk, the only coastal county in the Basin, until 2050. **It can be deducted that the rise of sea level will not pose a risk to agriculture**.
- ✓ Since soil alkali values, movements of mass, and variation of hail and flood incidents cannot be directly determined through climate projections, future variations in these parameters could not be taken into consideration.

### iii. Assessment of Climate Change Risk for Key Agricultural Products

- ✓ **Variation in the following climate factors were taken into account while assessing risks to key products:** Average temperature, number of extremely hot and cold days, drought, relative humidity, precipitation regime and amount, sea level, hail, frost, wind speed, soil composition and salinity, weed composition and amount.
- ✓ **Except for highlands, a high level of vulnerability is not expected in terms of soil salinity due to climate change.** In general, the Basin has soil free of salinity or with very low salinity, and the rise in annual average temperature and decline in precipitation that is expected by 2050 may slightly increase salinity.
- ✓ **Surface irrigation is still used in the Basin, which has a negative effect on the capacity to adapt to climate change.** Irrigation systems used by farmers and the water quality have significant impacts on soil salinity. Meanwhile, the use of soil by the growers of annual and seasonal flowers brought from other areas contributes to the adaptation of products to climate change.
- ✓ As cultivated plants will be more affected by climate change than weeds, managing weeds may become more difficult, which may create a negligible negative impact on olive, tomato, fig, and outdoor ornamental plants.
- ✓ **The farmers in the Basin face challenges in accessing finance.** Although agricultural enterprises are affected by environmental and climatic changes, awareness and prioritization in this regard remains low. This leads to insufficient demand in financial institutions for developing tailored products to finance investments for climate change adaptation. Regulations concerning incentives and support provided by the government is complex, leading to a significant gap in terms of the accessibility of funding for climate change adaptation or mitigation in the agricultural sector.
- ✓ **There is a lack of awareness and knowledge among public agencies, financial institutions, and farmers' organizations regarding adaptation to climate change in agriculture.** There is also lack of reliable and updated data that would allow for studies and detailed analyses on increasing resilience to climate change, particularly in regions with high agricultural potential.

#### *a) Olive (for oil)*

- ✓ The increase in the number of very hot days, rising average temperatures, dwindling average precipitation and shorter cooling periods that cannot satisfy the needs of some varieties **create a critical situation affecting olive yield.** It can be assumed that olive harvests will decline by between 10-20% if no action is taken by 2050. In this case, assuming no change in factors such as market, price and production culture, **the annual loss of value based on current prices in 2017 is expected to be between TRY 16.2m and 32.2m in the agricultural production phase, and between TRY 19.8m and 39.6m in total value after industrial processing.**
- ✓ As a result of a possible decline in harvesting in olive production, there may be a **risk of idle capacity in olive oil processing**, as well as **additional operating expenditures** for the supply of products from different places to compensate this idle capacity. Furthermore, a decline in olive oil quality would also lead to loss of income. The fall in production quantity may lead to a rise in prices, further reducing international competitiveness which is already at a low level.
- ✓ **Natural disasters such as hail, floods, and storms that may occur in the Basin may have adverse effects on the other links of the production chain.** Storms and blizzards in particular may damage the physical infrastructure of the enterprises and also lead to logistical problems.

*b) Tomato (industrial)*

- ✓ **Coupled with infrastructural problems, global climate change may have a negative effect on the production of tomato for industrial purposes.** Urbanization of the region due to migration and the development of industry may further exacerbate the pressure on agricultural water, leading to a greater decrease in yield than anticipated.
- ✓ A rise in temperature may have some positive effects on production, but extreme temperatures may have adverse effects on yield and quality.
- ✓ If other factors remain unchanged in the scenario where 4-7% loss occurs in harvest, **the annual loss of value in total production is expected between TRY 6.8m to TRY 11.9m in agricultural production, and between TRY 12.2m to TRY21.4m after processing.**
- ✓ A decrease in production quantity may have adverse effects on the other links in the chain. A decrease in product supply may prompt industrialists to purchase raw materials from different regions, leading to additional costs. Furthermore, **high input prices may increase production costs** and undermine the competitiveness of firms.

*c) Milk (cow)*

- ✓ Maize silage, the most common input for milk production in the Basin, will be affected by rising temperatures and declining precipitation, given its low resistance to drought and need for large quantities of water. **This, in turn, will cause a decline in yield and quality of the milk produced.**
- ✓ **Raw milk production is the most crucial phase within the production chain with vulnerabilities to climate change.** Rising average temperature and falling precipitation will have adverse effects on dairy cattle and their yield, due to various reasons such as the resulting stress in livestock, changes in their metabolism, and lower resistance to diseases. In addition, high temperatures are expected to affect the physical performance of people engaged in dairy farming, particularly during the summer months.
- ✓ **Between 2021 and 2050, the decline in milk production is anticipated between 3-5% in large enterprises.** As large enterprises are more likely to take climate-smart measures designed to enhance animal well-being, their capacity to adapt to climate change will be relatively higher.
- ✓ A decline in milk yield and quality is expected particularly in small farms which lack preventive actions and climate control. Loss of yield in small enterprises that make up the majority in the Basin may be as high as 10-15%. Assuming all other conditions such as the production infrastructure and input prices remain unchanged, the loss of yield **may lead to an annual loss of value to the tune of TRY 106.9m with regard to milk produced ex-farm, and a TRY 287.5m drop in production value resulting from processing.**

### *d) Fig (Dried)*

- ✓ **Climate change poses significant risks to dried fig production in the Basin.** Almost all fig orchards in Izmir are situated within Kucuk Menderes River Basin, and both the ecological conditions and the existing industrial capacity in the Basin allow the production of high quality figs. Variations in the wind regime may, however, render dried fig production in the Basin impossible.
- ✓ While the rise of temperature will have a positive effect on production to some extent, **excessively high temperatures will reduce yield and quality.** A partial decline in precipitation points to a rise in water stress.
- ✓ Assuming that the vital activities of the fig wasp are not affected and the wind regime during the fruit ripening period remain unchanged, it is predicted that harvest intervals will increase between 2021 and 2050 due to other climate stresses, and that a harvest loss ranging between 5% and 7% will occur. **The ex-farm value of this loss is expected to range between TRY 5m and TRY 6.9m.** The loss of harvested quantity and quality that may occur in the production phase may lead to a loss of income in the upper levels of the production chain, including wholesale, product processing, marketing and sales. Meanwhile, considering that a large proportion of figs are supplied to international markets, a potential decline in supply could be compensated by an increase in prices, mitigating the effects of losses. This situation may, however, create idle capacity, particularly in processing facilities. In that case, it is estimated that **wholesale trade will decrease between TRY 6m and TRY 8.5m as a result of climate change**.

### *e) Outdoor Ornamental Plants*

- ✓ **Production of outdoor ornamental plants in Turkey increased threefold over the past decade, gaining prominence particularly in the KMRB.** However, it is expected that due to climate change, these ornamental plants will be irrigated earlier within the year, leading to pressures on local water sources.
- ✓ **Depending on the species, climate change may affect the production of outdoor ornamental plants in the Basin to varying degrees.** Demand will be a determinant with regards to products that will be widely grown in the Basin. It is predicted that the production of varieties which are highly tolerant to drought and have less water stress will increase, in parallel with the rising need for irrigation due to rising temperatures. At this point, growing xerophytic plants will contribute to adaptation. As a highly advantageous region for growing bush-type plants, the Basin also has a great potential to grow xerophytic plants for landscaping purposes. With their low water need, xerophytic plants may secure a place in the markets of coastal areas and for landscaping.
- ✓ **Climate change may also enhance quality of ornamental plants**, as it will have a positive effect on the vegetative growth of plants, except for the July-August period.
- ✓ **Significant increases are expected in production costs due to climate change.** Some varieties that are sensitive to water stress may suffer a loss in yield ranging from 2% to 5% due to human factors or the insufficient supply of water. The loss of yield referred to above may be offset by price increases, as a higher quality is predicted for many species.
- ✓ The most important effect of climate change on the post-production chain of ornamental plants **include problems that may be observed in storage facilities, and a shortened marketing period as a consequence.** The potential decline in product quality will affect the economic value of products and limit marketing opportunities.
- ✓ The outdoor ornamental plants sector in the Basin encompasses hundreds of species that can be grown in different quantities and at different prices. In addition, unregistered production is considerably high, as ornamental plants are mostly grown by small family farms in the Basin. For these reasons, the net value of ornamental plants grown in the Basin could not be calculated.

## iv. Financial Resilience of Key Agricultural Products to Climate Change

- ✓ **Funds allocated to climate change are quite limited compared to government supports for agricultural production in Turkey** (6.8%). A large part of this budget is represented by 50% premium paid by the government to TARSIM agriculture insurance schemes on behalf of farmers, subsidies for good and organic agricultural practices, and ÇATAK.
- ✓ **In all sub-sectors across Izmir, use of agriculture insurance seems to be higher than the rest of Turkey.** Furthermore, tendency to insuring cattle, sheep, and goats in the province is higher than insuring plant production.
- ✓ In 2017, TARSIM launched the first "County-based Drought Yield Insurance", covering yield losses directly caused by the drought. Currently only available for wheat, this kind of insurance may be **a significant solution for agricultural resilience to climate change in the KMRB.**
- ✓ If ÇATAK (Environmental Based Agricultural Land Protection Program) – which provides application and funding support to farmers in areas such as agricultural erosion, evaporation, and loss of water for a period of 3 years – is extensively implemented in the Basin, it may enhance farmers' resilience to climate change. Meanwhile, **support for organic products and good farming practices represents a significant opportunity, particularly for tomato, fig and olive growers in Izmir and KMRB.**
- ✓ On top of the public supports for agricultural production, there are other finance sources for farmers including bank loans, loans borrowed from Agricultural Credit Cooperatives (TKK), input supplier credit, advance payments by buyers of products, and informal loans.
- ✓ **Access to agricultural finance is high in the Basin in relative to the rest of country.** In KMRB, thirteen banks have 78 branches. As of September 2018, Izmir accounts for 6.4% of total agricultural loans extended in Turkey. All farmers interviewed in the Basin in 2016 declared to have borrowed bank loans, and almost half of them borrowed the TKK loan in order to finance agricultural production. There is, however, limited access to finance with regard to climate change adaptation or mitigation.
- ✓ A large part of climate-related funds on-lent by banks in Turkey so far were channeled to renewable energy (hydro, solar, wind, geothermal) investments and energy efficiency projects, intended to reduce the energy consumption of corporates. **Attempts to extend those funds to SMEs and the agricultural sector have not been successful so far.** Three factors behind this failure is lack of information and awareness, insufficient demand from the clients, and lack of a sufficient number of studies on the solutions to climate change. To fund applicable solutions for climate change adaptation and mitigation in agriculture, **it is suggested that technical and financial support should be provided to local development agencies; the communication channels of public agencies should be used for this purpose; and agreements should be concluded with interested banks, based on an efficient financing model.**

# 1. Introduction

## 1.1. Background of the Project

The World Bank and IZKA have initiated the "Key Agricultural Product Risk Assessment (KAPRA)" for the Kucuk Menderes River Basin in order to strengthen Izmir's agricultural economy and to boost its competitiveness by ensuring the sustainability of natural resources and social dynamics. The project is being conducted in the Bayındır, Beydağ, Kiraz, Menderes, Odemis, Selçuk, Tire and Torbalı counties.

### Izmir's Role in the Agricultural Economy

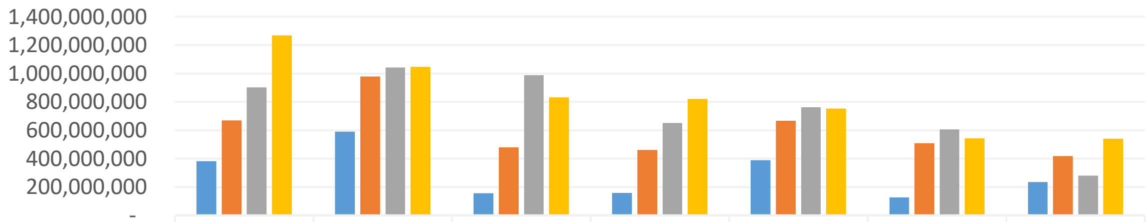
**Ranked third in livestock and vegetative production in Turkey, Izmir plays a key role in the country's agricultural economy, and is considered to be a hub of organic agriculture and alternative agro-food systems.** The city's agricultural economy has grown 2.5 times more than the national average in the last decade thanks to financial incentives and regional planning, and is now host to major processing and storage facilities, as well as being one of Turkey's agricultural export-import centers. The share of the provincial agricultural sector in the agricultural GVA of the Aegean Region is 22.3%, accounting for 4% of Turkey's agricultural GVA.

**Izmir is also one of the major livestock centers of Turkey and the Aegean region.** The value of livestock production represented 31.3% of total agricultural output in 2006, and had risen to 38.4% by 2016. According to 2017 data form TURKSTAT, it ranks third in terms of total milk production and second in terms of cows' milk production. The meat produced in Izmir accounts for 9.5% of the total meat production in Turkey and 44.1% of meat produced in the Aegean Region.

Sustainable development strategies jointly proposed by Izmir Metropolitan Municipality (IBB) City Strategies Centers and leading universities, institutes and research centers in Izmir aim at ensuring that fig, olive, cotton and tobacco – all of which are traditional crops in the Bakırçay, Gediz and Kucuk Menderes river Basins in Izmir – are sold at fair prices in both domestic and international markets, as well as providing more added value through plants to be built. In addition, organized industrial zones specialized in agriculture and livestock will be established and incentives will be provided for enterprises. There are also plans to provide services to farmers through agricultural industrial enterprises, cold stores, packaging plants, drying and canned food plants, packed product preparation plants and similar agricultural industry plants (Izmir Chamber of Commerce, 2015).

**Total exports from Izmir rose from USD 2.7bn in 2002 to USD 9.2bn in 2017. Exports of agricultural and livestock products tend to decline from one year to the next, whereas exports of processed food and beverage are on the rise.** Agricultural and livestock products were exported in the same portion as food products and beverages in 2012, and represented 10%, 9% and 8% of total exports in 2007, 2012 and 2017, respectively. Figure 1 shows the related figures.

*Figure 1: Exports From Izmir (in USD) by years and according to ISIC Rev3-Level2*

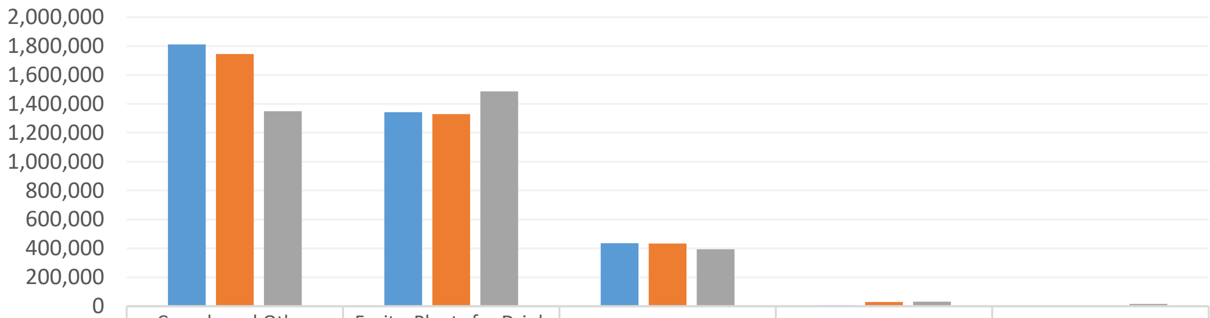



| | Food Products and Drinks | Clothing Items | Chemical Products | Machinery and Equipment Not Specified Elsewhere | Agriculture & Livestock | Motor Vehicles and Trailers | Textile Products |
|---|---|---|---|---|---|---|---|
| 2002 | 382,809,388 | 590,919,985 | 155,414,509 | 159,117,633 | 387,752,154 | 127,012,260 | 235,326,059 |
| 2007 | 669,294,802 | 980,120,693 | 480,405,828 | 460,655,317 | 667,586,562 | 508,080,971 | 418,490,608 |
| 2012 | 901,708,575 | 1,042,836,910 | 988,901,689 | 651,350,417 | 761,585,902 | 605,537,370 | 281,044,665 |
| 2017 | 1,269,445,690 | 1,046,716,010 | 832,728,124 | 820,834,436 | 753,710,196 | 542,465,397 | 539,541,909 |

*Source: TURKSTAT, 2017.*

Meanwhile, there has been an increase in agricultural production, and particularly in fruit production areas, in contrast to a contraction in areas used for field crops, and a relative decline in vegetable growing areas, which have followed a similar trend. As regards to ornamental plants, a 20-year trend cannot be determined as official statistics are available only since 2011. Figure 2 shows variations in agricultural areas in the province over the past 20 years.

*Figure 2: Utilization of Agricultural Areas in Izmir*




| | Cereals and Other Cultivated Crops Area (Decare) | Fruits, Plants for Drink and Spices Area (Decare) | Vegetable Gardens Area (Decare) | Fallow Land (Decare) | Ornamental Plant Area (Decare) |
|---|---|---|---|---|---|
| 1996 | 1,810,150 | 1,342,410 | 435,970 | 6,470 | 0 |
| 2006 | 1,744,829 | 1,329,945 | 434,757 | 29,795 | 0 |
| 2016 | 1,349,383 | 1,485,156 | 393,090 | 30,420 | 16,181 |

*Source: TURKSTAT, 2017.*

## Agricultural sector in the Basin

**The Kucuk Menderes River Basin (KMRB), the project region, has an area of 703,000 hectares, and is relatively suitable for agriculture based on its geological, hydrological and meteorological conditions.** The Basin has served as an agricultural breadbasket to many civilizations through ages. The most important products grown in the river Basin are olives, cotton, tobacco, figs, cereals, grapes, tomatoes and peppers. Cattle production is also significant, and production of indoor and outdoor ornamental plants is rapidly expanding. Some such products have a significant share in their respective markets, while others serve as an input for different agricultural productions. As regards to vegetative production, Odemis and Torbalı lead the production of field crops; Selçuk and Bayındır head the production of ornamental plants; Menderes and Torbali lead in viticulture; Tire and Odemis take place on the top in vineyards; Menderes produces most of citrus fruits; Bayındır leads in olive production; and Odemis heads arboriculture. The Odemis and Tire counties have a significant share in the cattle, sheep and goat production markets as well as in processing of dairy products. Torbalı and Tire stand out in the field of poultry breeding, while Menderes and Odemis play a key role in goat breeding and apiculture, respectively (data from FSFM field studies, 2011–2018).

**Most agricultural lands in the Basin are smallholdings run by families.** A significant part of the Basin's population over 480,000 is engaged in agriculture, and culturally they are known to be open to change, new information and cooperation.

## Potential Effects of Climate Change on KMRB's Agricultural Sector and Related Industries

**As one of the key economic sectors in the Basin, agriculture has recently been facing the effects of climate change and associated risks.** Projections on climate change demonstrate signs of serious risks threatening the Basin's ecosystem. The precise effects of climate change on land structure, erosion and pollution, however, are not fully known. Within the Basin, 73% of water resources are used for agriculture, while floods, drought and seasonal changes observed over the past couple of years have decreased the quality of agricultural products in the region.

**Despite the plans for further investments, there are concerns over the economic viability of the existing sectors and products, as well as the sustainability of the ecosystems on which they depend.** Investments in livestock breeding and milk production are gradually increasing, while their pressure on the water resources as well as changes in the amount and regime of precipitation pose a risk of sustainability. Similarly, higher temperatures and changing precipitation regimes lead to various problems in olive production, which is one of the traditional and economically key products in the Basin. This poses a threat to the sector, in which major investments have been made, particularly in the processing and industrial phases. In addition, the social difficulties and other dynamics experienced by farmers are affecting their economic and environmental decisions. The Basin was recently designated by law as a protected area for sustainable natural resources.

**Agricultural production in KMRB creates opportunities for other sectors in the region, while the risks originating from climate change may also spread to other sectors.** The agriculture and food sectors in particular, and sectors such as integrated logistics and energy, may also be affected by the risks that climate change may pose to agriculture. For instance, significant biogas investments were made over the last years as a result of the intensive livestock production activities in the region. This sector will most likely be affected by a decline in livestock production due to degradations in water resources in the region.

## 1.2. Project Objectives

The overall objective of the KAPRA, which is the first of its kind in Turkey, is to break new ground in the emerging field of climate resilience financing in agriculture, combining pro-business and ecosystem-friendly approaches that are socially acceptable. The project is built on the results of numerous new researches and planning activities carried out in Izmir.

**The project consists of four main axes:**

(i) To develop a framework for "key agricultural product[1]" and identify existing key agricultural products;
(ii) To assess climate change risks through the production chain (from producer to user) of five selected key agricultural products;
(iii) To identify resilience solutions, taking into account economic, ecological, and social dimensions;
(iv) To develop business cases and advise on novel financing strategies for implementation.

## 1.3. Methodology of the Report

Within this Report:

- ✓ The first chapter offers an analysis of past and current development strategies and policies related to agriculture, rural areas and climate adaptation in the KMRB, and assesses the current organizational framework through the use of regulatory and financing tools;
- ✓ The second chapter provides a definition of key agricultural products in line with the priorities and needs of the local stakeholders, the strategies and action plans of regional public and civil society organizations, as well as related international good practices; and outlines a selection framework;
- ✓ The third chapter offers a comprehensive look at the background and trends of each key product selected, the ecosystem services they depend on, the production capacity, targeted markets, assets and tools (from the place of production to the processing site, storage and logistics) and the production chain that comprises the stakeholders' map in the Basin;

[1]Key agricultural product: products on which other producers and users in the region depend and that have a significant share in regional and national supply, and whose absence may create a snowball effect that extends beyond the boundaries of the sector and the province. Forming resistance to climate change involves taking customizable actions (i) to mitigate risks that may have an impact on the physical integrity of an agricultural/natural asset and/or disturb its core function and (ii) to ensure optimum productivity and quality by taking into account potential changes in current conditions (average temperature, precipitation regime, etc.).

- ✓ The fourth chapter of the report presents the results of the risk analysis based on a multi-hazard approach on the key agricultural products selected. As specified in the Terms of Reference, this assessment focuses on prioritizing general results and trends (big ticket items) rather than scientific findings;
- ✓ The fifth and sixth chapters give the resilience solutions developed for the adaptation of key agricultural products in the region to climate change, as well as business solutions, including financing strategies, for the implementation of those solutions.

The preliminary results of this report were shared with the World Bank, IZKA and other local stakeholders during the Workshop on Risks for Key Agricultural Products held in Torbalı, Izmir on March 29, 2018.

***CHAPTER 1: CONCLUSIVE REMARKS***

*Fig, olive, cotton and tobacco are traditional crops in the Bakırcay, Gediz and Kucuk Menderes basins in Izmir, which plays a key role in the agricultural economy and ranks third in Turkey's animal and vegetative production. Therefore, it is of crucial importance to both producers and the national economy to ensure that these products are sold at a fair value, on both the domestic and international markets, and that they provide more value added to our national economy. Climate change and associated risks are the primary threat to this goal. Projections on climate change signal serious risks, particularly to the ecosystem of the Kucuk Menderes River Basin, which has a critical role in the agricultural economy of both the Aegean Region and the country.*

*The overall purpose of the "Key Agricultural Product Risk Assessment (KAPRA)" is to determine the necessary business cases and financing opportunities by combining ecosystem-friendly approaches that are socially and economically viable with a view to supporting adaptation and resilience to climate change in agriculture. The report was shared with the World Bank, IZKA and local stakeholders, and it details the climate change risks faced by the ecosystem, agricultural production facilities and their capacity, as well as the extended impacts affecting other sectors beyond the boundaries of the KMRB.*

## 2. Climate Change and Agricultural Sector in Turkey and KMRB

**There is an unprecedented increase in the global surface temperature over the past years** (Kirby et al., 2016; Janjua et al., 2010; Mahmood et al., 2012). Studies show that the increased temperatures and changes in rainfall patterns have a significant impact on food production.

**Factors such as vulnerability of plants, animals and aquatic creatures to high temperatures, access to water and severe weather conditions may pose a risk to agricultural yield and may inflict serious harm on farmers.** The Peterson Institute warns that agricultural production in the developing world would dwindle by between 10% and 25%; and, for instance, India's agricultural capacity would contract by 40% if the impact of global warming cannot be mitigated (Cline, 2007). In general, the total global agricultural output is projected to fall by between 3% and 16% by 2080. Most of the developing countries have temperatures almost equal to or above the temperatures that field crops can tolerate, and it is estimated that those countries will suffer a decline in agricultural production by 10-25% on average in the 2080s[2] (Mahato, 2014).

**The risks originating from climate change that will have a direct impact on the agricultural sector are as follows:**

- ✓ Thermal stress that can harm all crops and unusually hot days
- ✓ Heat waves
- ✓ Drought
- ✓ Severe storms
- ✓ Severe rain and snowfall
- ✓ Floods
- ✓ Hail
- ✓ Frost
- ✓ Cyclone

*Table 1: Estimated impact of climate change on agriculture over the next 50 years*

| Climatic Element | Projected Changes in the 2000s | Confidence Level of the Projection | Impact on Agriculture |
|---|---|---|---|
| $CO_2$ | Increase from 360 ppm to 450–600 pmm (from 379 ppm in 2005) | Very high | Good for field crops; increases photosynthesis, reduces water use |
| Rise in sea levels | 10-–15 cm rise<br>The level increases in the south, whereas this phenomenon is tolerated in the north due to the effects of natural tides. | Very high | Loss of land, coastal erosion, floods, salination of groundwater |
| Temperature | 1.4–3°C rise in temperature.<br>Winters warmer than summers<br>Increased frequency of heatwaves | High | Faster, shorter and earlier growth seasons, diversity shifting to the north and to high altitudes, thermal stress risk, increased water loss |
| Precipitation | ±10% change in seasonal variation | Low | Negative effects of drought on soil workability, absorption of water by soil and irrigation support, surface evaporation |
| Stormy Conditions | Increased wind speed, particularly in northern regions<br>More intense rainfall | Very low | Plant lodging, soil erosion, decline in infiltration of precipitation |
| Diversity | Increase in climate variables<br>Ambiguity of projections | Very low | Varying risks of phenomena (heat wave, frost, drought, flood) that affect field crops and the timing of farm operations, and that cause harm |

*Source: Mahato, 2014.*

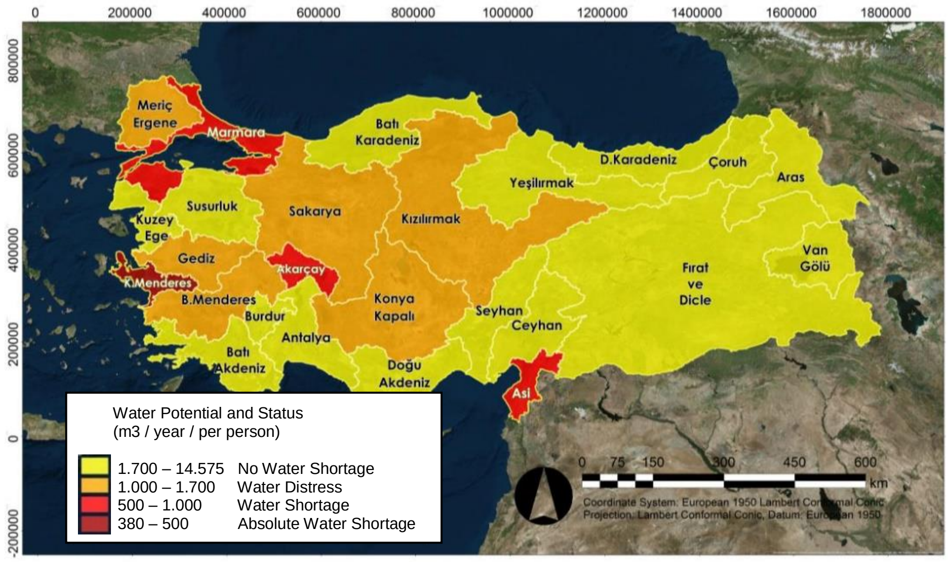
2The results on the maps have been computed based on climate, the effect of CO2 variations on plant growth and socioeconomic conditions.

## 2.1. Climate change in Turkey

**The Mediterranean Basin, encompassing Turkey, is defined as one of the "hot spots" in which climate change will be witnessed** (IUCN, 2014). While all climate models (General Circulation Model, GCM) indicate that there will be a decline in precipitation levels in the Mediterranean, numerous studies state that desiccation will occur on the Mediterranean and Aegean coasts of Turkey, in contrast to the humidity that will be witnessed along the Black Sea coastal strip. A 5%–25% decline in precipitation levels along the western strip, containing the Kucuk Menderes River Basin, in the first half of the 21st century supports these studies.

**Potential water sources per capita in Turkey is around 3,500 m³, which puts the country in the "limited water source" category** (The 2013-2017 Strategy and Action Plan for the Prevention of Agricultural Drought in Turkey). 1,500–1,735 m³ of the total amount of potential surface and groundwater is defined as "usable" water. The country's population will reach 100 million in 2030, and the amount of usable water per capita will decline to 1,000 m³, according to TURKSTAT projections. It is noted that agriculture, particularly agricultural irrigation, will account for 64% of all national water consumption in 2023, and that water used for agricultural purposes will continue to represent the largest source of demand for drinking water (FAO, 2017). **With an annual per capita water capacity of 380–500 m³, the Kucuk Menderes River Basin is the sole river Basin with absolute water scarcity** (Figure 3).

*Figure 3: Turkey's water potential per Basin (m³/year/person)*



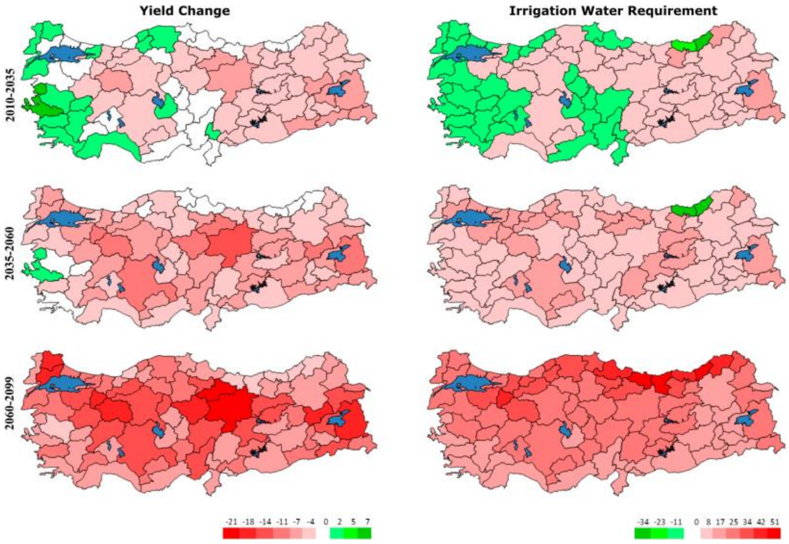

*Source: Yaykıran, 2016.*

### Impact of Climate Change on Turkish Agriculture

**The limited number of existing studies[3] indicate that climate change will have only limited effects on the Turkish economy and agricultural sector until the end of 2030.** Thus, an increase in average yield and a decline in the need for irrigation water has been observed in Izmir that encompasses the Kucuk Menderes River Basin, as a result of climate change between 2010 and 2035. A 7% increase in yield was observed only in Izmir among the provinces. The decline in the need for irrigation water is at a level similar to that of other provinces in the Aegean region. The exception in mean yield variation continues in 2035–2060 as well. In this period, an increase in yield of between 2% and 5% is projected in Izmir, although it will not be as high as the preceding period. The need for irrigation water will, however, rise across the entire Aegean Region, including Izmir. The positive effects of climate change in Izmir will end in 2060–2099. The average yield will decrease by 7% whereas the need for irrigation water will rise when compared to the preceding period (Dudu and Çakmak, 2018) (Figure 4).

[3] The study focuses primarily on the effects of climate change on yield and the water needs of agricultural products, taking into account variations in temperature, precipitation and wind in the provinces. Later, the effects of changes in agricultural production on the national economy are analyzed using a comprehensive economic model (Computable General Equilibrium Model) for an analysis of 12 regions and seven sectors. For the details of the study: https://doi.org/10.1080/17565529.2017.1372259

*Figure 4: Effects of climate change on yield and water needs in agricultural production, 2010–2099 (%)*




The same study **indicates that the ability of other sectors to substitute agricultural input utilization as a result of climate change would be possible to a certain extent, although substitution would not be possible once that threshold is exceeded, and the sector will thus become more vulnerable.** In general, the decline in the sector is relatively higher in the coastal areas. The effect of climate change on value added in the Aegean Region is higher in the non-agricultural sectors than in the agriculture-food sector.

*Source: Dudu & Çakmak, 2018.*

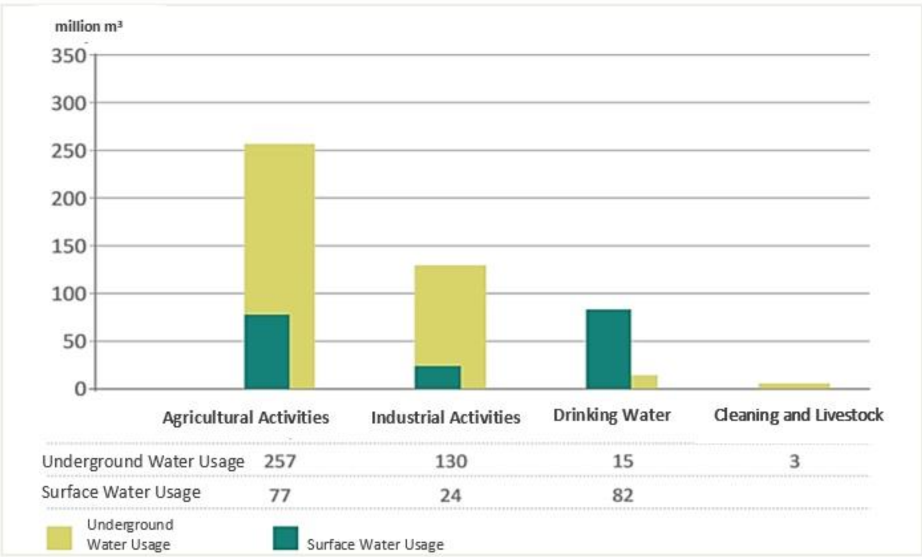
## 2.2. Climate Change in the Kucuk Menderes River Basin

### Water shortages in the Basin

A look at the annual water potential of Izmir indicates that the region is suffering from a water shortage. The available water potential represents only 50% of the amount of surface water in this region.

**A serious water shortage is expected in the Kucuk Menderes River Basin after 2020, with the steepest fall predicted to occur between 2051 and 2060 when only 36% of the water required being be supplied from sources within the Basin** (Ministry of Forestry and Water Affairs, 2016). A large proportion of the water required for irrigation and industrial purposes in the Basin is extracted from groundwater resources. As seen in Figure 5, agriculture is the main user of water resources, and groundwater in particular. The excessive use of groundwater on coastal belts and the fact that the level of sea water rises approximately 0.6 cm annually creates the possibility that sea water will infiltrate into the groundwater reserves. This phenomenon will unavoidably pose a threat to agricultural production in the region.

*Figure 5: Distribution of Annual Use of Groundwater and Surface Water in Izmir Province Across Activities*




*Source: Izmir Current Situation Analysis, IZKA, 2013*

A report[4] issued by Frankfurt School reveals that **frost and hail are the natural disasters that have the greatest impact on agricultural activities in Izmir, and particularly the counties in the Kucuk Menderes River Basin.** The fact that temperatures are over the ideal cooling needs in the winter and hence a significant decline in yield and hail is witnessed in summer moths, clearly shows the damage that climate change can cause. Unexpected atmospheric phenomena inflict heavy financial losses on farmers, affecting morale. Annex-1 details the extreme atmospheric and climatic phenomena observed in the recent past in the Basin.

Annex 2 presents the detailed results of the climate change risk analysis (Climate Change Risk Assessment in the KMRB).

***CHAPTER 2: CONCLUSIVE REMARKS***

*With the increasing frequency and severity of natural disasters such as floods, landslides, mudslides, drought and high temperatures as a result of climate change, it is inevitable that agricultural production in the world and in Turkey will be negatively affected.*

*The Mediterranean Basin, which encompasses Turkey, is described as a "hot spot" of climate change, and the frequency of droughts and irregular precipitation has already led to concerns related to agricultural production. An analysis of the potential impacts of climate change shows that its positive effects for Izmir will end during 2060–2099, that average yield will decline by 7% and that the need for irrigation water will rise afterwards.*

*Studies indicate a serious water shortage in the Kucuk Menderes River Basin after 2020, with the largest drop predicted to occur between 2051 and 2060, when only 36% of water will be supplied from sources within the Basin. Alongside water shortages, frost and hail are the natural disasters that will have great impact on agricultural activities in Izmir, particularly in the counties in the KMRB, and that atmospheric phenomena that occur unexpectedly lead to heavy financial losses among farmers.*

***Recently, local and national stakeholders in the region have initiated various studies and programs aimed at mitigating the impact of climate change and ensuring the climate change adaptation in agriculture, while also focusing on the efficient use of natural resources, raising awareness on climate change, and the development of action plans at a local/regional scale.***

4Quarterly sector reports issued by Frankfurt School of Finance & Management

# 3. Methodology for Selection of Key Agricultural Products in Kucuk Menderes River Basin

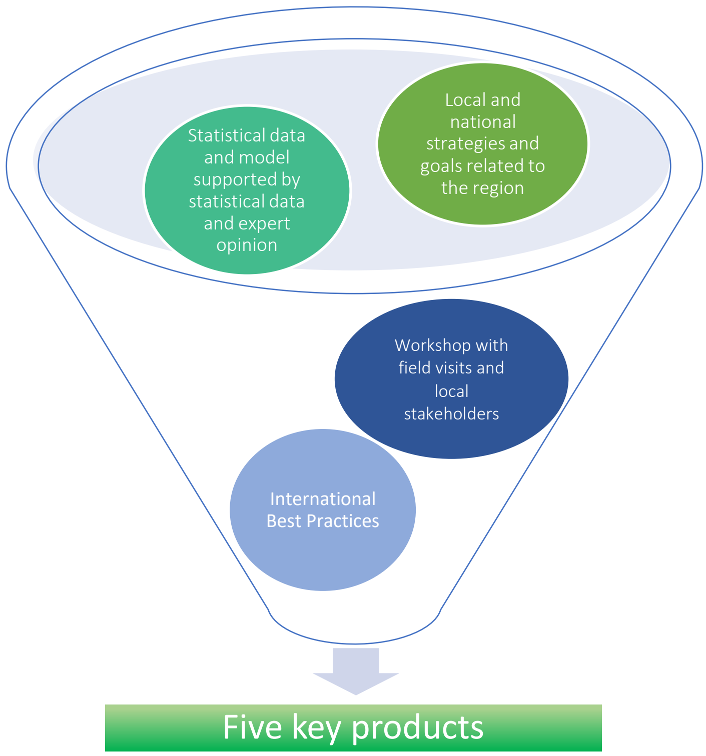
## 3.1. Introduction

This section presents a model for the identification of 5 key agricultural products on which actions for adaptation to climate change are analyzed in the Kucuk Menderes River Basin[5].

The key products were selected based on assessment of numerous international and national strategies, best practices and statistical data, as well as expert opinion (Figure 6). Accordingly:

- ✓ Policy and strategy papers at a national scale were reviewed and targets for adaptation to climate change were identified;
- ✓ The strategy and action plans of local stakeholders developed for KMRB were reviewed in order to understand their goals and principles;
- ✓ International best practices for the prioritization of key products/sectors were analyzed;
- ✓ Field visits were paid to producers, processors and other actors in the value chain, as well as public, private and civil society organizations in the region;
- ✓ Statistical data related to parameters defining critical products were gathered and literature was screened in order to form a model, supported with expert opinion;
- ✓ A workshop attended by the local stakeholders was organized to obtain additional ideas following a discussion of the preliminary outputs of the model; and its outputs were used for the selection of critical products.

*Figure 6: Process of Selecting Key Products*




5 The project area was determined as the Bayındır, Beydağ, Kiraz, Menderes, Ödemiş, Selçuk, Tire and Torbalı counties.

## 3.2. Factors taken into Consideration in the Selection of Key Products

### 3.2.1. Current Macro-Policies

#### EU policies

The Common Agricultural Policy (CAP) is one of the most significant policies of the European Union, ensuring sustainable and competitive farming and supporting adaptation to climate change. The EU Strategy for adaptation to climate change drawn up in 2013 aims at creating a climate-resilient environment for Europe. Recommendations for the following fields were included as part of the adaptation efforts.

- ✓ Conserve sustainable water systems through the efficient use of water resources;
- ✓ Cope with storms by developing stronger defenses against floods and make use of early warning systems;
- ✓ Adapt buildings to changes in climate and severe weather conditions in the future;
- ✓ Develop drought-tolerant plants;
- ✓ Select tree species and forestry practices that are less prone to storms and fires, and open flight corridors to help species migrate in such cases.

**The EU Adaptation Strategy (2013) has three primary objectives:**

***1. Promoting actions by the Member States:*** *The Commission will encourage all Member States to adopt comprehensive adaptation strategies, and undertake to provide funding to help them build adaptation capacities and take action. The commission will also support adaptation in cities by launching voluntary commitment programmes and supporting municipalities.*

***2. Promoting better informed decision-making:*** *Addressing gaps in knowledge related to adaptation and further developing the European climate adaptation platform (Climate-ADAPT) as the "one-stop shop" for adaptation information in Europe.*

***3. Promoting adaptation in sectors affected negatively****: promoting adaptation in vulnerable sectors such as agriculture, aquaculture and developing a cohesion policy, ensuring that Europe's infrastructure is more resilient, and promoting the use of insurance against natural and man-made disasters.*

#### Policies related to the Adaptation of the Turkish Agriculture Sector to Climate Change

Turkey ratified the United Nations Framework Convention on Climate Change in 2004 and the Kyoto Protocol in 2009. The country endorsed and ratified the Paris Agreement which was passed unanimously at a UN meeting in 2015, as part of its political commitments (Algedik et al., 2016).

The Tenth Five-Year Development Plan (2014–2018) that is currently in force details direct and indirect actions related to adaptation to climate change. **Agriculture-vegetative production, animal production, forestry, energy and tourism** have been identified as the main sectors in which adaptation activities must be performed. Agencies and organizations in Turkey have mostly been focused on mitigating the effects of climate change, and efforts to adapt to those changes have recently entered the agenda.

**A report entitled "Turkey's Climate Change Adaptation Strategy and Action Plan" published in 2011 includes a detailed analysis of "Agricultural Sector and Food Safety" in terms of climate change.** The first strategy devised by the Ministry of Environment and Urbanism focuses on critical issues related to adaptation to the impacts of climate change, including food safety, production, consumption, price, insurance systems, support for farmers and market policies, yield and competition, drought and desertification, preservation of biological diversity, animal and plant health, plant production and livestock in an integrated manner.

See Annex 3 for the basic strategy devised at the national level, along with laws and plans.

Basic Strategies Related to the Adaptation of the Agriculture Sector to Climate Change are detailed in numerous strategy reports, particularly the Five-year Development Plans. These documents, which define a macro-strategy and include a selection of key products, are summarized below.

*Table 2: Basic Documents and Policies in the Strategy Regarding Climate Change in the Turkish Agriculture Sector*

| Strategy | Time Frame | Objective |
|---|---|---|
| National Action Plan for Prevention of Desertification in Turkey | 2005–2015 | *Identify factors leading to desertification and prevent and/or mitigate the effects of desertification.* |
| National Strategy for Climate Change | 2010–2020 | *In line with sustainable development policies, contribute to the joint fight against climate change based on national conditions, and the principles of different responsibilities.* |
| Action Plan on Climate Change | 2011–2023 | *Limit greenhouse emissions in the fight against climate change, ensure adaptation to climate change, and minimize the effects of climate change.* |
| 10. FIVE-YEAR DEVELOPMENT PLAN | 2014–2018 | *The fight against and adaptation to climate change will be continued in line with the principles of "common but differentiated responsibilities" and "relative capabilities", taking into account the country's facts.*<br>*The primary objective is to preserve and improve the quantity and quality of water and soil resources, and to develop a management system that will ensure their sustainable use, particularly in the agricultural sector, where demand is at the highest level.* |
| MINISTRY OF AGRICULTURE AND FORESTRY - NATIONAL RURAL DEVELOPMENT STRATEGY | 2014–2020 | *The primary objective of the rural development policy in Turkey has been defined as to improve and ensure the sustainability of minimum life quality in rural areas with the objective of bringing it close to the national average, and ensuring that the working and living conditions of the rural community are harmonized with urban areas. The conservation of the rural environment and natural resources was identified as one of the sub-objectives based on principles of green growth.* |
| NATIONAL AGRICULTURE PROJECT | | *The project will monitor climate change and agricultural policies will be devised accordingly. A Basin- and product-based fertilization and chemical pesticide guide and plant-based water consumption guides will be compiled in order to conserve our soil and water resources and to ensure their sustainable use, with the aim being to prevent the unnecessary use of fertilizers and pesticides.* |
| STRATEGIC PLAN OF THE MINISTRY OF AGRICULTURE AND FORESTRY | 2018–2022 | *The basic strategy comprises development of strategies for adaptation to climate change and agricultural drought and crop projection systems; identifying organic carbon stock and biomass in the soil; developing a monitoring and management system for the taking of appropriate actions; the extension of the agricultural insurance system; devising Basin-based support plans that are focused on production, investment and marketing in which water criteria and rotations are considered as basic indicators.* |

## *2018–2022 Strategic Plan - Ministry of Agriculture and Forestry*

The 2018–2022 Strategic Plan made public by the Ministry of Agriculture and Forestry lists the objectives and goals that are also related with KAPRA in Table 3:

*Table 3: Relationship Between KAPRA and the 2018–2022 Strategic Plan of the Ministry of Agriculture and Forestry*

| | |
|---|---|
| Agricultural Production and Supply Security: To ensure the accessible and sustainable supply of agricultural products and to establish an agricultural sector that is highly competitive at national and international levels | ✓ Objective (H1.1): To ensure supply security for agricultural products<br>✓ Objective (H1.2): To devise policies and to identify appropriate policy tools for the creation of a competitive and sustainable agricultural sector<br>✓ Objective (H1.3): To play an active role on the international arena<br>✓ Objective (H1.4): To develop a training and consulting system targeting producers and consumers |
| Food Reliability: To ensure food and feed reliability in order to protect natural resources and human health from production to consumption, in accordance with international standards | ✓ Objective (H2.1): To enhance the effectiveness of formal control services provided with regard to food and feed reliability |
| Plant Health, Animal Health and Welfare: To take actions to protect plant health, to control and eradicate animal diseases and pests, to ensure animal welfare | ✓ Objective (H3.1): To preserve quality and to boost yield in vegetative production through environment-friendly plant health activities<br>✓ Objective (H3.3): To improve services related to the prevention of animal diseases and pests, and to preserve animal health |

| | |
|---|---|
| **Agricultural Infrastructure and Rural Development:** To develop the rural economy; to improve the agricultural, social and physical infrastructure of rural areas | ✓ Objective (H4.1): To enhance income and job opportunities in rural areas and to diversify the rural economy<br>✓ Objective (H4.3): To ensure the preservation and efficient use of soil and water resources |
| **Management of Aquatic Products and Fish Stocks** To preserve resources of aquatic products and to ensure their sustainable operation, to improve the production of aquatic products | ✓ Objective (H5.2): To preserve aquatic products and their resources; to enhance the effectiveness of controls and inspections |
| **Research & Development:** To conduct research & development aimed at enhancing quality and productivity in agricultural production | ✓ Objective (H6.2): To preserve genetic resources and biological diversity; to ensure their sustainable use<br>✓ Objective (H6.3): To develop R&D cooperation with national and international organizations<br>✓ Objective (H6.4): To measure the potential effects of climate change on agricultural systems and to devise proposals for taking actions |

With regards to social and environmental effects of climate change, **farmers that are poor or in low-income category, and particularly women, who represent 70% of the labor force in the agricultural sector** are the most adversely affected group (ÇŞB, 2012). There are no sufficient number of studies addressing this matter in Turkey.

The State Hydraulic Works department drafted an **Action Plan for Basin Management for the Kucuk Menderes River** in 2010 to identify the challenges faced by river Basins due to climate change. The plan is designed to have three phases (short term - 2010–2015; medium term - 2015–2020; and long term - 2020–2040), covering a 30-year period, regarding the order of importance, technological and economic feasibility and sustainability after determining water source potential, point or diffused sources of pollution, and the current water quality in order to prevent pollution in the Basin, and to protect and rehabilitate water sources in the Basin.

### 3.2.2. Current Micro-Policies

Various development projects and strategy/action plans led by public and civil society organizations at a national scale targeting the project region were reviewed for the selection of development goals that would guide the selection of key products. The relationship between the target that each selected indicator attempts to measure and the targets specified in the local strategy, working plans and action plans in question is summarized in Annex 4. The basic studies reviewed and their priorities related to KAPRA are summarized below:

*Sustainable Development and Life Strategy for the Kucuk Menderes River Basin - Izmir Metropolitan Municipality*

This strategy paper, drafted by the Higher Technology Institute of Izmir, Ege University and Dokuz Eylul University for the Izmir Metropolitan Municipality in December 2016 defines the assets in the region and targets an asset-centered development strategy. The documented strategies and projects of almost all stakeholders concerning the region were reviewed during the preparation of this document, and many workshops were held with the attendance of the stakeholders, providing guidance for the selection of goals and priorities to be adopted for the KAPRA study (IBB, 2016). Specifically, the outputs of sections entitled "agriculture," "environment, energy and water resources," and "innovative and entrepreneurship" of the strategies contained valuable results for KAPRA.

*Izmir Regional Plan - Izmir Development Agency*

The Izmir Regional Plan developed by IZKA for 2014–2023 is a comprehensive study conducted to bolster the economy of the Izmir region which involves KMRB, and to ensure development. It is seen that taking actions to ensure the sustainability of the environment and to improve accessibility are the main issues in the attainment of a high quality of life. A look at the more detailed strategic goals and sub-goals under the basic headings in the report shows that the plan is largely in line with the basic principles and goals taken into consideration in KAPRA (İZKA,2015).

*Action Plan for the Conservation of the Kucuk Menderes River Basin - TUBITAK*

Another study undertaken with regard to sustainability in the region is the Action Plan for the Conservation of the Kucuk Menderes River Basin, which was carried out by TUBITAK in 2010. The project firstly determined the current situation and potential water resources, the point and diffused sources of pollutants, and the current water quality with a view to preventing pollution in the Basin, ensuring conservation and making improvements. Prioritized and technologically more economic, feasible and sustainable plans were subsequently devised for the short, medium and long terms (TUBITAK MAM, 2010). The short-, medium- and long-term goals established in the light of the study findings include water quality and reduction of ecological pollution; alleviating the current pressure on water sources; the reduction of groundwater use; conducting Agricultural Pollution Management studies in villages close to rivers and in residential areas where the tributaries of the stream in order to minimize the effects of agricultural pressure; reducing the use of fertilizers and chemicals down to controlled levels and encouraging positive use; directing the rural population to climate-smart agricultural practices, such as organic farming and drip irrigation; afforestation and erosion control efforts, and soil protection measures in parallel with KAPRA.

*Pollution Prevention Plan for the Kucuk Menderes River Basin - Ministry of Environment and Urbanization*

Released in August 2016, the Plan emphasizes that water sources and efficient irrigation should be improved to encourage agricultural development in the KMRB. The Plan notes that groundwater sources are at risk from excessive abstraction.

### 3.2.3. International Literature and Best Practices

A review of recent international development practices that prioritize key products, sectors or value chains **found that studies tended to be conducted in limited areas, and no study could be identified in key product identification focusing on adaptation to climate change or ecological sustainability.** Almost 90% of the studies lack a sufficient rationale for product selection, or any information in that regard (White et al., 2011).

For the selection of key products in the Basin, a comprehensive analysis of literature was conducted, and studies focusing on the selection and prioritization of basic/key products/sectors/activities conducted in various sectors, particularly the agricultural sector, were reviewed. These studies were generally assessed from the perspectives outlined below, and the approaches adopted in the analyzed studies were used to develop a methodology for the selection of indicators for KAPRA.

- ✓ Focusing on agriculture and the industrial sectors linked to agriculture;
- ✓ Similarities between climatic conditions in concerned area and the climate characteristics observed in the Basin;
- ✓ Topographical similarities with the types of lands within the Basin;
- ✓ Social dynamics in area studies approximating to social/rural dynamics in the Basin;
- ✓ Aim to prioritize a product and/or sector linked to a specific development goal and containing a suitable methodology;
- ✓ Matching study goals and principles with those of KAPRA.

Nonetheless, useful approaches that could serve as a reference for KAPRA were discovered in the prioritization methods employed in those studies. Studies involving those approaches and their relationship with KAPRA are presented in the following table. Please see Annex 5 for details of the studies.

*Table 4: International Best Practices Contributing to the KAPRA Product Selection Methodology*

| *Study* | *Objectives and goals* | *Aspect providing input to KAPRA product selection methodology* |
|---|---|---|
| *"Identification of Lands of Agricultural Importance" - Western Australia (2000)* | To identify agricultural areas in western Australia for the utilization of best agricultural use and management approach and to clear the way for such areas<br><br>Sustainability of agricultural activity in those regions with maximum value | CAASAM (Comparative Agricultural Area Suitability Assessment Methodology)<br>✓ Economic, social and environmental perspective<br>✓ To identify 15 physical and non-physical criteria that are important for key agricultural activities, and the use and improvement of each area<br>✓ To rank and weight sub-categories depending on their importance Critical (1), Important (2) and Desired (3) |

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| | added and yield based on the principles of rural development and ecological sustainability | |
| *"Guide for the Selection of a Value Chain: Integration of Economic, Environmental, Social and Institutional Criteria" - GIZ (2015)* | To develop an integrated approach to the selection of value chains that need to be promoted or preserved for any development goal | ✓ To draw up a shortlist of potential value chains using a narrow set of indicators, and then defining a final list by employing a wider set of indicators as an option<br>✓ The following phases were followed in the selection: 1. Start point; 2. Shortlisting; 3. Election criteria and modeling; 4. Literature study; 5. Education; 6. Field study; 7. Workshop with stakeholders; 8. Final selection |
| *"Development of Competition in African Agriculture" - World Bank (2010)* | Prioritization of investments selected from among approaches aimed at the development of agricultural value chains that will be supported to improve productivity and quality due to the increased demand for African goods | ✓ Stakeholder involvement and multi-voice approach<br>✓ To hold regular interviews and organize a workshop to hear the expectations and priorities of the stakeholders, and to obtain their feedback on the results of the study in the first and subsequent phases of the project |
| *"Environmental Indicators for Agriculture: Methods and Results" - OECD (2001)* | To draw up an inventory of the environmental effects of agriculture in OECD countries | ✓ Considering the environmental effects of agriculture and the economic and social aspects of sustainable agriculture based on Driving Force-State-Response (DSR)<br>✓ Integration of economic, social and environmental contexts.<br>✓ The following criteria were looked at: Agricultural GDP, agricultural production, agricultural employment, distribution of farmer age/sex, number of enterprises, agricultural subsidies, land use: Utilization of agricultural land, revenue of enterprise<br>✓ Enterprise management and environment: General operating method: Existence of general environmental farm management plans, organic farming, plant nutrition method: Fertilizer use, soil and land management: Practices for the conservation of topsoil and land management, elimination of pests: Utilization of non-chemical pest eradication methods, irrigation and water management: Efficiency and intensity of water use, water stress<br>✓ Using the effect of the environment on agriculture as a selection criterion: Soil quality and protection, water quality, greenhouse gases (gross agricultural greenhouse emissions) |
| *Olive Oil Value Chain Study - Greece (2007)* | To develop an alternative business model that ensures the environmental, social and economic sustainability of olive oil production in a local rural community | ✓ To take into account the various factors affecting farms in the region, including climate, government policy and the effects of the market<br>✓ To include topography and the applied plant nursing practices, along with such indicators as the cultural importance, traditional character and economy of products, and their eligibility for government subsidies in the model<br>✓ Difficulties faced by small farmers, utilization of conventional farming methods, farmer experience, subjective approach of local stakeholders, density of older farmers, topography and the insufficiency of cooperatives should be taken into consideration in the model, and should be similar to those in KAPRA project region<br>✓ The model should make use of interviews and the researcher's own observations, as well as statistical data |
| *Slow Food Delegations (Founded in 1986, Italy)* | To monitor and assess sustainable farming and food systems through an indicator-based method | ✓ To include economic, ecological and socio-cultural indicators in the model, as well as product quality<br>✓ Weighting of indicators and criteria with the involvement of local stakeholders |

| | | |
|---|---|---|
| *Sustainable Agriculture and Soil Conservation (SoCo Project) - Italy (2009)* | Environmental sustainability and protected agriculture<br><br>Land planning and soil protection<br><br>(Models were used to assess land degradation risk when measuring the area's vulnerability to erosion, compaction and reduction of organic substance content) | ✓ Case study approach<br>✓ Classification based on topography and soil structure (High Mountains, Medium Mountains, Low Mountains, Internal Alluvial Flat, Coast Alluvial Flat)<br>✓ Emphasis on the need to ensure equilibrium between sustainable agriculture, and socioeconomic and environmental factors |

### 3.2.4. Stakeholder Comments

Regular meetings were held with various public and private stakeholders in the region, and the priorities of those stakeholders and the problems and opportunities that they observed in the KMRB were shared during the selection of key products, in parallel with the project's participatory and multi-stakeholder approach. The results of those meetings are parallel to the strategy studies and status assessment reports referred to above.

In addition to all of the stakeholder interviews, **a workshop attended by the stakeholders in the Basin was held in Torbalı, Izmir on March 29, 2018; and the results of the workshop were used for the development of the methodology.** The workshop was mostly attended by public and civil society organizations working on agricultural/rural development, as well as some producer groups.


*A photo from the stakeholder workshop held in Torbalı*

In the first session of the workshop, an exercise was conducted to identify the key agricultural products and development priorities in the region from the standpoint of the participants, and the results were assessed to check the consistency of the selected indicators with regional dynamics. As a result of the discussion, the following indicators were found appropriate to be integrated into the model:

- ✓ **Complementarity** to production of other products in KMRB
- ✓ Infrastructure should be suited to the product, and the product should be **adapted to the region**
- ✓ Dependency of the producer's **welfare** on the product
- ✓ The level of know-how of the farmers in the region and traditional products with product experience
- ✓ **Products with no alternative** (such as chestnut and cherry, of which there are no alternatives in the mountains)
- ✓ High **value added created when the product is processed**
- ✓ High **economic value** of the product and its extensive production

- ✓ Allowing further use of technology in the future
- ✓ **Helping decreasing dependence on imports**
- ✓ **Capacity to adapt to climate change**
- ✓ Having a **comparative advantage** over other regions related to the production of the crop.

In addition, the following comments were shared by the participants and were included in the methodology:

- ✓ Producers in the region are inclined to shift to **innovative products**. The Basin has a high capacity to switch to new crops with a higher economic value.
- ✓ It is essential that the IBB and the government develop **support policies**.
- ✓ The methodology should include **outdoor ornamental plants and fruit arboriculture,** in which the Basin ranks first in Turkey in terms of production.
- ✓ **The support and subsidized loans provided** has a serious effect on product pattern.
- ✓ A **priority ranking should be made regarding the utilization of water** when identifying the key products.

In the subsequent sessions of the workshop, different groups of participants were asked to assess the selected indicators, ranking them in terms of importance. The list of indicators was finalized based on the outcome of this exercise. The prioritizations of each group of participants and a detailed report on the workshop can be found in Annex 6.

In addition, a survey and a free discussion session were held in order to understand the opinions and level of awareness of the stakeholders regarding climate change in the Basin, and opinions were received from various groups in order to shape a scope of works that may yield results.

The matrix in Table 5 summarizes how national development strategies and policies related to the agriculture sector and climate change, as well as studies carried out and plans devised specifically for the Kucuk Menderes River Basin, coincide and are linked to the **goals and principles set forth in the product selection methodology developed for KAPRA**. The detailed content of the table can be seen in Annex 4.

*Table 5: Relationship between national and local strategy papers and plans and the KAPRA goals*

| Goal of the Selection of Key Products Underlying the KAPRA Methodology | Related Goals / Strategies / Principles | | | |
|---|---|---|---|---|
| | *GTHB 2018–2022 Strategy Plan* | *IBB Kucuk Menderes Sustainable Development and Life Strategy* | *IZKA - Izmir Regional Plan* | *TÜBİTAK – KMRB Conservation Action Plan* |
| **Economic Goals** | | | | |
| *To boost the competitiveness of agricultural products grown in the Kucuk Menderes River Basin in the domestic and international markets.* | ✓ | ✓ | ✓ | |
| *To ensure food reliability and safety at national and regional levels* | ✓ | ✓ | ✓ | |
| *To reduce price instability and to improve farmers' decision-making processes related to agricultural activities* | ✓ | ✓ | ✓ | |
| *To boost the economic welfare of the regional population by ensuring the sustainability of crops that are produced with a higher yield and value added when compared to the national average, and to make a maximum contribution to the Basin's agricultural income* | ✓ | ✓ | ✓ | |
| *To ensure the continuity of the main products providing input into the region's infrastructural industry and to minimize the vulnerability of the agricultural sector to climate change* | ✓ | ✓ | ✓ | ✓ |
| *To reduce the vulnerability of stable markets to climate change by ensuring the continuity of agricultural products where well-established market channels exist* | ✓ | ✓ | ✓ | |
| *To preserve agricultural sectors with relatively well-developed innovation and technical capacity and to support the production of crops with value added in the region* | ✓ | ✓ | ✓ | |
| *To reduce the vulnerability of products exported from the region to climate change and to preserve their competitiveness in foreign markets* | ✓ | ✓ | | |
| **Social Goals** | | | | |
| *To reduce unemployment by ensuring continuity in the production of crops that create most of the agricultural jobs in the region, to support socioeconomic prosperity in the region, and to reduce migration from rural to urban areas by activating the idle workforce* | ✓ | ✓ | ✓ | |

| | | | | |
|---|---|---|---|---|
| *To maintain agricultural sectors in which disadvantaged social groups are active, such as women and young people, and to preserve their socioeconomic welfare while increasing their participation in the workforce* | ✓ | ✓ | | |
| *To ensure the continuity of production of traditional and geographically-marked crops in the region and to prevent the potential effects of climate change from negatively affecting the region's social and cultural structure* | ✓ | ✓ | | |
| *To ensure that women, young people and small family enterprises contribute to agricultural production in an active and sustainable manner in the Basin* | ✓ | ✓ | ✓ | |
| *To raise awareness on climate change among farmers and the agricultural sector in the sectors accorded priority by public policies, to enhance their adaptation efforts and to ensure that public support is highly welcomed by civil society* | ✓ | ✓ | | |
| *To support agricultural sectors in which farmer organizations are active and influential, and to provide better opportunities for farmers to access the market, funding and knowledge* | ✓ | ✓ | ✓ | |
| *To support products with a high social reputation, to prevent people engaged in farming from leaving the sector and rural areas, and to prevent the degradation of the social structure* | ✓ | ✓ | | |
| Environmental Goals | | | | |
| *To identify the green, blue and grey water footprints of agricultural production, and to conserve groundwater and surface water sources* | ✓ | ✓ | ✓ | ✓ |
| *To ensure the efficiency of resources in agricultural production* | ✓ | ✓ | ✓ | ✓ |
| *To support decisions related to the efficient use and conservation of soil* | ✓ | ✓ | ✓ | ✓ |
| *To propose agricultural production methods that are resistant to climate change* | ✓ | ✓ | ✓ | |
| *To promote agricultural products more suited to climate-smart practices in the region* | ✓ | | | |
| *To promote production methods with limited adverse effects, such as organic and good farming* | ✓ | ✓ | ✓ | ✓ |

## 3.3. Methodology for the Selection of Key Agricultural Products

An assessment based on products was conducted for the analysis of the potential effects of climate change on regional agriculture and value chains. Many agricultural crops are grown in the region. The environmental, economic and social sustainability of agricultural production was identified as a precondition in the method.

### 3.3.1. List of Main Agricultural Products in the Region

Approximately 200 agricultural crops are grown in Izmir, singling it out as the province with the richest product diversity in the country. Hosting more than 100 agricultural products, the KMRB also has a broad spectrum of outputs. According to an analysis of TURKSTAT data for the 2012–2016 period:

- ✓ Field crops with an annual production value of over TRY 10m: **barley**[6]**, wheat, maize grain, cotton, potato, maize silage**, clover (green grass)[7], tobacco;
- ✓ Vegetables with an annual production value over TRY 10m: **tomato (paste and table), cucumber (table and pickle), okra, watermelon, artichoke, pepper (fresh and paste), black-eyed pea (fresh), bean (fresh), lettuce;**
- ✓ Fruits with an annual production value over TRY 10m in the region where fruit is grown extensively: **grape (table, dried and wine), olive (table and oil), fig (dried), mandarin (satsuma), cherry, peach** and **chestnut.**
- ✓ A look at animal production indicates that cows' milk production was **716,928** tons in the Basin in 2016 (production value: TRY 824.5m), compared to **5,817** tons of beef (cattle and sheep and goats included) (TRY 184.6m) and only **827 tons** of honey (TRY 19m) production. There is no commercial poultry production in the Basin. Thus, **cows' milk,** which is widely produced in KMRB representing 99% of animal production, was included in the list as the main animal product.[8]

6Wheat was included as the growing cycles of barley and wheat are almost identical, though wheat is grown more extensively.
7Fodder crops are generally cultivated by livestock breeders to provide roughage for their own livestock. Maize silage is no longer a fodder crop sown by livestock breeders, and has become a crop that is widely sown for the purpose of selling. Thus, maize silage was included on the list as the main fodder crop which broadly comprises the forage and also stands out as an economic asset.
8There are numerous types of production method, varieties, and processing methods for vegetative production in the Basin. While a comparison based on area or quantity would not be very reliable, product groups were ranked based on a comparison of their production values, and threshold values were set based on the value added that they brought to the region. A review of the report entitled "Izmir Province 2016 Agricultural Structure" issued by the Provincial Agriculture and Forestry Office of Izmir suggests that the highest value added crops and extensively grown products were selected if the KMRB counties are excluded from the tables.

- ✓ **The KMRB supplies a significant proportion of the outdoor plant and cut flower market in Turkey.** Rose and chrysanthemum production in the Basin represents more than 25% of total production in Turkey, and this ratio is 52.5% in chrysanthemum. Thus, the **cut flower group** was included in the list in line with field observations, despite the fact that it has a lower production value than the other product groups based on the available statistical data.

The final list consists of 34 products with sub-varieties:

| | | |
|---|---|---|
| ✓ *Cotton (unginned)* | ✓ *Artichoke* | ✓ *Fig (dried)* |
| ✓ *Maize (silage)* | ✓ *Pepper (capia paste)* | ✓ *Mandarin (satsuma)* |
| ✓ *Maize (grain)* | ✓ *Pepper (fresh)* | ✓ *Cherry* |
| ✓ *Potato* | ✓ *Black-eyed pea (fresh)* | ✓ *Peach* |
| ✓ *Tobacco* | ✓ *Cows' milk* | ✓ *Chestnut* |
| ✓ *Wheat (bread)* | ✓ *Bean (fresh)* | ✓ *Clove* |
| ✓ *Tomato (table)* | ✓ *Lettuce* | ✓ *Gerbera* |
| ✓ *Tomato (paste)* | ✓ *Grape (table)* | ✓ *Chrysanthemum* |
| ✓ *Cucumber (table)* | ✓ *Grape (dried)* | ✓ *Rose (cut)* |
| ✓ *Cucumber (pickle)* | ✓ *Grape (wine)* | ✓ *Lilium* |
| ✓ *Okra (fresh)* | ✓ *Olive (table)* | |
| ✓ *Watermelon* | ✓ *Olive (oil)* | |

### 3.3.2. Development of a scoring matrix

The ranking of the key agricultural products is determined among the 34 products **based on a multi-criteria decision model**. This assessment involves the analysis of a series of social, economic and environmental indicators reflecting the priorities of regional stakeholders and dynamics. General statistical data, data provided by stakeholders, the results of studies, including Technical Consultant observations and surveys in the field, and the outcomes of the meetings were used to reflect these indicators in the model.

**Economic Impact**
- Economic yield and economic sustainability of the production of the related crop.

**Social Impact**
- Effects such as the involvement of active rural population, migration to cities, extent of family farming and the share of women in agricultural income in the project area.

**Environmental Impact**
- Impact of environmental risks - e.g. heightened risk of flood in the basin as a result of agricultural activity; impacts from pressure on existing water sources; or impact on the ecosystem.

A scoring matrix comprising economic, social and environmental aspects was developed, and the **indicators to be assessed under each aspect and their weights within the model were identified in line with project goals and principles, taking into account also the priorities of the project stakeholders.** When the criteria and indicators were set, it was ensured that they thoroughly encompass the relative importance and characteristics of the product.

#### Precise and inclusive outcome based on expert opinion

Data on agricultural products was obtained for each indicator from existing local, national and international sources, and care was taken to base such data on objective statistical data to the maximum extent. **Approximated variables and expert opinions were used frequently, particularly those of a social and environmental nature, when**

As the types of animal products were more limited than those of vegetative production, a comparison of production quantity was made in order to show the extent and level of production in the Basin. As both the quantity and value of cows' milk produced was higher than those of other animal products, no threshold value was set, and only cows' milk was included.

**there was a lack of statistical data.** This approach was in parallel to the best practices observed at a global scale (BMZ, GIZ & ILO, 2015).

**A scenario was developed to determine the effects of the indicators on the total index of the products, with weighting based the Budget Distribution Process** (*OECD, 2008*) **method[9].** It was observed that indicators are weighted based on a similar approach to that was followed in the international studies aiming sector/product/value chain prioritization.

**To reflect the priorities of regional stakeholders during weighting the indicators**, the outcome of the Kucuk Menderes Sustainable Development and Life Strategy by Izmir Metropolitan Municipality, the 2018–2022 Agriculture Strategy of the Ministry of Agriculture and Forestry, the IZKA Regional Action Plan and the TUBITAK Kucuk Menderes River Basin Conservation Action Plan were taken into consideration. To confirm the relationship between the selected indicators and the project area, these documents were analyzed in detail and the extent to which the key product determination goals were included in those reports was noted.

Explanations of the indicators are presented in Table 6 alongside causality.

9The team members were asked to distribute their "budgets" made up of 100 units delivered to them for each indicator according to the relative significance of the indicators as part of this report. A Delphi session was held to ensure convergence in the weights after the first weighting, and experts were asked to reassesses the weights after discussing the rationale. A seven-strong team made up of agronomists, agricultural financing experts, and rural and social development experts assessed the weights individually and independently in KAPRA, and the final scenario was devised taking the average of the weights provided for each indicator. The total weight of those indicators was 100% in their respective categories, determined based on the importance of the category within the project goals. There was no true or false in the weightings, and the weight of a category within the total index was clarified based on the project's goals and expectations of the actors regarding the project output.
The Delphi technique allows individuals to contribute to related parts of problems from different perspectives using their individual knowledge, skills and experience, and hence is consistent with the identification of key products within KAPRA (Şahin, 2001). Aimed at making forward-looking projections and reaching a compromise when there is a divergence of opinions within similar situations, the Delphi technique requires the participants to be experts in the subject, and a team of experts made up of a minimum of seven members expresses its ideas and opinions to reach a conclusion (Şahin, 2001).

*Table 6: Indicators and their explanations addressed in the key product methodology*

| Indicator (weight assigned in the model %) | Explanation |
|---|---|
| Economic Indicators | |
| If the product is exported (9%) | The most important determinant of the product’s ability to bring in proceeds in a foreign currency is its openness to external demand and the extent to which it is integrated into the global value chain. Products exported from the region create value added for the economies of both the region and the nation. |
| Ratio of the production value of the product in the KMRB to its production value in Turkey (8%) | This indicator measures the product’s contribution to agricultural production in Turkey and the Basin. |
| Ratio of the product’s growing area in the KMRB to total agricultural lands in the KMRB (8%) | Land use is a determinant of not only economic, but also social and environmental impact, as well as change in general, and in the agricultural sector in particular. As climate and land characteristics are uniform, the product’s weight in the use of agricultural land in the Basin is used. |
| Agricultural sector of which the product is an input (8%) | Aims at measuring the externality effects of changes in products with strong and advanced regional non-agricultural ties with other regional economic activities. The existence of agro-industrial processes that include the product as an input was reflected in the related product in the form of a high score. |
| Ratio of the product’s production in the KMRB to its production in Izmir (7%) | Determines the KMRB’s extended regional weight in production. The fact that the Basin accounts for a significant part of the Izmir region’s demand for the related product denotes that the region is a key supplier for the entire province, and that it contributes to regional prosperity. |
| Ratio of the annual production cost of the product to annual gross income (per hectare/animal) (7%) | Measures the level of the product’s contribution to the farmer’s income. The unit production cost is compared with the income that a farmer gains from a product in the KMRB. The costs of these plant products have been calculated by dividing the gross income gained from the regional product from one decare of cultivated area by production cost per decare, based on data from Frankfurt School’s agricultural income-expenditure database. Animal product (milk) costs were computed by dividing the gross income gained from a milked cow in one pear by the cost of one cow per year. |
| Existence of market channels infrastructure (wholesalers market, market, warehouse, licensed warehouse) (7%) | The easy marketing of a product and the timing of its sale determine the producer’s share of the value chain. A well-established market channel infrastructure related to a product allows a producer to create products with a higher value added, to access well-established markets in a timely manner and to earn more money from the operation. Such products thus receive high scores in the model. As no statistical data was available for this indicator, interviews conducted in the region and expert opinions were used as a determinant. |
| Ratio of the product’s average yield in the KMRB to its average yield in Turkey (6%) | The level of yield of a product is affected by the suitability of the climate and the land, as well as the producer’s managerial skills (quantity and timing of input utilization, accumulated knowledge, etc.). Land partial yield ratios aim at determining the Basin’s relative advantage in the production of the product, and hence, its economic sustainability. |
| Priority is given the production of a product according to the implemented public policies (6%) | Public support policies (high customs duties and support payments from the budget) raise awareness on the relative yield of the products, while ensuring that production is recorded. In addition, if policymakers accord priority to the product, a synergy with concerned public actors can be created supporting the sustainability of the product in the region, meaning that researches conducted by the government have concluded that the product is considered important and eligible for support from a social and economic perspective. Related sources were explored with this in mind, and products that have been prioritized by the public sector were given high scores. |
| Existence of contract production for the product in the region (6%) | Contract production facilitates marketing while minimizing the price risk that may be faced by the producer during the harvesting season. Furthermore, in some contract production mechanisms, the processor provides the producer with inputs, and hence funding. Meanwhile, regions with significant contract production are also essential for the profitable sustainability of the agriculture sector in the region. For all these reasons, the product was assigned a high score if its contract production is extensive in the KMRB. This scoring is based solely on expert opinion and observations due to a lack of statistical data. |

| | |
|---|---|
| Geographical indication transfer (5%) | Geographical indication increases the producer's share of the value added related to a product that has, or may have, local characteristics, resulting in a higher income. The quality of the product is a guarantee, symbolizing the strong bond that is established between the traditional production method and its geographical origin, and can hence have a positive effect on demand in the domestic and international markets. If the product has a geographical indication, it will receive a high score. |
| Product's suitability for innovation and technical development in the KMRB (5%) | It is essential that the product be new to the region and have new markets and processing systems. In addition, the market share of the product, both as a raw material and as a final product, as well as its type and structure, should be conducive to innovation. |
| Labor productivity of the product in the KMRB (5%) | To determine the labor productivity related to the products produced in the Basin, the gross income obtained from a unit product in the process of production in the region, obtained from Frankfurt School's agricultural database, was divided by the labor hours required for its production in the process. The income resulting from the unit labor hour was computed and the labor productivities of the products in the Basin were compared. As a significant partial productivity criterion, labor productivity is used as a measure of the product's potential to create income. Seasonal employment is more prevalent than full-time employment in the agricultural sector. Nonetheless, the agricultural sector is an area in which family labor is used intensively as a means of reducing production costs. The efficient use of labor in any agricultural production activity in which mechanization is limited to specific products will increase profitability, while also ensuring the sustainability of the production activity. |
| Product provides input to another agricultural product in the region (5%) | This indicator measures a product's contribution to integration in farm production. Enhanced integration leads to a decrease in uncertainties in input prices while increasing the value added derived from production. |
| Level of mechanization in production of the product (5%) | Being open to technological change and the implementation of innovative production techniques in agriculture has begun to play a role in increasing efficiency to an extent that surpasses input utilization. The level of mechanization used for the production of a product is one such indicator. |
| Existence of opportunities to access formal (bank, etc.) financing (3%) | The presence of possibilities enabling a producer to access financing is quite critical in meeting the input requirements of a product and in reducing price risk during harvesting. Accessing the right amount of financing when needed prevents a producer from shifting his capital to non-agricultural activities, while also paving the way for sustainable agricultural activity. It can be presumed that in regions in which the level of registration is high, the producers of the related products have better access to government support. For this reason, products for which accessibility to formal financing opportunities is high were assigned high scores. |
| Social Indicators | |
| Potential to create jobs for women in production of the product (12%) | The ratio of female labor within the total labor needed for the production of a unit product in the KMRB was calculated using the database of Frankfurt School, and thus the product's potential to create jobs for women was determined. Employment of women in Turkey is very low when compared to men, according to the results of TURKSTAT's household labor survey (2017), although agriculture has a significant share of employment for women. While men carry out works requiring physical strength, such as irrigation, women tend to deal with works requiring hand skills and sensitivity, such as harvesting and sorting. High scores will be assigned to such products in order to prevent the vulnerability of the female population, who depend on the agricultural product for their livelihood, to the risks of climate change. |
| Intensive family farming (12%) | The size of individual farms in Turkey is quite low when compared to the averages in developed countries, amounting to is 6.5 hectares on average per farm, according to data provided by the Ministry of Agriculture and Forestry (2016). Small farms cannot benefit from the advantages associated with larger sizes, and have a relatively fragile structure. Some products requiring intensive labor in Turkey are produced in farms run by families. Ensuring the sustainability of these farms is important in preventing migration from the rural to urban areas and in preserving rural sociological structures. The intensity of family farming in production results in employment for women and young people. Accordingly, products involving intensive family farming were assessed and scored based on expert opinions. |
| The ratio of registered farmers producing the product in the KMRB to the total number of registered farmers in the KMRB (10%) | This measures the prevalence of self-employed farm managers at a product level as a sub-group of labor intensity. |
| Existence and activeness of the farmers organizations engaged in the production of the product (10%) | The establishment of all kinds of cooperatives provides producers with access to markets, input into the determination of price and technical assistance, or any of them alone, as a minimum. On the other hand, insufficient organizations in the region is an important trend (İBB, 2016). The existence of active producer organizations contributes to the social development of the region. The sufficiency of the number of organizations producing the product was assessed based on expert opinions, the number of members and their level of activity. Products involving a high number of organizations were assigned high scores. |

| | |
|---|---|
| Total labor intensity in the KMRB regarding the product (10%) | Importance of agriculture in the KMRB in the creation of jobs makes it necessary to spread changes in production processes in which labor intensity is high over time, and to take precautions against sudden disruptions. In addition, labor-intensive production has the potential to create new jobs and to prevent migration to cities. For this purpose, the ratio of labor in the total cost of a unit product in the production process was determined and the labor intensity of production was calculated. |
| Traditional production of the product in the region (10%) | Farmer experience in traditional products is extensive and the accumulation of knowledge was ensured at a specific level. Employment opportunities and productivity increases can be achieved at a lower cost with regard to such products. Threats to traditional products can be expected to trigger social resistance in the region, and the sustainability of such products is also necessary for the preservation of the social structure. Data for this indicator was determined based on expert opinion, based on the field observations of the team of technical consultants, and the products that have been produced in the region for years were designated as "traditional products". |
| Production of product creates continuous/stable employment (9%) | The severity of the effect of seasonality on employment in production is determined qualitatively. Products that create full-time employment permit long-term employment and contribute to family livelihood, and are assigned high scores to increase their potential to become a critical product. Other products lead to migration from the region and create social disruption. For this indicator, products were assigned based on expert opinion. |
| Product causes migration from the KMRB (9%) | Youth unemployment and migration from rural areas to cities are major problems in the KMRB, where an agricultural product's ability to create new jobs affects migration in the region. The effects of population movements linked to the product, which may lead to the depopulation of rural areas and degradation of the social structure, are measured, and products causing migration to other areas are allocated low scores. |
| Social reputation of the production activity for the potential product (9%) | One of the primary reasons for migration from rural to urban areas is the low social reputation associated with certain agricultural activities. The farmer and his family may withdraw from such activities if they are not content with their social status and may opt to look for paid jobs in cities. This phenomenon is common in the KMRB, as is the case in the Aegean Region and across Turkey, and leads to a deterioration of the social fabric by increasing migration from rural areas. This indicator is intended to ensure that agricultural activities with a high reputation are least affected by the risk. This indicator has been scored based on expert opinions and on an entirely intuitive method, making no use of data or statistics due to its nature. |
| Production of the plant allows the earning of continuous income (9%) | The severity of seasonality observed in the proceeds of production is determined qualitatively. The production of products that bring continuous revenue prevents social disintegration and migration from rural areas, as they permit long-term livelihood; accordingly, such products seem to be highly critical products. |
| Environmental Indicators | |
| Daily water consumption of the product in a production cycle depending on climatic and soil conditions in Izmir (11.2%) | The agricultural sector in Turkey, as is the case round the world, is one of the largest consumers of water among other sectors. The efficient use of water sources is vital for sustainable production. Variations that may be observed in the amount and distribution of precipitation resulting from climate change may render the production of a product impossible, and may also lead to the excessive use of limited water sources. The products were, therefore, assessed based on water requirements during the production processes and scored according to their dependence on water. The water needs of the products were computed using CropWat software and FAO Penman Montheith method. The plant coefficients issued by the Ministry of Agriculture and Forestry and General Directorate of State Hydraulic Works, and listed in the Guide for Water Consumption of Irrigated Plants in Turkey, were used for the calculation, while climate data was derived from FAO's ClimWat Program. The product was given a low score if its daily water consumption was high. |
| Product's blue water footprint in Izmir province (9.4%) | Specifies the total groundwater and surface water volume required for one ton of product. The product was assigned a negative score of its blue water footprint was high. |
| Impact of the production of the product on groundwater quality (9.3%) | Measures the effect of the intensity of water use on the pollution of groundwater. Pollution resulting from both intense groundwater use and existing agricultural activity inflicts significant harm on the quality of the groundwater. Artesian wells in particular may have serious impacts on aquifers where groundwater is accumulated. In addition, factors such as nitrate resulting from agricultural production and phosphate pollution further reduce the quality of groundwater. The product is assigned a low score of it has a high impact on groundwater quality. |
| Intensity of groundwater use for production of the product (8.5%) | This indicator measures the physical effects of the intensity of groundwater use, and allocates a score that is inversely proportional to groundwater use. Irrigation water used for agricultural production is sourced from individual groundwater wells in many regions, including the KMRB. Intensive exploitation of these wells leads to numerous problems, such as dwindling groundwater resources and, hence, the formation of local sinkholes, earthquakes and a constantly growing energy need for the supply of water due to the falling groundwater level. In this indicator, the intensity of groundwater consumption related to products was ranked based on expert opinions. |

| | |
|---|---|
| Product's grey water footprint in Izmir province (8.1%) | This is an expression of the quantity of freshwater that one ton of product pollutes and destroys. All data related to the water footprint parameters were derived from the database of the Water Footprint Network for Izmir and the assigned scores. The products were allocated scores in inverse proportion to their water footprint. |
| Energy requirement of the product within the production process in the KMRB (7.7%) | This is intended to determine the effect of all kinds of pollution created by the product's energy demand after calculating the diesel equivalent energy consumption for the production of each unit product, based on Frankfurt School's agricultural database. Energy is one of the main inputs into agricultural production. Aside from the fact that liquid fuels account for a large part of the energy used during the production process, electrical energy is also used for such activities as irrigation. The intensity of energy use in agriculture has a significant effect on the total emissions released into the atmosphere, and also creates considerable dependence in the production activity. The products were assigned scores in inverse proportion to their required energy consumption. |
| Intensity of the product's land use (7.7%) | From the ecological angle, excessive soil fatigue has a negative effect on biodiversity, and yields impacts in opposition to the sustainability goal. The soil structure will be no longer suitable for agricultural production if the same plant variety is sown in the same field every year, as this leads to *soil fatigue*. Agricultural production on soil affected by fatigue may not reach the desired yield level, and will thus lead to economic loss (Rekor Gelişim, n.d.). Organic substance and water losses from soil occur as a result of traditional cultivation, while the intensive cultivation of soil accelerates wind and water erosion (Ministry of Agriculture and Forestry, n.d.) Accordingly, if the product permits the limited use of soil, it was allocated a high score based on expert opinions. |
| Intensity of consumption of pesticides/chemicals for production of the product (7.5%) | This measures the environmental pollution caused by all kinds of pesticides used in the production process. One of the trends observed in the KMRB is the pollution of the soil and water resources by pesticides (IBB, 2016). The more pesticide and chemicals used for the production of the product, the lower the score assigned to it. |
| Existence of extensive and innovative climate-smart practices suited to the product (7.3%) | Existence of extensive and innovative climate-smart practices suited to the product in the region denotes a social awareness of such products and certain established practices, which facilitates the development of strategies to adapt to climate change and their implementation in the region. Thus, a product was assigned a high score of the answer to this question was "yes". |
| Utilization of fertilizer per hectare for the production of the product (in kgN and P205) (6.5%) | The pure nitrogen (N) and phosphorus ($P_2O_5$) consumed by products in the Kucuk Menderes River Basin was calculated from the agricultural database of Frankfurt School. The intensive use of fertilizers for agricultural production leads to significant phosphate pollution. The production of chemical fertilizers is regarded as the phase involving the largest share of energy consumption in the chain. Turkey imports part of its fertilizer needs due to the intensive energy in particular in the process of fertilizer production. Products with a high fertilizer consumption were given a low score due to the pollution resulting from the uncontrolled application of fertilizers and energy dependence. |
| Product's green water footprint in Izmir province (6.2%) | Represents the quantity of storm water in $m^3$ consumed by one ton of product, that does not feed the groundwater and that is temporarily stored in the upper layers of the soil during the vegetation period. If a product obtains the water it needs mostly from green water, it means that it consumes existing water sources at a lower level, and this has a positive effect on its score related to the product. |
| Ratio of the product's good agriculture production area to the product's total cultivation area in the KMRB (5.7%) | In organic and good agricultural practices, ecological cycles function more efficiently as synthetic inputs obtained from sources outside the enterprise are limited or eliminated entirely. There are many reporting on organic agriculture and the associated reduction of carbon emissions that lead to global warming and climate change and the preserve soil biodiversity, hence contributing to sustainability. If organic and good agricultural practices related to that product are widespread, the product is given a high score. |
| Ratio of the product's organic production area to the product's total cultivation area in the KMRB (5%) | The comment in the preceding section is also applicable to this section. |

Table 7 shows the economic, social and environmental indicators and their respective weights. (See Annex 7 for indicator-based scores received by products and weighted scores).

*Table 7: Indicators and their weights in their group*

| Economic Criteria | Weight (%) | Social Criteria | Weight (%) | Environmental Criteria | Weight (%) |
|---|---|---|---|---|---|
| If the product is exported | 9 | Potential to create jobs for women in the production of the product | 12 | Daily water consumption of the product in a production cycle depending on climatic and soil conditions in Izmir | 11.2 |
| Ratio of the production value of the product in the KMRB to its production value in Turkey | 8 | Intensive family farming | 12 | Product's blue water footprint in Izmir province | 9.4 |
| Ratio of the product's growing area in the KMRB to total agricultural lands in the KMRB | 8 | Ratio of registered farmers producing the product in the KMRB to the total number of registered farmers in the KMRB | 10 | Impact of the production of the product on groundwater quality | 9.3 |
| Agricultural industry for which the product is an input | 8 | Existence and activeness of farmers' organizations producing the product | 10 | Intensity of groundwater use for production of the product | 8.5 |
| Ratio of the product's production in the KMRB to its production in Izmir | 7 | Total labor intensity in the KMRB regarding the product | 10 | Product's grey water footprint in Izmir province | 8.1 |
| Ratio of annual production cost of the product to annual gross income (per hectare/animal) | 7 | Production of product creates continuous/stable employment | 9 | Energy requirement for the production process related to the product in the KMRB | 7.7 |
| Existence of market channel infrastructure (wholesalers market, market, warehouse, licensed warehouse) | 7 | Traditional production of the product in the region | 10 | Intensity of the product's land use | 7.6 |
| Ratio of the product's average yield in the KMRB to its average yield in Turkey | 6 | Product causes migration from the KMRB | 9 | Intensity of consumption of pesticides/chemicals in the production of the product | 7.5 |
| Public policies in force prioritizing the product | 6 | Social reputation of the production activity for the potential product | 9 | Existence of extensive and innovative climate-smart practices suited to the product | 7.3 |
| Existence of contract production of the product in the region | 6 | Production of the plant allows earning of continuous income | 9 | Utilization of fertilizer per hectare for the production of the product (in kgN and P2O5) | 6.5 |
| Geographical indication transfer | 5 | | | Product's green water footprint in Izmir province | 6.2 |
| Product's suitability for innovation and technical advances in the KMRB | 5 | | | Ratio of the product's good agriculture production area to the product's total cultivation area in the KMRB | 5.7 |
| Labor productivity of the product in the KMRB | 5 | | | Ratio of the product's organic production area to the product's total cultivation area in the KMRB | 5 |
| Product provides input to another agricultural product in the region | 5 | | | | |
| Level of mechanization in the production of the product | 5 | | | | |
| Existence of possibilities to access formal (bank, etc.) financing | 3 | | | | |
| TOTAL | 100% | | 100% | | 100% |

| | |
|---|---|
| Those receiving a high score (making a positive contribution) gain a higher rank. | Those receiving a low score obtain a higher rank (in inverse proportion to the harm they cause). |

Scores received by 34 products and their ranking as a result of this weighting are presented in Table 8. **Balancing factors were taken into consideration when determining the total score; and economic, social and environmental** criteria were weighted, respectively, as 34% ,33% and 33%. These weights were multiplied by the scores obtained from E-S-E assessments to come up with a total score. The methods used for the calculation of weights allocated to the indicators and details of the results are presented in Annex 7.

*Table 8: Scores received by products and ranking*

| Products | Result of Economic Assessment | Result of Social Assessment | Result of Environmental Assessment | Total Score |
|---|---|---|---|---|
| Olive (oil) | 44.84 | 38.45 | 49.98 | 44.43 |
| Fig (dried) | 42.35 | 33.78 | 50.83 | 42.32 |
| Cows' milk | 54.84 | 37.51 | 34.07 | 42.27 |
| Grape (wine) | 30.42 | 29.40 | 55.49 | 38.36 |
| Olive (table) | 33.01 | 32.07 | 46.72 | 37.23 |
| Chestnut | 22.30 | 34.32 | 50.24 | 35.49 |
| Tomato (paste) | 46.10 | 41.41 | 12.04 | 33.31 |
| Mandarin (satsuma) | 34.06 | 30.14 | 32.49 | 32.25 |
| Peach | 42.08 | 19.56 | 31.19 | 31.05 |
| Cucumber (table) | 40.68 | 40.62 | 9.05 | 30.22 |
| Grape (dried) | 43.86 | 29.53 | 13.57 | 29.14 |
| Cherry | 34.90 | 24.13 | 27.82 | 29.01 |
| Tomato (table) | 32.47 | 41.40 | 11.72 | 28.57 |
| Lilium | 41.37 | 18.12 | 22.41 | 27.44 |
| Tobacco | 31.11 | 44.56 | 6.48 | 27.42 |
| Potato | 39.86 | 32.32 | 8.69 | 27.08 |
| Black-eyed pea (fresh) | 35.38 | 35.67 | 8.72 | 26.67 |
| Cucumber (pickle) | 39.24 | 31.44 | 8.93 | 26.66 |
| Grape (table) | 36.71 | 29.18 | 13.53 | 26.57 |
| Pepper (capia paste) | 41.62 | 27.39 | 9.21 | 26.23 |
| Okra | 31.12 | 37.88 | 8.89 | 26.01 |
| Pepper (fresh) | 38.88 | 29.14 | 8.38 | 25.60 |
| Lettuce | 27.37 | 33.04 | 16.01 | 25.49 |
| Rose (cut) | 35.86 | 18.24 | 19.58 | 24.67 |
| Bean (fresh) | 31.48 | 32.19 | 9.28 | 24.39 |
| Chrysanthemum | 32.29 | 18.11 | 22.41 | 24.35 |
| Clove | 31.27 | 18.14 | 22.41 | 24.01 |
| Gerbera | 30.08 | 18.09 | 22.41 | 23.59 |
| Cotton (unginned) | 44.91 | 14.51 | 10.11 | 23.39 |
| Artichoke | 26.98 | 26.42 | 11.47 | 21.68 |
| Watermelon | 26.33 | 27.92 | 10.11 | 21.50 |
| Wheat (other) bread | 30.18 | 15.48 | 13.46 | 19.81 |
| Maize (silage) | 33.45 | 11.86 | 8.30 | 18.03 |
| Maize (grain) | 22.63 | 14.49 | 4.98 | 14.12 |

*Source: Frankfurt School's surveys*

The top 10 products with the highest index resulting from the scenario were deemed to be the region's *key agricultural products*. The five key agricultural products for which risk analysis and adaptation strategies will be developed under KAPRA were identified as follows (Table 9). Two of these five products are different from the first five products. On the final list of products, outdoor ornamental plants and tomato (industrial) did not appear on the first list.

*Table 9: Key agricultural products to be worked and their characteristic properties*

| Key Agricultural Products To Be Worked: | Product characteristic |
|---|---|
| Olive (oil) | Traditional product, grown on highlands, perennial |
| Milk (cow) | Animal product, innovative product |
| Tomato (industrial) | Annual, lowland plant, outdoor production |
| Fig (dried) | Perennial, lowland plant |
| Outdoor ornamental plants | Lowland plant, innovative, greenhouse & outdoor production |

Outdoor ornamental plants were not included in the first phase of the assessment, as there was insufficient statistical data regarding their production in the region. The field analyses, workshop and stakeholder interviews, however, show that the **production of outdoor ornamental plants has grown rapidly in the Basin over the last years, and that a significant part of Turkey's total outdoor ornamental plants production was supplied from this region.** Serial production can be carried out at fixed temperatures throughout the year, as they are largely grown in greenhouses. Meanwhile, rising temperatures and other effects originating from climate change may change the ventilation methods used in greenhouses and their costs, while also creating water stress in products subject to intensive watering.

**The production of tomato for industrial use has secured a significant place in the Kucuk Menderes River Basin due to both agricultural production and the phases following agricultural production.** The capacity of industrial plants established in the Basin, its proximity to export ports and the ecosystem services offered by the Basin for production demonstrates the importance of tomato production in the Basin for industrial purposes. Thus, tomato grown for industrial production was included on the list of products to be analyzed in the study.

A production chain focusing on selected key products was determined in the next phase of the study in which the existing production trends in the Basin and the points of vulnerability to climate change through the production chain were analyzed.

***CHAPTER 3: CONCLUSIVE REMARKS***

*A methodology for the identification of key agricultural products in the KMRB was developed after analyzing the outcome of stakeholder meetings, reference studies and best examples in the world. Local and natonal policies and strategies were followed for the identifying of key products.*

*While this methodology was being developed, new strategies related to and integrated with the "Key Agricultural Product Risk Assessment (KAPRA)" program for the KMRB and working and action plans were reviewed as guiding materials. The key agricultural products, representing those that contribute to the economic, social and ecological welfare and development of the region have been identified after listing the relevant agricultural products and drafting a scoring matrix. After the scoring matrix has been created, the weights of the economic, social and environmental indicators within their respective groups were determined and calculated separately.*

***Olive (oil), tomato (paste), cows' milk, fig (dried) and outdoor ornamental plants*** *were identified as five key agricultural products in the KMRB taking into account the findings of stakeholder meetings and expert opinions.*

# 4. Climate Risk Analysis for Key Agricultural Products

Within the scope of KAPRA, a climate change multi-hazard risk analysis was conducted for the Kucuk Menderes River Basin. In this chapter, potential effects of developed scenarios based on the outcome of a climate change risk analysis on the five selected key agricultural products and their vulnerability to climate change was assessed along the production chain.

The analysis of the **predicted risks in the following factors** depending on the availability of current and reliable data:

- ✓ Average temperature,
- ✓ Number of extremely hot and cold days,
- ✓ Drought,
- ✓ Relative humidity,
- ✓ Precipitation regime and amount,
- ✓ Sea level,
- ✓ Hail
- ✓ Frost
- ✓ Wind speed
- ✓ Soil structure and salinity
- ✓ Structure and quantity of weed

As a result of these analyses, **efforts were made to determine loss of function, yield and quality in the selected agricultural products resulting from climate change, and the domino effect of those losses on other agricultural sectors**. For this purpose, the process that the key product goes through, from the first phase of production to the time of delivery to the end consumer, was analyzed. A “stakeholder map” was drawn up for each product in the KMRB and field studies were planned and carried out using those maps as a guide. While field studies may vary slightly from product to product, they include in-depth interviews with the producers, input providers, processors, commissioners, wholesalers and retailers that play an active role in the sales and marketing channels within the Basin. These interviews attempt to draw a production chain map and calculate the loss of value that climate change will cause in the region. Stakeholder interviews were supported by previous studies and expert opinions.

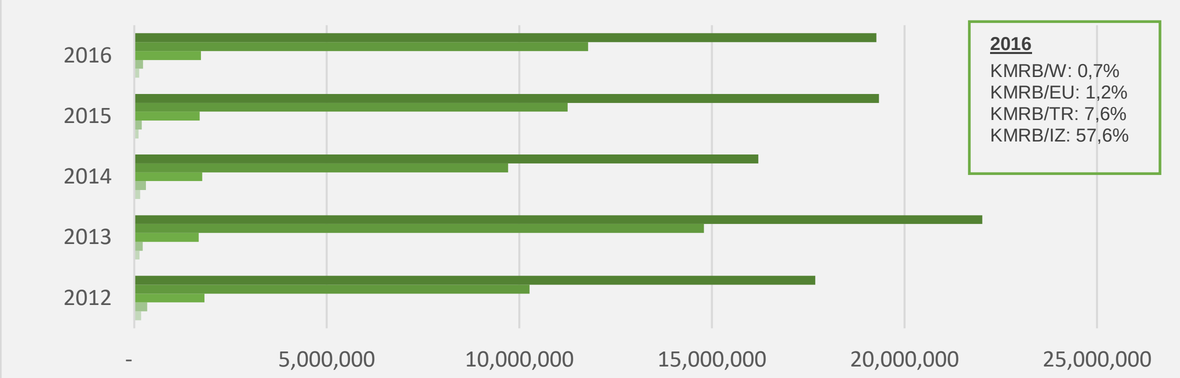
Annex 8 contains detailed climate risk assessments specific to the products.

## 4.1. Impact of Climate Change on Critical Agricultural Products

### 4.1.1. Olive (for oil)

- ✓ *While a significant proportion of the olives grown in Turkey are processed to olive oil; table olive also has an extensive share in total production.*
- ✓ *Ranked fourth after Spain, Greece and Italy in terms of olive production, Turkey’s olive oil production is significantly below those of other producer countries.*
- ✓ *Turkey exports a large proportion of its olive oil to the United States.*
- ✓ *Countries in the MENA region, representing a cheap export market for agricultural products, have a considerable share in exports.*
- ✓ *Olives grown in the KMRB represent 7.6% of national production and 1.2% and 0.7% of production in Europe and the world, respectively (TURKSTAT, FAOSTAT, 2016).*
- ✓ *The share of olives grown in the Basin for oil production in the total olive production is around 90%, and a third of olive fields for oil production in Izmir are located within the Basin.*
- ✓ *A recent decline has been observed in olive production in the Basin.*
- ✓ *Olive production in the hilly areas of the Basin has been shifting to the lowlands over the last years.*
- ✓ *Bayındır county stands out in terms of production area and quantity.*

*Figure 7: Comparative Olive Production (tons)*




| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| World | 17,683,520 | 22,025,129 | 16,208,881 | 19,340,999 | 19,267,493 |
| Europe | 10,263,797 | 14,791,038 | 9,705,310 | 11,256,205 | 11,785,083 |
| Turkey | 1,820,000 | 1,676,000 | 1,768,000 | 1,700,000 | 1,730,000 |
| İzmir | 340,084 | 220,213 | 300,600 | 192,181 | 229,510 |
| KMRB | 181,852 | 139,699 | 153,040 | 113,597 | 132,250 |

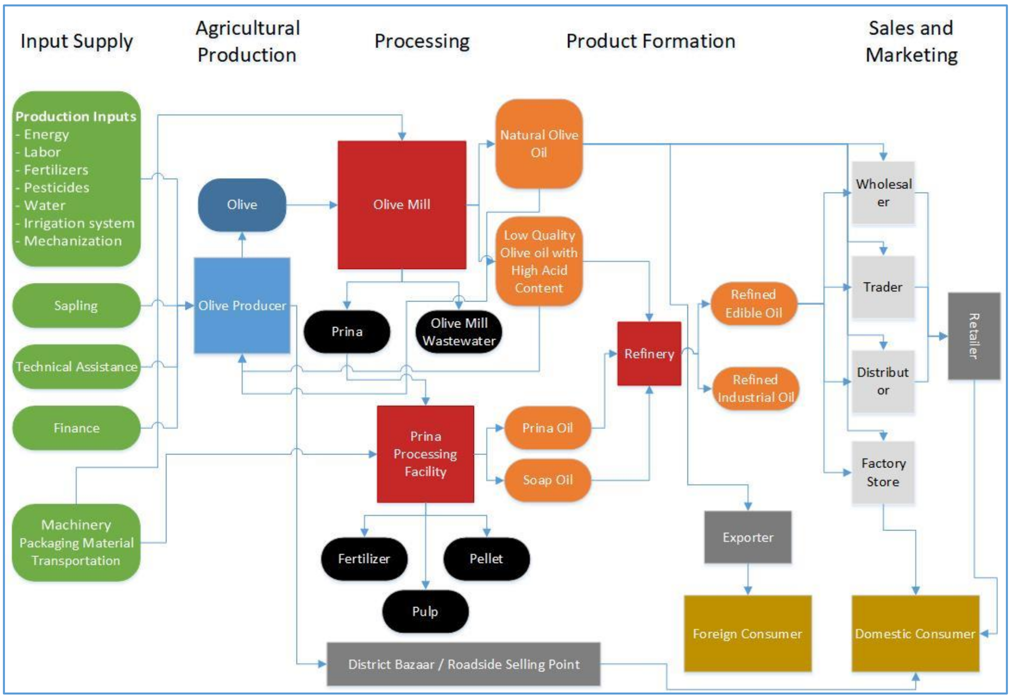
World Europe Turkey İzmir KMRB

*Source: TURKSTAT, FAOSTAT*

## Main phases of olive oil production

Olive oil production consists of five main phases, including **supply of input, agricultural production, processing, formation of product, and marketing & sales** (Figure 8).

*Figure 8: Diagram Showing the Olive Production Chain for the Production of Oil in the Basin*




*Source: Frankfurt School's surveys*

- ✓ The primary input components include production inputs, energy inputs (liquid fuel and electricity) and technical support, including ***saplings (particularly during the investment period), mechanization, labor, energy, fertilizer, pesticides, water and irrigation system,*** and mechanical depreciation.
- ✓ The main activities in the production process include ***harvesting, pruning, elimination of diseases and pests, fertilization, irrigation and soil preparation***. Olive groves that are not subjected to fertilization and pesticides have significant potential for organic agriculture, and serve as a major source for the production of organic olives as table olives or for the production of olive oil after the required inspection and certification processes, ensuring a significant increase in value added related to regional production.
- ✓ Processing & Formation of Product: Olives are harvested in the Basin in November and December, either manually or through the use of olive harvesting machines. Harvested olive is delivered to extrusion plants both within and outside the Basin. Izmir, including the KMRB, **ranks first** in Turkey in terms of number of plants and processing capacity, according to TURKSTAT Industry Statistics. **The region is home to 44.5% of all installed olive oil processing capacity and 19.1% of plants in Turkey. Izmir's olive production capacity is 401 million kg.**
- ✓ Sales & Marketing: Producers growing olive for oil production sell most of their produce to the district markets, and they may also sell directly to their acquaintances. Olives grown are used within the Basin, whereas almost all olive oil produced is sold in the local market. Olive for pomace oil, a side product of olive oil production, is sold to pomace oil plants in the region, and the pomace oil produced in those plants is used in soap factories in the region while pomace wood is used in different areas in the province.

  Meanwhile, the natural and refined/riviera olive oil produced is sold to consumers through different channels.

  During stakeholder visits it was stated that 95% of the olives grown in the KMRB was used to produce natural olive oil, while 5% is used to produce cooking oils of a lower quality. The produced olive oil is sold to consumers in different packaging, with or without a brand, depending on the demands of the buyer. Olive oil is the primary product whereas pomace oil is a side product.

### Climate change and potential impact

**Growers in the Basin have begun feeling the effects of climate change and irregularity in the distribution of annual precipitation. Heavy precipitation has been concentrated in different periods, and increases in temperatures have been observed.** It was stated that variations in precipitation have not led to any problems in production to date, but some diseases and pests prosper in the region as a result of changes in air temperatures and humidity levels.

Table 10 outlines the effects of the climate change on the olive production chain and its adaptation capacity between 2021 and 2050.

*Table 10: Effects of climate change predicted in the KMRB between 2021 and 2050 on the olive production chain and adaptation capacity*

| Climate Change Factors | Sub-headings | Potential Anticipated Outcome | Supply of Input | Phase of Agricultural Production | | | Processing and Formation of Product | Marketing -Sale | Adaptation Capacity | Suggestions |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Impact on Olive Production | Impact on Yield | Impact on Quality | Impact on Olive Oil Processing Industry | | | |
| Variation in average temperature | Active growing period | ↓ 3.4% decrease in the number of ideal days | Increased demand from companies providing irrigation input due to increased need for irrigation | Period of stress to which plants are exposed and extension of vegetation period | Decreases in yield that could not be determined as part of the study | No impact | Trivial impact | Trivial impact | No actions taken to reduce stress in plants. | Proliferation of varieties resistant to heat and dissemination of efficient irrigation methods |
| | Physiological Period | ↑ Temperature rise | No impact | Period in which the period of stress to which plants are exposed is maximized | Decreases in yield that could not be determined as part of the study, increase in periodicity coefficient | Decrease in oil quality that could not be determined as part of the study | If a product of low oil quality and/or in insufficient quantities is obtained, idle capacity in the industry is created or an increase in operating expenditures as a result of the supply of olives from different sources | Loss of income as a result of the productio n of olive oil of low quality | | |
| | Flowering Period | ↑ Temperature rise | Increase in the sale of saplings of those varieties if varieties that bloom earlier are preferred | Pollination problems in varieties that blossom late | An immeasurable decrease in yield | No impact | Decline in yield, creation of idle capacity in industry / increase in operating expenditures due to supply of olive from different places | Dwindling trade volume due to a fall in productio n quantity | Producers are aware of climate change, but lack sufficient information about appropriate actions | Proliferation of varieties that blossom earlier |
| | Fruit ripening period | ↑ Temperature rise | No impact | Advancing harvesting period 1 or 2 weeks (trivial impact) | No impact | | | | | |
| Excessive cold | Physiological impact | ↑ Temperature rise | No impact | Exposure to cold reduced by 71% | Tiny increase in yield | No impact | | | Positive impact | |
| | Frost affecting flower | Excluded from the assessment as no risk of exposure exists | | | | | | | | |
| Excessive heat | Physiological impact | ↑ Increase in the number of very hot and cold days | Increased demand from companies providing irrigation input due to increased need for irrigation | Period in which the period of stress to which plants are exposed is maximized | Decreases in yield that could not be determined as part of the study, increase in periodicity coefficient | Decrease in oil quality that could not be determined as part of the study | If a product of low oil quality and/or in insufficient quantities is obtained, idle capacity in the industry is created or an increase in operating expenditures as a | Loss of income as a result of the productio n of olive | No actions taken to reduce stress in plants. | Reduction of other stress factors (fertilizer, pesticide, water) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | result of the supply of olives from different sources | oil of low quality | | |
| Temperature rise during winter | Need to cool off | ↓Decline in cooling period by up to 50% | Rise in demand for saplings of varieties with low cooling need | Low yield of varieties with high cooling need, loss of variety and trees | Serious decreases in yield that could not be determined as part of the study | No impact | As a result of serious decline in yield, the creation of idle capacity in the sector or the increase in operating expenditures due to the supply of olives from different sources | Significant decline in trade volume in case of idle capacity in the sector | Producers lack awareness of the need of cooling | Development and proliferation of varieties that have a low cooling need, low periodicity coefficient, low oil content and resistant to drought |
| Precipitation | Physiological impact | ↓3.07% decrease in precipitation | | Increase in plant stress during phenological periods | Slight fall in harvest | Slight decrease in oil quality | If a product of low oil quality and/or in insufficient quantities is obtained, creation of idle capacity in the sector or increases in operating expenditures as a result of the supply of olives from different sources | Loss of income as a result of the production of olive oil of low quality | Insufficient terracing of olive trees planted in the Basin | Mulching and terracing to prevent water loss from soil |
| | Need for irrigation water | ↑ 5.83% increase in the plant's water need | Increased demand from companies providing irrigation input due to the increased need for irrigation, increased energy demand | Increase in water stress Drying trees, branches and leaves; dwindling water source; retracting well waters; energy and cost increases | 12.6% yield loss in dry conditions, 5% yield loss based on existing conditions | Decrease in oil quality | If a product of low oil quality and/or in insufficient quantities is obtained, the creation of idle capacity in the sector or increases in operating expenditures as a result of the supply of olives from different sources | Loss of income as a result of the production of olive oil of low quality | Extensiveness of surface irrigation; lack of modern and pressurized irrigation infrastructure | Drip irrigation, closed-system irrigation, prevention of evaporation from in ponds and soil |
| Snowfall | Mechanical effect | ↓ Decrease in snowfall | No impact | Decrease in branch breakage | No direct impact | No direct impact | Trivial impact | Trivial impact | Positive impact | |
| Relative humidity | Pollination | ↓ 1.3% decrease in relative humidity | Decline in pesticide demand | Positive effect during flowering period, positive effect on decrease in diseases | Tiny increase in yield | | | | | |
| Fog | Pollination | There was no data available for a study of climate change | | | | | | | | |
| Hail | Flower and fruit, leaf damage | ↑ Relative increase in hail incidence due to increase in climatic frequency intervals | No impact | Leaf, branch fruit loss | Slight decrease in yield | Slight effect decreasing quality | Trivial impact | Trivial impact | Rise in awareness of agricultural insurance | Agriculture insurance |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wind speed and direction | Mechanical effect | ↑ Increase in the number of stormy days due to increase in climatic frequency intervals | Rising demand from companies supplying saplings | Tree loss | Trivial decline in yield | → No impact | | | | | |
| | Pollination | ↑ Slight increases in wind speed | No impact | Positive impact on pollination and fruit setting | Tiny increase in yield | → No direct impact | | | Positive impact | | |
| Carbon dioxide decrease | Vegetative growth | ↑ Carbon dioxide increase in the air | No impact | Positive development in vegetative growth | Slight increase in yield | Increase in oil quality | | | Insufficient awareness of carbon release | Actions to reduce carbon release | |

| Positive | Trivial | Slightly negative | Negative at a medium level | Significantly negative |
|---|---|---|---|---|

↑ increase ↓ decrease → stationary/ineffective

### Impact of climate change on the value added in the production chain

Considering climate change projections for the Basin – although positive effects are mentioned – increases in the number of very hot days and average temperatures, a 3.1% decrease in the quantity of average precipitation, and low cooling periods that fail to meet the needs of some olive varieties combine to create a critical situation for olive yield. As a result, **olive yield is predicted to fall by between 10% and 20%** in the best-case scenario unless action is taken by 2050. Assuming no changes in other factors such as market, price and production culture, **the loss of value based on current 2017 prices is estimated to be between TRY 16.2–32.2m in the primary production phase, and between TRY 19.8m and TRY 39.6m after industrial processing** (Table 11).

*Table 11: KMRB Olive Oil Production Chain in Case of a 10%, 15% and 20% harvest loss*[10]

| Production Phase | Product | Existing Production Quantity (tonnes) | Existing Production Value (thousand TRY) | 10% Harvest Decrease (thousand TRY) | 15% Harvest Decrease (thousand TRY) | 20% Harvest Decrease (thousand) TRY |
|---|---|---|---|---|---|---|
| Primary Production | Olive Grown for Oil | 65,781.12 | 154,585.63 | 138,482.96 | 130,431.63 | 122,380.29 |
| Olive Oil Production | Natural Olive Oil | 12,498.41 | 170,415.86 | 152,664.21 | 143,788.38 | 134,912.55 |
| | Table Olive Oil of Low Quality | 657.81 | 6,643.89 | 5,951.82 | 5,605.78 | 5,259.75 |
| | Pomace oil | 29,601.50 | 1,118.94 | 1,002.38 | 944.10 | 885.83 |
| Pomace oil processing | Table Pomace Oil | 888.05 | 4,795.44 | 4,295.92 | 4,046.16 | 3,796.39 |
| | Industrial Pomace Oil | 1,184.06 | 3,836.35 | 3,436.73 | 3,236.92 | 3,037.11 |
| | Pomace Olive Wood | 16,280.83 | 4,395.82 | 3,937.93 | 3,708.98 | 3,480.03 |
| Total | | | 190,087.37 | 170,286.61 | 160,386.22 | 150,485.84 |

*Source: Frankfurt School surveys*

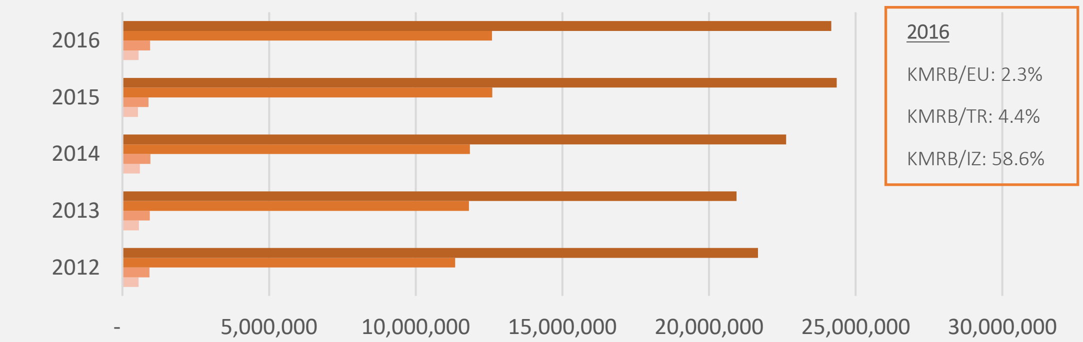
**There may be a risk of idle capacity in processing as well as additional operating expenditures for the supply of products from different regions to maintain capacity** as a result of a possible decline in harvest and loss of quality in the olive production. The dwindling supply of raw materials resulting from climate change will lead to a decline in processing capacity. In this case, the cost of olive oil production will go up due to fixed operating costs, even if the product prices remain unchanged. As transportation costs increase when enterprises purchase raw materials from sources outside the Basin to make use of their full capacity, production costs would still rise. Furthermore, a decline in olive oil quality would also lead to a loss of income. In addition, a quantitative fall in olive oil production would push prices upward and further reduce international competitiveness, which is already low, creating negative repercussions in the sector.

## 4.1.2. Tomato (industrial)

- ✓ *Tomatoes is the most widely grown and consumed vegetable around the world. Industrial tomato is grown on the boundaries of the Basin, while table tomato is grown in the Gediz - Bakırçay Basins.*
- ✓ *China ranks first among growers; followed by India, the United States and Turkey.*
- ✓ *The tomatoes grown in Turkey meet 7% of the total global demand for tomato (FAOSTAT).*
- ✓ *The tomatoes grown in the Kucuk Menderes River Basin in 2016 represented 4% of Turkey's total tomato production, corresponding to approximately 2% of all tomato grown in Europe.*
- ✓ *Torbalı grows 57% of Turkey's industrial tomatoes due to the intensive industrial infrastructure in the county.*

[10] These values are estimated as a result of a decrease in harvest only due to the yield loss by assuming that all other conditions and prices remain unchanged.

*Figure 9: Comparative Tomato Production (tons)*




| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| Europe | 21,673,770 | 20,935,815 | 22,629,551 | 24,349,689 | 24,169,570 |
| Turkey | 11,350,000 | 11,820,000 | 11,850,000 | 12,615,000 | 12,600,000 |
| İzmir | 926,222 | 931,935 | 955,875 | 891,373 | 944,750 |
| KMRB | 555,329 | 561,474 | 596,540 | 530,428 | 554,114 |

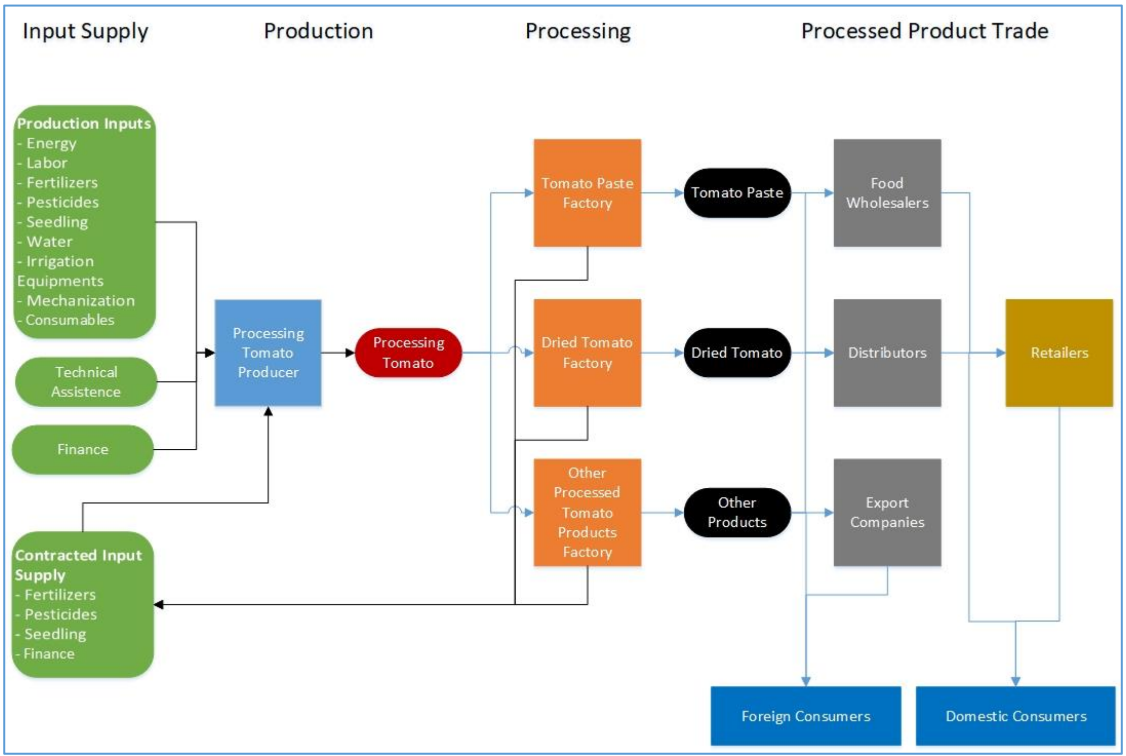
Europe Turkey İzmir KMRB

*Source: TURKSTAT, FAOSTAT [11]*

## Main phases of industrial tomato production

The production phases of tomatoes include the supply of inputs, agricultural production, product processing and trade in the processed product (Figure 10).

*Figure 10: Industrial Tomato Production Chain Diagram for the Basin*




*Source: Frankfurt School's surveys*

[11] Turkey is classified as a Western Asian country, according to FAOSTAT, and so its production is not included in European production figures.

- ✓ The main components of the input supply include ***investment inputs*** (investments in machinery/equipment and irrigation), ***intensive labor*** (female workers are used for works requiring manual skills such as harvesting, sowing/planting, and the elimination of weeds; whereas male workers are mostly used for work requiring physical strength such as irrigation, field preparation and the application of pesticides), ***fertilizer, irrigation*** (pressurized and surface irrigation), ***energy*** (liquid fuel and electricity) and ***technical advisory***.
- ✓ The primary phases of production include ***soil preparation, planting saplings, irrigation, fertilization, elimination of diseases and pests, and harvesting.*** Saplings are planted in march and april; and the biggest challenge relates to fluctuations in product prices. Many growers fail to exercise due care when plowing soil which makes harvesting by machinery difficult, and products harvested using machinery are of low quality.
- ✓ Processing / Formation of Product: Industrial tomatoes grown in the Basin are used in different areas, but are mostly processed to produce tomato paste and dried tomato. While there are a large number of tomato paste and dried tomato factories in the Basin, the product is also sent to factories outside the KMRB. There are a total of 59 tomato paste and 32 dried tomato plants in Turkey, according to TOBB Industrial Statistics. Izmir ranks second in terms of tomato paste production and third in dried tomato production in Turkey.
- ✓ Sales / Marketing: Tomatoes processed to tomato paste are sold on the domestic market and exported. Sales within the domestic market are made through food wholesalers and company distributors. Factories may directly export the products in addition to some other exporters. Dried tomatoes are mostly exported.

### Climate change and potential impact on production

Table 12 shows the impact of climate change on the production of industrial tomatoes in the Kucuk Menderes River Basin between 2021 and 2050, along with adaptation capacity and suggestions.

*Table 12: Effects of climate change predicted in the KMRB between 2021 and 2050 on the industrial tomato production chain and adaptation capacity*

| Climate Change Factors | Sub-headings | Potential Anticipated Outcome | Supply of Input | Agricultural Production | | | Product Processing | Adaptation capacity | Suggestions |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Impact on Tomato Production | Impact on Yield | Impact on Quality | Impact on Product Processing, and Trade in the Processed Product | | |
| Variation in average temperature | Active growing period | ↑ Temperature rise | Increase in demand for irrigation equipment | ↑Advancement of plantation dates, vegetation variation | Trivial impact on harvest | Trivial impact | | | |
| | Flowering Period | | | Average rise in temperature remains within the range of pollination temperatures. | No impact | No impact | | | |
| | Fruit ripening period | | | Advancing harvesting period 1 or 2 weeks (trivial impact) | | Positive effect on quality | | | |
| Excessive cold | Morphological Period | Difference between day and night temperatures | The variation in temperatures between day and night could not be measured based on a climate change scenario. | | | | | | |
| | Flower and seedling affected by frost | ↑ Temperature rise | Increase in demand for supply of seedling | Decreased possibility of frost affecting flower and seedling | Increase in harvest | Trivial impact | | | |
| Excessive heat | Physiological impact | ↑ Increase in the number of very hot days | Trivial impact | Burning of product and shorter vegetation times due to excessive heat affecting plants | Significant decreases in harvest that could not be determined under the project | High decrease in fruit quality | Additional production costs arising from supply of raw material at a price higher than those in the Basin from sources outside of the Basin due to dwindling harvest; Need for additional raw material and loss of revenue due to a decrease in the quality of raw materials. | No actions taken to reduce stress in the plants. | Incentives and funding for shading nets, hay and kaolin |
| Precipitation | Physiological impact | ↓2.74% decrease in precipitation | Trivial impact | Increase in plant stress during all phenological periods | Declining harvest | Trivial decrease in quality | | Surface irrigation is widespread in the KMRB Insufficient awareness on quantity and duration of irrigation | Funding of mulching to prevent water loss in soil |
| | Need for irrigation water | ↑ 5.4% increase in the plant's water need | Increase in demand for irrigation equipment | Increase in water stress Withering plant, retracting well waters, energy and cost increases | 50.5% yield loss in dry conditions, 3.3% yield loss based | Slight increase in quality | | Insufficient modern and pressurized irrigation infrastructure | Funding for modern and pressurized irrigation infrastructure |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | on existing conditions | | | | |
| Relative humidity | Diseases | ↓ 1.3% decrease in relative humidity | Decline in pesticide demand | Positive effect of decrease in diseases | Trivial positive effect | | | | Trivial effect on quality |
| Fog | Pollination | No data was available for a study on climate change | | | | | | | |
| Hail | Flower and fruit, leaf damage | ↑ Relative increase in incidences of hail due to increase in frequency intervals | Increase in demand for supply of seedling | Loss of leaves, seedlings, fruit | Very little decrease in yield | Effect decreasing quality | Supply of raw materials at a higher price due to falling yields, additional production costs | There is a growing awareness of agricultural insurance | - Agriculture Insurance |
| Wind speed | Mechanical effect | ↑ Increase in the number of stormy days due to increase in frequency intervals | Increase in demand for supply of seedling | Loss of seedling, branches | Trivial decline in harvest | No impact | Trivial Impact | | |
| | Pollination | ↑ Slight increases in wind speed | Trivial impact | Positive effect on pollination | Tiny increase in yield | No direct impact | Supply of raw material of a higher quality as a result of a decrease in the supply of raw materials | Trivial positive effect | |
| Carbon dioxide decrease | Vegetative growth | ↑ Carbon dioxide increase in the air | Trivial impact | Positive development in vegetative growth | Slight increase in yield | Increase in fruit quality | | Insufficient awareness of carbon release | - Raising awareness of actions to reduce carbon release –Afforestation support |

| | | | | |
|---|---|---|---|---|
| Positive | Trivial | Slightly negative | Negative at a medium level | Significantly negative |

↑ increase ↓ decrease → stationary/ineffective

### Impact of climate change on the value added in the production chain

Climate change projections for 2021-2050 indicate a negative effect on the production and yield of industrial tomatoes in the KMRB. **These negative effects are expected to result from not only the climate change, but also the Basin's agricultural infrastructure.** For example, there will be more challenges related to the supply of water, as open system ponds and canals will increase evaporation. The urbanization of the region as a result of migration and the development of industry will lead to a gradual increase in the water used by the agricultural sector and the demand for water among the rural community.

Temperature increases are expected to yield some positive effects. Extreme temperatures, however, may produce negative consequences in yield and quality.

Considering climate change projections and assuming that there will be a 4% to 7% loss in harvest while other factors remain unchanged, it is estimated that the value decrease in total production will be in the range of **TRY 6.8m to TRY 11.9m in agricultural production, and between TRY 12.2m to TRY 21.4m after processing** (Table 13).

*Table 13: KMRB Industrial Tomato Production Chain in the event of a 4% to 7% harvest loss[12]*

| Production Phase | Product | Existing Production Quantity (tonnes) | Existing Production Value (thousand TRY) | 4% Harvest Loss (thousand TRY) | 7% Harvest Loss (thousand TRY) |
|---|---|---|---|---|---|
| Primary Production | Industrial Tomato | 487,564.00 | 170,647.40 | 163,821.50 | 158,702.08 |
| Processing | Tomato Paste | 82,711.75 | 285,851.81 | 274,417.74 | 265,842.18 |
| | Dried Tomato | 1,625.21 | 19,307.53 | 18,535.23 | 17,956.01 |
| Total | | | 475,806.74 | 456,774.47 | 442,500.27 |

*Source: Frankfurt School surveys*

**Decrease in production quantities may also affect the other links of the chain.** A decrease in product supply may lead to additional costs that would compel industrialists to purchase raw materials from different regions. In addition, falling supplies may increase production costs, as it will lead to an increase in product prices. The resulting quality loss and rising production costs may be detrimental to the international competitiveness of the company, and may have a negative effect on their market shares.

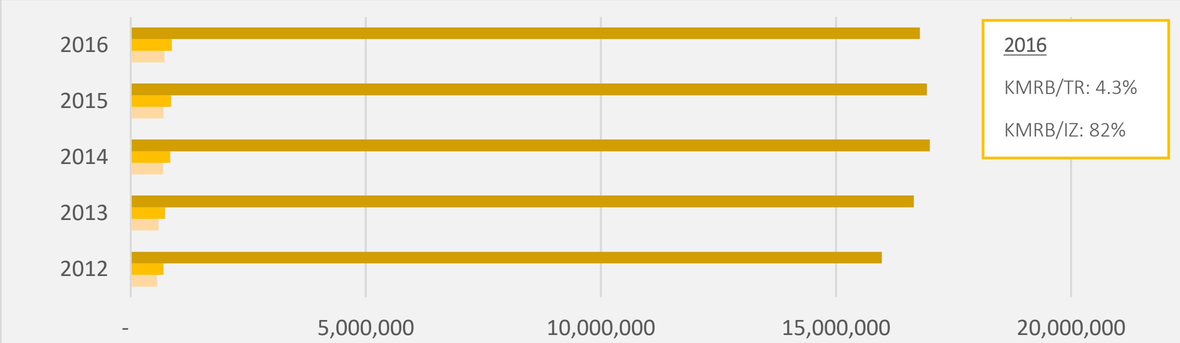
It was observed that local growers who were familiar with climate change **were not inclined to invest in adaptation measures** due to their low levels of income.

## 4.1.3. Milk (cow)

- ✓ *Milk produced in the Basin in 2016 met 4.3% of domestic demand in Turkey.*
- ✓ *Dairy cattle farming is growing in the plain and in the east of the Basin as a result of the development of cold chain, processing and marketing facilities, as well as farmer organizations.*
- ✓ *The amount of milk produced in the Basin has increased gradually as a result of the improvements in husbandry and farm management, the proliferation of farmers' organizations in the form of cooperatives, and the increased presence of milk-processing industries.*
- ✓ *Odemis, Tire, Bayındır and Kiraz in particular have become major milk production centers.*
- ✓ *A large part of the milk produced in those counties is collected by cooperatives through a cold chain. The cooperatives then process the milk or sell it to industrial milk processing facilities.*

[12] These values are estimated as a result of a decrease in harvest only due to the yield loss by assuming that all other conditions and prices remain unchanged.

*Figure 11: Comparative Milk Production (tons)*




| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| Turkey | 15,977,838 | 16,655,009 | 16,998,850 | 16,933,520 | 16,786,263 |
| İzmir | 699,049 | 730,684 | 843,326 | 862,089 | 877,497 |
| KMRB | 563,336 | 591,704 | 689,824 | 697,278 | 716,928 |

Turkey İzmir KMRB

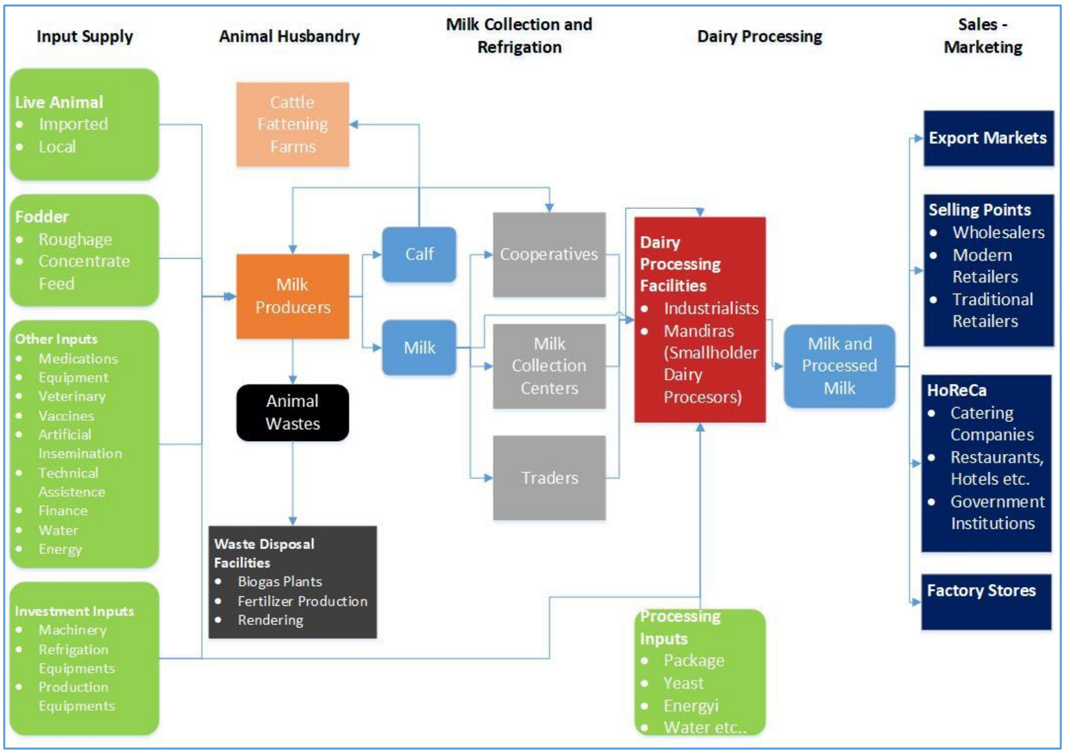
*Source: TURKSTAT, FAOSTAT*

## Main phases of cows' milk production

**Milk and dairy production is a major source of income for the Basin through the production chain, from the supply of the input to the end product.** The milk production chain, therefore, prevents migration from the Basin to urban areas, while also making a significant contribution to the economic development of the Basin.

Milk production in the KMRB occurs in five phases, which are ***supply of input, animal production, milk collection and cooling, milk processing, sale and marketing***. The raw milk obtained is sent to the milk processing facilities in the Basin or sold as raw milk in the local market. Processed dairy products are typically consumed in the domestic market, but may also be exported.

*Figure 12: Cows' Milk Production Chain in the Basin*




*Source: Frankfurt School's surveys*

## Climate change and potential impact on production

International studies focusing on the effects of climate change on milk yield predict a 5% yield loss, given that many enterprises in developed countries subject to such studies have initiated climate-smart practices. Thus, a minimum loss of 3% to 5% in milk yield is expected in large enterprises in the KMRB between 2021 and 2050. Firms that do not practice climate control are more exposed to declines in yield and quality. The table below demonstrates the effects of climate change in the milk production chain and its adaptation capacity in the Kucuk Menderes River Basin.

*Table 14: Effects of climate change predicted in the KMRB between 2021 and 2050 on the cows' milk production chain and its adaptation capacity*

| Climate Change Factors | Sub-headings | Probable Outcome | Impact on Milk Cattle Production | Impact on Yield | Impact on Quality | Adaptation capacity | Suggestions |
|---|---|---|---|---|---|---|---|
| Effect on the production and supply of feed materials | Production | ↑ Annual 1°C rise in average | Yield and quality of fodder crop will drop.<br>May lead to a change in sowing patterns of fodder crop varieties.<br>Production costs will rise. | Significant impacts on yield that could not be determined as part of the study | Decline in milk quality, particularly in milk fat content | Seeds of fodder crops, which are specific and adapted to the Basin, are used. There is a shift to different fodder crops. | - Using and supporting varieties that are resistant to heat and have a high reproduction and growth performance. |
| | | ↓ 3.1% drop in total precipitation | Yield and quality of fodder crop will drop to a certain level.<br>May lead to a change in sowing patterns of fodder crop varieties.<br>Production costs will rise. | Low impact on harvest that could not be determined as part of the study. | Slight decline in milk quality, and particularly in milk fat content | Surface irrigation is widespread in the KMRB<br>There is insufficient awareness of irrigation quantities and periods. | - Extending and funding of subsurface drip irrigation systems to reduce water loss |
| | | ↓ 1.25% drop in annual total humidity | No variation affecting pollination could be determined.<br>May have a partly positive effect on the formation of fungal diseases. | Trivial impact | Trivial impact | | |
| Care works | Human Resources | ↑ Annual 1°C increase in average and 1.6°C extreme temperature rise | Will have a significant effect on employee performance.<br>Negative employee behavior may cause stress in animals. | Drop in milk harvest and yield that could not be determined as part of the study | Trivial impact | The KMRB is one of the regions with a high adaptation capability. | Improvement of personnel training and working conditions and regulation of working hours according to climate |
| Animal Metabolism | Reproduction Biology | ↑ Annual 1°C rise in average | The resulting average annual temperatures may not be a problem for large enterprises applying a reproduction program. It will, however, be negatively affected in June, July, August and September, as there is no reproduction planning in traditional small-sized enterprises. | Drop in insemination productivity<br>Drop in raw milk production<br>Extended service period<br>Increase in calving frequency | | There are reproduction programs in large enterprises, and excessively hot months are excluded from the program. Small enterprises do not have reproduction programs. | Development of reproduction and herd management programs, training and funding |
| | | ↑ 1.6°C temperature rise in July and August | Potential extreme temperatures will have a negative effect on reproduction performance in the livestock sector in the Basin, irrespective of the size of the enterprise. | | Trivial impact | Large enterprises have climate-smart barn designs and equipment. Small enterprises have limited adaptation capability. | Designing barn systems in buildings with semi- or fully-controlled air-conditioning<br>Supporting and funding the cross-breeding of breeds with a high temperature tolerance |
| | | ↓ 1.25% drop in annual total humidity | A low-level relationship exists between humidity and reproduction functions, sweating or the release of body temperature in animal metabolisms. Change in existing humidity is not expected to have a negative effect. | No impact | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Feeding | ↑ Annual 1°C rise in average | Annual average temperatures will not lead to metabolic problems arising from feeding in enterprises with sufficient equipment and knowledge.<br>Metabolic problems related to feeding will be observed in July and August in small enterprises, particularly those with fully- or semi-closed barn systems. | Drop in milk yield<br>Drop in raw milk production<br>Reduction in live weight increase | Decline in raw milk quality, particularly in milk fat content | Buffer chemicals and air-conditioning components are widely used in large enterprises. There is an insufficient use of buffers, and air-conditioning components are inadequate in small enterprises. | Projects funded by the government that prioritize air-conditioning components and animal welfare.<br>Funding for air-conditioning channeled to small enterprises<br>Support for the development of hybrids that are resistant to heat and disease |
| | | ↑ 1.6°C temperature rise in July and August | Potential extreme temperatures will have an obvious negative effect on feeding performance in the livestock sector in the Basin in June, July and August. | Drop in milk yield<br>Drop in raw milk production<br>Reduction in live weight increase<br>Increase in energy inputs and costs<br>Increase in the cost of feeding animals in the growth period | Decline in raw milk quality, particularly in milk fat content<br>Retardation of development of animals in the growth period | Buffer application is low, regardless of enterprise size. Structural applications for improvements to air-conditioning and animal welfare are insufficient.<br>There is a low tendency to switch to feed containing high nutrients and roughage used for feeding animals. | Projects funded by the government that prioritize animal welfare.<br>Funding for air-conditioning channeled to small enterprises<br>Support for the development of hybrids that are resistant to heat and disease<br>Funding support for renewable energy in order to cut energy costs |
| | | ↓ 1.25% drop in annual total humidity | There is a low-level relationship between humidity and feeding functions, sweating and the release of body temperature in animal metabolisms. Change in existing humidity is not expected to have a negative effect. | No impact | | | |
| | | ↑ Carbon dioxide increase in the air | The feed assessment coefficient drops and carbon dioxide increases when a barn is not sufficiently ventilated. | Drop in milk yield; drop in raw milk production<br>Reduction in live weight increase<br>Increase in cost of energy inputs | Trivial impact | Large enterprises have ventilation systems.<br>Small enterprises have weak adaptation capabilities. | Projects funded by the government that prioritize ventilation components and animal welfare. |
| Animal Health | Diseases and Pests | ↑ Temperature rise, increased humidity in the barn | Increase in pest factors<br>Problems of the feet and udder<br>Digestion problems | Drop in milk yield<br>Loss of young breeding animals<br>Reduction in live weight increase<br>Rise in milking costs | Increase in the number of somatic cells<br>Decline in quality<br>Retardation of growth in calves | | Supporting and funding of veterinary practices for animal protection in small enterprises and related training |

| | | | | | |
|---|---|---|---|---|---|
| Positive | Trivial | Slightly negative | Negative at a medium level | Significantly negative | ↑ increase ↓ decrease → stationary/ineffective |

*Table 15: Potential Effects of Climate Change in the Post-Production Phases of the Milk Production*

| | Collection and Cooling | Milk Processing | Marketing & Sale |
|---|---|---|---|
| Temperature Rise | More sophisticated systems are needed for milk collection and cooling due to rising temperatures. Additional investments in energy consumption and the protection of systems may be needed for this reason. | The time needed to process the collected milk is shorter, and delays may lead to a decline in the quality of the product. | Protecting products on sale in the market, and switching to more sophisticated transportation, storage and short-shelving systems may become necessary. |

☐Slight negative effect, ☐medium negative effect

### Impact of climate change on the value created in the production chain

Milk yield is anticipated to drop by up to 10% between 2021 and 2050 as a result of climate change in the Basin, where the number of small enterprises is high. This may increase to 15% if indirect effects on vegetative production are also taken into consideration. In this scenario, if it is assumed that other conditions, such as production infrastructure and input prices, remain unchanged, this yield loss **may lead to a loss to the tune of TRY 106.9m with regard to milk produced ex-farm and a TRY 287.5m drop in production value resulting from processing.**

*Table 16: Loss of Value in Production Chain for Milk and Dairy Products in the KMRB in Case of a 5%, 10% and 15% Drop in Production[13]*

| Production Phase | Product | Production Quantity (ton) | Existing Production Value (thousand TRY) | 5% Production Loss (thousand TRY) | 10% Production Loss (thousand TRY) | 15% Production Loss (thousand TRY) |
|---|---|---|---|---|---|---|
| Milk Production | Raw Milk | 684,494.09 | 980,170.14 | 932,616.35 | 883,531.28 | 834,446.21 |
| Milk Processing | Packaged Milk and Street Milk | 197,675.90 | 683,167.92 | 649,009.53 | 614,851.13 | 580,692.73 |
| | Separation of Milk Fat and Butter Production | 7,672.32 | 198,866.61 | 188,923.28 | 178,979.95 | 169,036.62 |
| | Milk Used for Producing Dairy Products | 486,818.18 | 366,572.21 | 348,243.60 | 329,914.99 | 311,586.38 |
| | Cheese ex-factory | 35,440.36 | 650,685.08 | 618,150.83 | 585,616.57 | 553,082.32 |
| | Yoghurt | 51,115.91 | 128,628.07 | 122,196.67 | 115,765.27 | 109,333.86 |
| | Buttermilk | 34,807.50 | 63,530.65 | 60,354.12 | 57,177.58 | 54,001.05 |
| Total | | | 3,073,151.97 | 2,919,494.37 | 2,765,836.78 | 2,612,179.18 |

*Source: Frankfurt School's surveys*

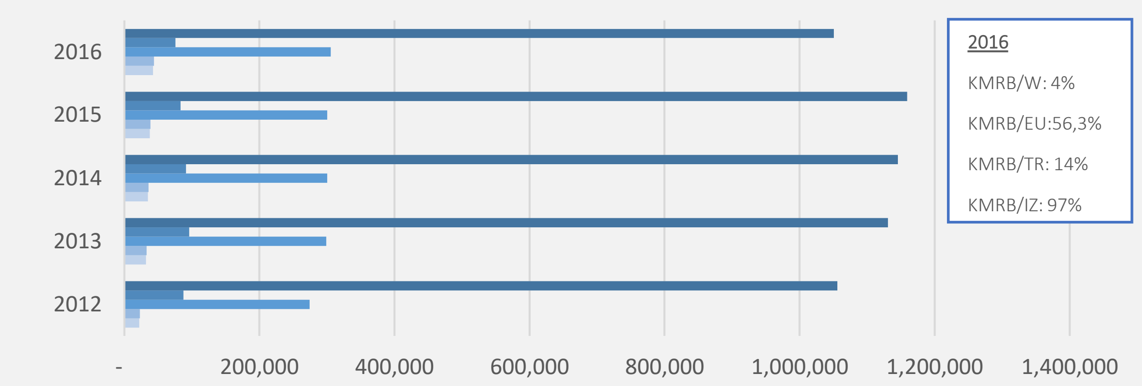
Temperature rise may affect the phases after primary production. Thus, it will become necessary to revise existing milk collection and cooling systems based on peak points in critical values and expected temperature rises in order to ensure that milk obtained from farms is delivered to processing dairies, factories and integrated facilities before it turns sour. Solar energy systems installed at collection centers run by cooperatives would cut the energy costs associated with cooling, considering the distribution of milk collection and storage systems in farms and villages in the Basin. In addition, a shorter period will be needed for the processing of collected milk to prevent it from turning sour as a result of rising temperatures, which will have a negative effect on product quality. Storage, transportation and shelving systems will be needed to protect the product against rising temperatures in the marketing and sales phase.

[13]These values are estimated as a result of a decrease in harvest only due to the yield loss by assuming that all other conditions and prices remain unchanged.

### 4.1.4. Fig (dried)

- ✓ *Turkey is a leading producer of dried figs. It ranks first globally in terms of both fresh and dried fig exports, growing 60% of all exported dried figs. Some 90% of the figs grown in Turkey are exported, annually bringing USD 250m on average into the national economy.*
- ✓ *The KMRB accounted for almost all of the figs grown in Izmir in 2016, and responds to 14% of fig demand in Turkey. Its share of global fig production is 4%.*
- ✓ *Ecosystem factors such as temperature, humidity and wind, its proximity to the Buyuk Menderes River Basin which is the actual center of fig production, and its marketing and processing capacity have a positive combined effect on the fig production in the KMRB.*
- ✓ *Tire county accounts for 45% of fig production in Izmir.*

*Figure 13: Comparative Fig Production (tons)*




| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| World | 1,056,036 | 1,130,940 | 1,145,611 | 1,159,215 | 1,050,459 |
| Europe | 87,295 | 96,104 | 91,182 | 83,096 | 75,728 |
| Turkey | 274,535 | 298,914 | 300,282 | 300,600 | 305,450 |
| İzmir | 22,776 | 32,997 | 35,883 | 38,753 | 43,741 |
| KMRB | 21,859 | 32,092 | 34,943 | 37,793 | 42,620 |

World Europe Turkey İzmir KMRB

*Source: TURKSTAT, FAOSTAT*[14]

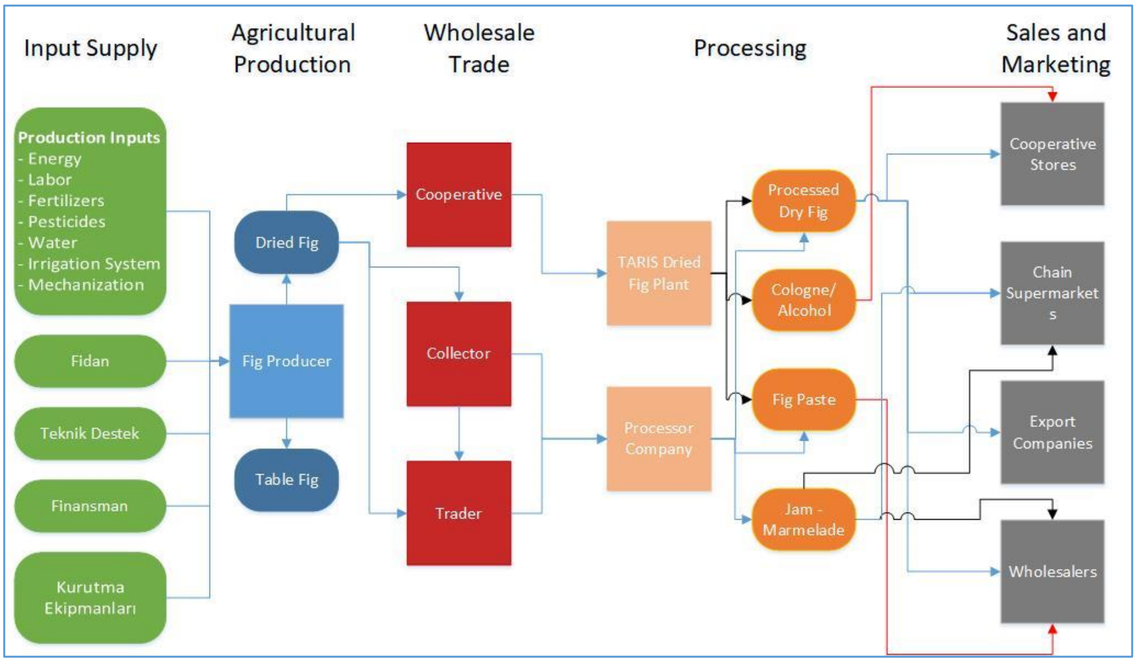
#### Main phases of fig production

Fig production is carried out in five phases, including **supply of input** (labor, energy, fertilizer, pesticide, irrigation, mechanization, seedling, technical support, funding, dehydration equipment), **agricultural production, product processing** (dried fig, fig paste, fig marmalade, ethyl alcohol, wax, *eau de cologne* via TARİŞ and industrialists), and **marketing and sale** (to cooperative sale units, market chains, wholesalers, exporters) (Figure 14).

A significant proportion of the fig grown in the Basin is sold to the fig processing plants located in the Büyük Menderes Basin after the drying process, with a small part of the harvest being sold in the county capitals. Some 90% of the product turned into the main product in fig processing plants is exported, and the rest is delivered to the domestic market.

[14] Turkey is classified as a Western Asian country, according to FAOSTAT, and so its production is not included in European production figures. Europe's total fig production is lower than that of Turkey.

*Figure 14: Fig Production Chain in the Basin*




*Source: Frankfurt School surveys*

In addition to the production of conventional figs in the Kucuk and Buyuk Menderes River Basins, **organic figs** are grown in considerable quantities. The rising global demand for organic dried fig has led to a significant rise in the number of certified growers, and the stakeholders interviewed in the Basin state that 30% of the figs grown in the region were certified as organic.

**Like olives, figs are among the Basin's traditional products.** Figs have been grown in the Basin for centuries, and creates employment particularly in the hilly areas. In addition, the post-production phases involving industry and logistics are a major source of employment and have the potential to prevent migration, although there is no major effect in the KMRB in this regard, as most of the stakeholders involved in those phases live in the areas adjacent to the GMB boundaries.

**Fig growing applies only limited pressure on natural resources when compared to other agricultural produce,** and plays a key role in preventing soil erosion as it is mostly grown in hilly areas. Accordingly, the environmental value of fig is quite high when compared to other products.

### Climate change and potential impact

**Variations in the wind regime resulting from global climate change may render dried fig production in the Basin impossible.** Temperature increases may, however, yield some positive effects. Extreme temperatures may produce negative effects on yield and quality. A very small drop in precipitation, when coupled with a temperature rise, leads to heightened water stress.

Table 17 shows the impact of climate change on the production of dried fig in the KMRB between 2021 and 2050, as well as adaptation capacity and suggestions.

Annex 3 includes detailed data on the production history of figs and the related trends; the production and value chain in the Basin; and a risk analysis focusing on climate change along the production chain.

*Table 17: Effects of climate change predicted in the KMRB between 2021 and 2050 on the fig production chain, and adaptation capacity*

| Climate Change Factors | Sub-headings | Probable Outcome | Supply of Input | Agricultural Production | | | Product Processing and Marketing | Adaptation Capacity | Suggestions |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Impact on Fig Production | Impact on Yield | Impact on Quality | Impact on Product Processing, Marketing and Sale | | |
| Variation in average temperature | Active growing period | ↑ Temperature rise | Trivial impact | Average temperatures resulting from climate change are within the growing range | No impact | No impact | | | |
| | Physiological Period | ↑ Temperature rise | Trivial impact | | | | | | |
| | Flowering Period | ↑ Temperature rise | Trivial impact | | | | | | |
| | Fruit ripening period | ↑ Temperature rise | Trivial impact | 1–3 weeks earlier than scheduled harvest | No impact | Positive effect on quality | Increased quality will increase the product's value on the international markets. | Positive impact | |
| Excessive cold | Morphological Period | ↑ Temperature rise | Trivial impact | Risk of exposure to cold weather significantly lower | Tiny increase in yield | No impact | Trivial impact | Positive impact | |
| | Frost affecting flowers | Excluded from the assessment as there was no risk of exposure | | | | | | | |
| Excessive heat | Effect on the male fig's biological cycle | ↑ Increase in the number of very hot and cold days | Reduced quality of male fig, increase in demand for male fig | Negative effect on the life cycle of the male fig | Decreases in yield that could not be determined as part of the study | Decreases in fruit quality that could not be determined as part of the study | Decline in quantity and quality of the product may lead to a slight drop in income and idle capacity. | Difficult to take action | |
| | Physiological impact | ↑ Increase in the number of very hot days | | Period in which the period of stress caused by excessive heat to which plants are exposed is maximized | | | | No actions taken to reduce stress in plants. | Training for the reduction of other stress factors (fertilizer, pesticide) |
| Temperature rise during winter | Effect on the male fig's biological cycle | ↑ Rise in winter temperatures | Increase in male fig quality | Positive effect on the wintering of male fig | Slight increase in harvest | Increase in quality | Increase in the quantity of high quality product will lead to a rise in its value on the international markets. | Positive impact | |
| | Need to cool off | ↓Drop in cold winter temperatures, up to | Trivial impact | Cooling periods resulting from climate change do not | No impact | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 50% decline in the cooling period | | represent a critical risk to fig. | | | | | |
| Precipitation | Physiological impact | ↓3.1% decrease in precipitation | Trivial impact | Loss of precipitation does not constitute a risk to fig. | No impact | | | | |
| | Need for irrigation water | According to the climate scenario, dried fig does not need irrigation water as it gets more rain than it needs (550 mm) throughout the year. | | | | | | | |
| Snowfall | Mechanical effect | ↓ Decrease in snowfall | Trivial impact | Decrease in branch breakage | Trivial positive effect | No direct impact | Trivial impact | Positive impact | |
| Relative humidity | Diseases | ↓ 1.3% decrease in relative humidity | Decline in pesticide demand | Positive effect of decrease in diseases | Trivial positive effect | Trivial effect on quality | Trivial impact | | |
| Fog | Pollination | Insufficient data | | | | | | | |
| Hail | Flower and fruit, leaf damage | ↑ Relative increase in hail incidence due to increase in climatic frequency intervals | Trivial impact | Leaf, branch fruit loss | Slight decrease in yield | Effect decreasing quality | Slight loss of income and the formation of idle capacity due to a decline in the quantity and quality of the product | Raising awareness of agricultural insurance | - Agriculture Insurance |
| Wind Direction | Wind Direction | It is not known if the wind direction will change. | Trivial impact | Different wind directions in the morning and afternoon during the fruit ripening period is the most critical climate parameter for figs. Whether or not this parameter will change should be studied specifically on the hills of KMRB looking toward the Buyuk Menderes River Basin. It is of crucial importance for dried fig production to provide support and funding for such studies. | | | | | |
| Wind speed | Mechanical effect | ↑ Relative increase in the number of stormy days due to an increase in climatic frequency intervals | Rising demand for saplings | Tree loss | Trivial decline in harvest | No impact | Trivial impact | Raising awareness of agricultural insurance | - Agriculture Insurance |
| | Pollination | ↑ Slight increases in wind speed | Rising demand for male fig | It has a negative effect on flying male fig pollens | Tiny increase in harvest | No direct impact | Trivial impact | Trial negative impact | |
| Carbon dioxide decrease | Vegetative growth | ↑ Carbon dioxide increase in the air | Trivial impact | Positive development in vegetative growth | Slight increase in yield | Increase in fruit quality | Increase in the quantity of high quality product will lead to a rise in its value on the international markets. | Insufficient awareness of carbon release | - Raising awareness of actions to reduce carbon release<br>- Afforestation |

| | | | | | |
|---|---|---|---|---|---|
| Positive | Trivial | Slightly negative | Negative at a medium level | Significantly negative | ↑ increase ↓ decrease → neutral |

### Impact of climate change on the value created in the production chain

Assuming that the vital activities of the fig wasp and the wind regime during the fruit ripening period remain unchanged, it can be assumed that harvest realization intervals will increase between 2021 and 2050 due to other climate stresses, and that **a harvest loss ranging between 5% and 7% will occur.**

In a scenario based on such a loss in yield, the ex-farm value is expected to range between TRY 5m and TRY 6.9m. The loss of harvested quantity and quality that may occur in the production phase may lead to a loss of income in the upper levels of the production chain. Considering that a large proportion of figs are supplied to international markets from this region, a potential decline in supply may be **compensated by an increase in prices, and losses may have a slight effect in those phases**. This phenomenon may, however, create idle capacity, particularly in the processing plants. **This scenario also predicts that wholesale trade will dwindle to between TRY 6m and TRY 8.5m as a result of climate change** (Table 18).

*Table 18: Loss of Value in Production Chain for Dried Fig in the KMRB in the event of a 5%–7% Decrease in Harvest Yield*[15]

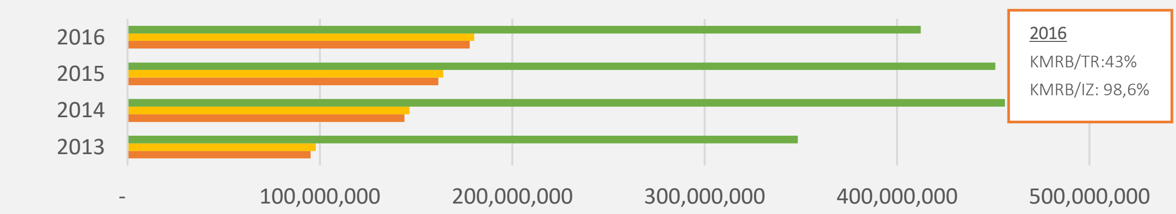
| Production Phase | Product | Existing Production Quantity (tonnes) | Existing Production Value (thousand TRY) | 5% Harvest Loss (thousand TRY) | 7% Harvest Loss (thousand TRY) |
|---|---|---|---|---|---|
| Agricultural Production | Dried Fig | 8,294.80 | 99,53760 | 94,560.72 | 92,569.97 |
| Wholesale Trade | Dried Fig | 8,045.96 | 121,896.23 | 115,801.42 | 113,363.50 |
| Total | | | 221,433.83 | 210.362,14 | 205.933,47 |

*Source: Frankfurt School's surveys*

### 4.1.5. Outdoor ornamental plants

- ✓ *Ornamental plants is an alternative category of agricultural production that includes many different varieties, such as seasonal flowers, indoor and outdoor* ornamental plants, woody plants, bushes, groundcover and bulbous plants.
- ✓ *Turkey has major advantages in the growth of outdoor ornamental plants, including suitable climatic and geographical conditions, a strategic location, proximity to markets and cheap labor.*
- ✓ *The greatest increase in production area observed in countries that lead the production of outdoor ornamental plants was registered in France (1,042%), followed by Spain (230%) and Turkey (64%) (AIPH and Union Fleurs, 2010–2016).*
- ✓ *Almost all outdoor ornamental plants grown in Izmir in 2016 originated from the KMRB, which accounts for 43%of all outdoor ornamental plants sold in Turkey.*

*Figure 15: Comparative Production of Outdoor Ornamental Plants (unit) (TURKSTAT*[16]*)*




| | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| Turkey | 348,426,162 | 456,026,600 | 451,142,538 | 412,227,915 |
| İzmir | 97,818,800 | 146,573,450 | 163,979,403 | 180,275,419 |
| KMRB | 95,115,100 | 143,858,050 | 161,564,003 | 177,860,019 |

■ Turkey ■ İzmir ■ KMRB

[15] These values are estimated as a result of a decrease in harvest only due to yield loss by assuming that all conditions and prices remain unchanged.
[16] It was planned to make a comparative review of production quantities with other countries, however there is a lack of current publicly available data. Accordingly, the comparative production table for outdoor ornamentals plants includes only national data, although national data for 2012 is missing from the TURKSTAT sources.

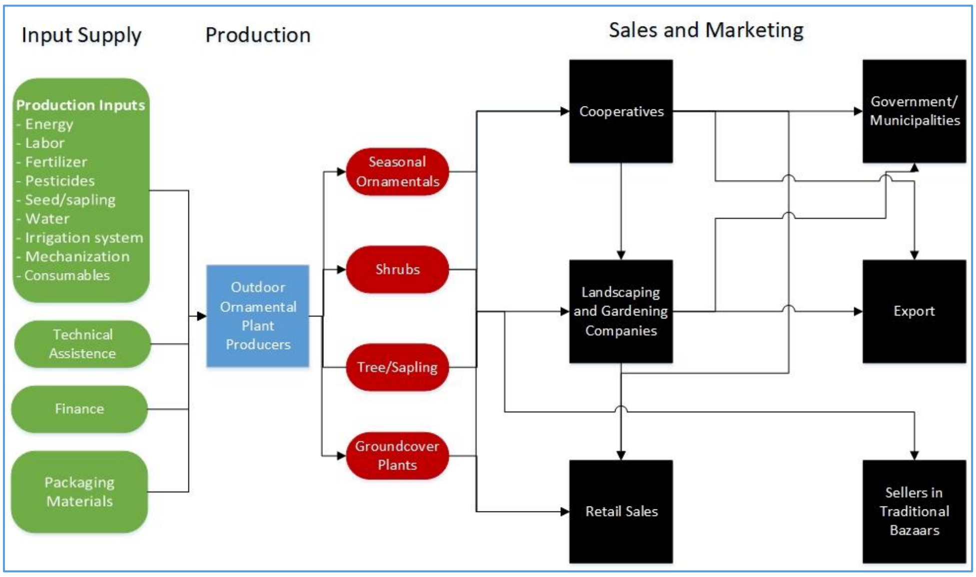
**Izmir is an appropriate area for the cultivation of outdoor ornamental plants, having suitable climatic and geographical conditions, strategic location, close proximity to markets and access to family labor.** Ornamental plants are grown in 13 counties in Izmir, and particularly in Bayındır, Odemis, Tire and Urla (Ministry of Agriculture and Forestry, 2018). **The KMRB is expected to take center stage in the production and marketing of indoor and outdoor ornamental plants, and to increase its production by 7% annually over the next five years (IBB, 2016).** In addition to local ventures in the Basin, firms from other provinces have invested in this sector, contributing to the growth of production and new technological investments.

New investments to lower production costs and extend production through cooperation and support from local organizations have prompted local producers to switch to the production of outdoor ornamental plants.

### Basic phases of production of outdoor ornamental plants

The production chain for outdoor ornamental plants comprises three main phases, including ***supply of input*** (labor, energy, irrigation, fertilizer, pesticide, seed, mechanization, consumables, technical support, funding, packaging materials), ***agricultural production*** (seasonal ornamental plants, bush group, tree/seedling, groundcover), and ***sales and marketing*** (Figure 16).

*Figure 16: Production Chain for Outdoor Ornamental Plants*




*Source: Frankfurt School's surveys*

**Growing outdoor ornamental plants is a major source of income, particularly for small agricultural enterprises.** The sector is dominated by family-run enterprises and creates a significant number of jobs for women and young people in rural areas. In addition, growing ornamental plants creates employment in the Basin throughout the year with the involvement of large enterprises in the sector, and thus prevents migration from the region. Furthermore, there is high awareness among growers on cooperating with cooperatives, which play a key role in production planning and marketing in the production chain of ornamental plants.

**Ornamental plants grown in the Basin are generally purchased by municipalities and landscaping firms.** Exports are limited to saplings, as ornamental plants in other categories cannot be exported due to the low quality standards in the sector and seasonal restrictions.

### Climate change and potential impact

The effects of climate change may lead to different vulnerabilities in each link of the production chain. The potential effects of those vulnerabilities that may result from changes in the players along the production chain and their roles, adaptation capacities and suggestions are presented in Table 19. Annex 3 contains detailed data on the production history of outdoor ornamental plants and related trends; the production and value chain in the Basin; and a risk analysis focusing on climate change along the production chain.

*Table 19: Impact of climate change on the production of outdoor ornamental plants in the KMRB between 2021 and 2050, adaptation capacity and suggestions*

| Climate change factors | Sub-headings | Probable Outcome | Supply of Input | Phase of Agricultural Production | | | Marketing - Sales | Adaptation capacity | Suggestions |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Impact on the Production of Ornamental Plants | Impact on Yield | Impact on Quality | Impact on Marketing and Sales of the Product | | |
| Variation in average temperatures | Active growing period | ↑ Temperature rise | Trivial impact | Advancement of plantation dates, extended vegetation period | Tiny increase in yield | Increase in product quality | Trivial positive effect | | |
| | Flowering period | ↑ Temperature rise | Trivial impact | Average rise in temperature, positive effect on flowering and pollination | | | | | |
| Excessive cold | Seedling or saplings affected by frost | ↑ Temperature rise | Trivial impact | Decreased percentage of frost affecting flowers and seedlings | | | | | |
| Excessive heat | Physiological impact | ↑ Increase in the number of very hot and cold days | Rise in demand for shading equipment | Excessive heat affecting plants, sunburn suffered by some species, interruption to growth during summer | Insignificant decreases in yield that could not be determined as part of the study | Very high decrease in product quality | Energy demand and costs will go up during the processes of marketing, storage and sale. There may be slight falls in value as a result of the declining quality of the product. | Measures intended to reduce stress in plants vary from one grower to another. | - Shading nets, - fogging - kaolin practices |
| Precipitation | Physiological impact | ↓Fall in precipitation, which is different for seasonal, annual and perennial plants, groundcover, bushes, saplings or trees, and for each species. | Rise in demand for irrigation equipment | Increase in product stress during all phenological periods | Tiny drop in yield | Decline in quality | | All kinds of irrigation systems exist in the KMRB. Insufficient awareness on quantity and duration of irrigation | Funding of mulching to prevent water loss in soil, shading and fogging |
| | Need for irrigation water | ↓Fall in the plant's water need, which is different for seasonal, annual and perennial plants, groundcover, bushes, saplings or trees, and for each species | | Increase in water stress Withering plant Dwindling water sources, retracting well waters, energy and cost increases | Loss of yield varying from species to species and from variety to variety that could not be determined as part of the study | Loss of quality varying from species to species and from variety to variety that could not be determined as part of the study | | Partial insufficiency of modern and pressurized irrigation infrastructure | Funding for modern and pressurized irrigation systems - Rehabilitation of water wells |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Relative humidity | Diseases | ↓ 1.3% decrease in relative humidity | Decline in pesticide demand | Positive effect of decrease in diseases | Trivial positive effect | | | | |
| Hail | Damage to bushes, flowers, trees and leafs | ↑ Relative increase in hail incidence due to increase in climatic frequency intervals | Rise in demand for seedlings/saplings | Loss of leaf, seedling and sapling quality | Slight decrease in yield | Impact that leads to a high drop in quality | Shorter marketing period<br><br>There may be slight falls in value as a result of the declining quality of the product. | Raising awareness of agricultural insurance | - Agriculture Insurance |
| Wind speed | Mechanical effect | ↑ Relative increase in the number of stormy days due to an increase in climatic frequency intervals | Rise in demand for seedlings/saplings | Loss of seedling, sapling and leaf | Trivial decline in harvest | Impact that leads to a high drop in quality | | Raising awareness of agricultural insurance | - Agriculture Insurance |
| Carbon dioxide decrease | Vegetative growth | ↑ Carbon dioxide increase in the air | Trivial impact | Positive development in vegetative growth | Slight increase in yield | Increase in product quality | Increase in value of the product in parallel with the higher quality of the product | Insufficient awareness of carbon release | - Raising awareness of actions to reduce carbon release<br>–Afforestation support |

| | | | | |
|---|---|---|---|---|
| Positive | Trivial | Slightly negative | Negative at a medium level | Significantly negative |

↑ increase ↓ decrease → stationary/ineffective

#### Impact of climate change on the value created in the production chain

**If growers of ornamental plants in the Basin can successfully predict demand, it will be highly likely that they will be able to change product patterns and take advantage of climate change.** The impact of climate change on the production of outdoor ornamental plants in the Basin will vary depending on the species, and growing xerophytic plants will increase adaptation capacity. The production of varieties resistant to drought may increase as a result of the rising need for irrigation due to higher temperatures. Highly advantageous for growing plants in the bush category, the Basin has a great potential to grow xerophytic plants for landscaping purposes. With a low water need, xerophytic plants may secure a place in the markets of coastal areas and for public landscaping.

**Quality will increase as climate change will have a positive effect on the vegetative growth of plants in the Basin, except for in the summer.** Uprooting interval for perennial plants requiring uprooting or rootball will narrow. All these factors will bring about additional costs, such as for storage. Varieties sensitive to water may suffer a yield loss ranging from 2% to 5% due to human factors or water shortages. This value will prompt companies investing in the production of outdoor ornamental plants and growers in the Basin to switch to plants that need less water, and to invest in efficient water saving systems. The loss of yield referred to above may be tolerated as a higher quality is predicted in many species.[17]

**Problems may be encountered in the storage capabilities of cooperatives working with municipalities and market chains as a result of climate change, and the marketing period may be shortened as a consequence.** Thus, it is inevitable to invest in the development of systems required for efficient storage, stock control and distribution. Meanwhile, the potential decline in product quality will affect the economic value of products and limit marketing opportunities. Accordingly, species that are resistant to heat and water shortages should be promoted and mechanisms guiding market demand should be established.

## 4.2. Other Effects of Climate Change on the Agricultural Sector in the Basin

Other general effects that a potential climate change may produce on agricultural production in the Basin were assessed, and risk analyses were carried out, as shown below:

### (i) Effect of Climate Change on Weed Control

**Climate change may render it difficult to control weeds, which may require additional chemical pesticides.** It can be said that climate change will create a need for more efficient control of weeds in olive, tomato, fig and ornamental plants in the KMRB against risks such as fire. A decline in the effects of herbicides may increase the importance of mechanical control, and this may be reflected in the products through more labor requirements and increased costs. **A reduction in precipitation in the KMRB by up to 3.1% by 2050 will, however, not lead to a significant vulnerability to weeds, according to the outcome of the climate change scenario.**

### (ii) Impact of Climate Change on Soil Structure

**The climate has a direct bearing on soil formation.** Temperature and precipitation affect soil formation by determining both the physical and chemical decomposition and the type of vegetation. Only a detailed and long-term study could determine the role played by climate change in a transformation involving so many interrelated factors. Under KAPRA, a risk projection was made in which the two soil parameters that are critical to the production of selected products were analyzed based on the climate change scenario in question.

#### a. Impact of Climate Change on Soil Salinity

**Salinity in soil and irrigation water has become even more important as a result of global climate change.** Salt is not washed away in semi-arid areas, and accumulates in the topsoil due to rising temperatures and falling

[17] A more detailed and numerical projection could not be made in this section due to a lack of data on the production of outdoor ornamental plants in Turkey.

precipitation. The risk of salinity is aggravated as water is extracted from much deeper sections of wells. This phenomenon restricts the development of plant roots and causes abiotic stress in plants. **Thus, species that are resistant to salinity should be selected for agricultural activities in areas affected by salinity problems** (Dölarslan et al. , 2017).

A look at the soil salinity levels in the Basin indicates that the entire Basin, aside from the coastal part of Selçuk county and the southwestern parts of Odemis county, has salinity-free soil or very low salinity. While salinity levels will increase **as irrigable agricultural land receives less precipitation, a high level of vulnerability resulting from climate change is not expected to be observed in soil salinity in other regions until 2050.**

#### b. Impact of Climate Change on Soil pH and Alkalinity

**As no drastic decline in precipitation in the Basin is anticipated, no noteworthy change in soil pH is expected to occur until the 2050s.** A rise in temperature may lead to changes in the soil pH via capillary tubes in the soil.

### (iv) Impact of Climate Change on Diseases, Pests and Bee Populations

**Climate change projections carried out for the Basin point to some increases in fungal disease and yield and quality losses in the future.** It is observed that there are shortcomings in the collective fight against diseases and pests in vegetative production. Olive fruit fly and ring stain disease affecting olives, *ceroplastes rusci* in figs, *tuta absoluta* in tomatoes and Mediterranean fruit fly affecting citrus fruits are rapidly spreading.

**Potential increases in fall temperatures and humidity may directly affect the development of honey bees and create problems in wintering and different stress points.** Apiculture is not a common agricultural activity in the Basin, and this will be a critical issue for agricultural products that need bees for growth (Şahinler et al., 2008.)

***CHAPTER 4: CONCLUSIVE REMARKS***

*A comprehensive multi-disaster risk analysis was conducted in an assessment of climate change for the Basin as part of KAPRA. Factors such as the reproduction biology, physiology and feeding characteristics of five products were analyzed, their vulnerability to climate change and adaptation capacity was determined, and all phases, from initial production to delivery to the end consumer, were examined. The effects of potential climate change on products covered by the study vary. To make an accurate assessment of the impact of climate change on a single product, the product and all related ecosystem services should be addressed individually.*

***Olive (oil)***

- ✓ *Increase in the number of very hot days and rising average temperatures, dwindling average precipitation and shorter cooling periods create a critical situation affecting olive yield. It can be assumed that olive harvests will decline by between 10% and 20% if no action is taken by 2050.*
- ✓ *There may be a risk of idle capacity in olive oil processing, as well as additional operating expenditures for the supply of products from different places to cover this idle capacity as a result of a possible decline in harvesting in olive production. Furthermore, a decline in olive oil quality would also lead to loss of income. In addition, falling production may lead to a rise in prices and may further weaken international competitiveness.*
- ✓ *Storms and blizzards that may occur in the Basin may damage the physical infrastructure of enterprises and lead also to logistical problems.*

***Tomato (industrial)***

- ✓ *Climate change may have a negative effect on the production of tomato for industrial purposes as a result of infrastructural problems. Migration to the region and the development of industry may exacerbate pressure on agricultural water and lead to a greater decrease in yield than anticipated.*
- ✓ *A rise in temperature may have some positive effects on production, but extreme temperatures may cause a 4%–7% drop in yield and quality.*
- ✓ *A decrease in production quantity may also affect the other links in the chain. A decrease in product supply may prompt industrialists to purchase raw materials from different regions, leading to additional costs. Furthermore, high input prices may increase production costs and undermine the competitiveness of firms.*

***Milk (cow)***

- ✓ *Maize silage, the most common input in milk production in the Basin, will be affected by droughts given its need for large quantities of water, leading in turn to a decline in yield and the quality of the milk produced.*
- ✓ *Raw milk production is the most crucial phase in the production chain in which vulnerabilities may be observed due to climate change. A rise in average temperatures and a decrease in precipitation will have adverse effects on the yield of milked cattle, and may also affect the performance of those breeding cows for milk production, particularly during the summer.*
- ✓ *The decline in milk production is anticipated to be in the range of 3–5% in large enterprises between 2021-2050. Large enterprises will have higher adaptation capacity as a result of climate-smart measures intended to enhance animal welfare.*

***Fig (dried)***

- ✓ *Climate change also poses a risk to dried fig production in the Basin. Changes in the wind regime may render fig growing impossible. Excessive temperatures will also decrease yield and quality. A partial decline in precipitation will lead to a rise in water stress.*
- ✓ *Assuming that the vital activities of fig wasp will not be affected and the wind regime during the fruit ripening period remains unchanged, a harvest loss ranging between 5% and 7% will occur between 2021 and 2050 due to other climate stresses. This phenomenon may lead to a loss of income in wholesale trade, product processing, marketing and sale, which represent the highest levels of the production chain. A declining supply may be compensated by rising prices.*

***Outdoor ornamental plants***

- ✓ *The irrigation needs for outdoor ornamental plants are expected to begin earlier, meaning that pressure on the water sources may be observed as a result of climate change. There will be an increase in the production of varieties that are highly tolerant to drought and that are resilient with regard to water as a result of the rising need for irrigation, which will contribute to adaptation. Climate change will also enhance quality, as it will have a positive effect on the vegetative growth of plants.*
- ✓ *Significant increases are expected in production costs. Some varieties that are sensitive to water stresses may suffer a loss in yield ranging from 2–5% due to human factors or the insufficient supply of water. Yield loss may, however, be offset by an increase in quality and economic value. Climate change may also create storage problems and shorten the marketing period.*

# 5. Agricultural Support and Financing Mechanisms for Climate Change Adaptation in Turkey and Kucuk Menderes River Basin

This section briefly analyzes the existing support instruments and financing mechanisms used for agricultural, rural and climatic activities and investments in Turkey, including the Kucuk Menderes River Basin, and discusses the potential of those mechanisms to meet the financing requirements that the climate change mitigation and adaptation actions set forth in KAPRA will entail at the level of farmers and other stakeholders in the Kucuk Menderes River Basin.

Aside from their own financial resources, the main sources of financing used by farmers to fund agricultural production activities in Turkey are as follows:

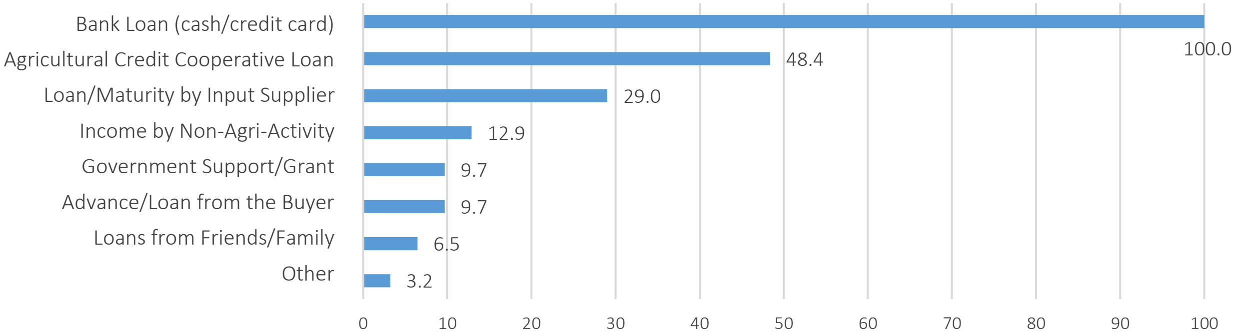
- ✓ **Government supports:** Agricultural supports can be classified in three main categories, consisting of around 120 sub-categories: 1) supports provided based on land area, number of livestock, quantity of product sold and agricultural insurance premium support, 2) agricultural / rural investment grants and 3) price / intervention purchase / interest support.
- ✓ **Bank loan:** Loans in the form of cash or cards with a defined line of credit (agricultural credit card, consumer credit card) provided by government-owned and private banks.
- ✓ **Agricultural Credit Cooperative (TKK) loan:** mostly small loans in the form of inputs (fertilizer, feed, diesel, seed, etc.) and partly cash loans[18].
- ✓ **Input supplier loan:** Post-harvest payment for inputs that the farmer has purchased from suppliers of fertilizer, pesticide, seed, etc. during an agricultural growing cycle.
- ✓ **Advance payment by buyers of products:** Advance payments or down payments that farmers receive from brokers or processors who collect harvested crops from farmers during the growing cycle.
- ✓ **Informal loans:** Loans borrowed by a farmer from family members, relatives, friends or wealthy people whom they know for repayment at the end of the harvesting season.

**Bank/cooperative loans, purchases of inputs on account and advance payments from buyers are the primary sources of financing used by Turkish farmers.** Aside from agricultural supports and investment grants provided by the government, these loans aim to make a partial contribution to decrease input costs or to compensate for loss of income. A field survey, which is conducted by Frankfurt School in 2016 in which 796 farmers in 58 provinces were interviewed, found that one out of every two farmers (52%) used bank loans and one out of three farmers (34%) use TKK loans to finance their agricultural production.

**The outcome of the same survey indicates that the creditworthiness of farmers in Izmir, where agricultural production is concentrated in the Kucuk Menderes River Basin, and the access of producers to financing was higher than the national average in Turkey.** It was seen that all farmers interviewed in Izmir borrowed bank loans; half of them preferred TKK loans in addition to bank loans; and that a third of them purchased inputs from input suppliers subject to payment upon the completion of the harvest (Figure 17). Thus, Izmir, which accounted for 3.5% of total agricultural production for Turkey at the end of 2017, took a 6.1% (TRY 5.3m) share of total loans extended to agricultural sector in the same period.

[18] The maximum line of credit assigned to a partner of a cooperative is TRY 50,000 in 2018, with a maximum 25% (TL 12,500) made available in cash. Collateral (mortgage, pledge, etc.) is required for loans equal to or over TRY 20,000 in total.

*Figure 17: External finance resources used by farmers in Izmir for agricultural production (2016)*



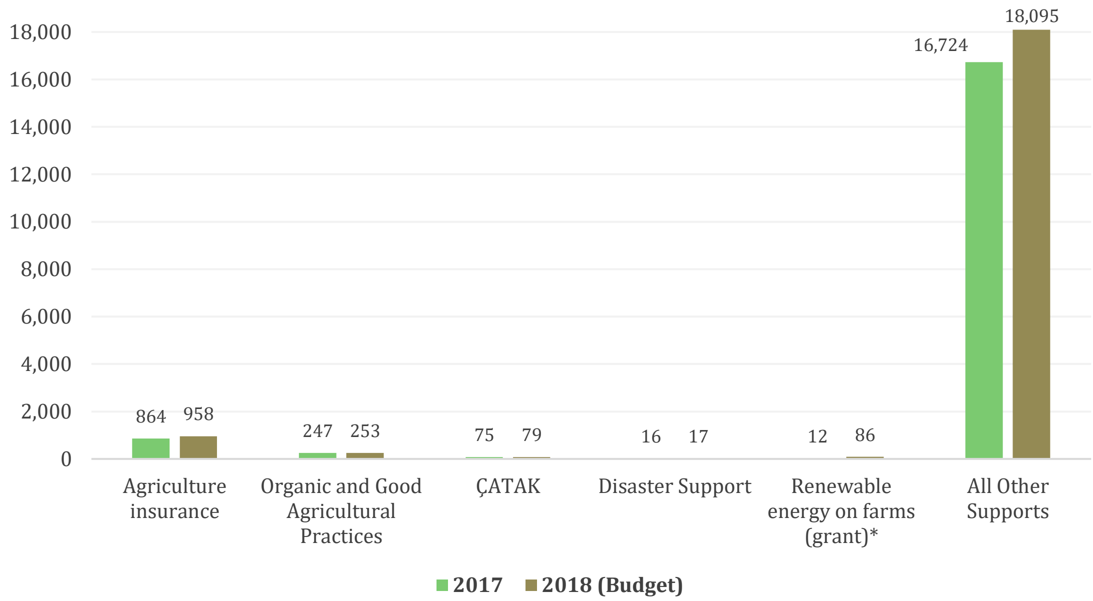

*Source: Frankfurt School Agricultural Financing Field Study, 2016*

**It is observed that farmers in Izmir have high creditworthiness not only for banks and TKKs, but also for input suppliers.** Sales on account offered by input suppliers is a rapid and readily available source of financing for farmers without access to a sufficient amount of formal loans, although they entail high interest.

## 5.1. Agricultural Government Supports for Climate Change Adaptation & Mitigation

**Direct or indirect supports to farmers for climate change adaptation and/or mitigation represent a relatively small percentage of agricultural government supports in Turkey.** In total, TRY 19.4bn was earmarked for the agricultural sector from the government budget in 2018, although only 6.8% of this was allocated to climate change mitigation and adaptation efforts (Figure 18). Premium contributions paid by the government for agricultural insurance had the largest share, with TRY 958m. This was followed by support provided to farmers engaged in organic farming and good agricultural practices with TRY253m, while there was negligible support for the protection of agricultural fields for environmental purposes (ÇATAK), natural disasters and farm needs. Other supports include supports according to the land area size, number of livestock, quantity of product sold and more. Detailed information about the structure and functioning of these support mechanisms are provided below.

*Figure 18: Agricultural supports related to climate change and all other types of support (%, TRY mio)*



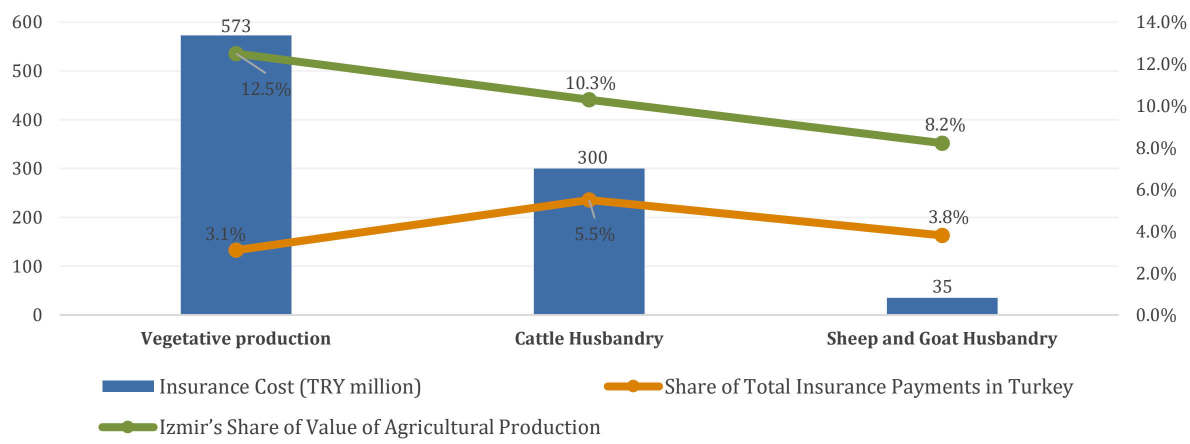

*Source: T.O.B., H.M.B., 2018*
** Grants for renewable energy were provided only by the Rural Development Investments Support Program (KKYDP) before 2017, while IPARD began providing such grants after 2018.*

**1. Agricultural insurance (TARSIM) premium support:** The loss of crops witnessed in vegetative production as a result of natural events, and losses of cattle, sheep and goats, poultry, aquatic products and bees caused by diseases are covered by a government-supported insurance system called TARSIM. Insurance is optional for farmers and the government provides two types of support: (i) 50% of the premium that the farmer is required to pay, and (ii) the transfer of additional funds to compensate for damage if the value of the actual damage is higher than the premiums collected. Since its launch in 2006[19], agricultural production valued at TRY 30,303m has been insured in exchange for TRY 1.628m paid as insurance premiums in 2017. Of this amount, plant products accounted for 77%, cattle accounted for 18% and the rest was shared by the sheep and goat, poultry, aquatic product and apiculture sectors. The government funded 53% of all insurance premiums. A comparison of the assets insured in each insurance category with the production value of the related sectors in Turkey indicates that insurance penetration in vegetative production, cattle, sheep and goat, and poultry was respectively 14%, 9%, 4% and 3%.

Demand for agricultural insurance is rising in parallel with the increasing anomalies resulting from climate change in Turkey. It is estimated, therefore, that the rate of penetration will increase. Payments made to farmers for damages shows that the insurance payouts for incurred damage represent approximately 4% of the agricultural assets insured by TARSIM. The most frequently reported causes of damage include **frost** (40%), **hail** (37%), **snow weight** (9.4%) and **storms** (8%). The primary causes for compensations paid for livestock include animal death (51%) and the compulsory slaughter of animals that are expected to die (35%).

Insurance was obtained for vegetative production worth TRY 573m, cattle worth TRY 300m, and sheep and goat worth TRY 35m in Izmir in 2017 (Figure 19). Based on these results, Izmir is considered to account for around 4% of the total insured value in each category (orange line in figure). A comparison of the insured production value in each sub-sector with production in the province (green line) indicates that Izmir has a slightly lower penetration rate (12.5%) than the national average in Turkey, but has reached a much higher awareness level of insurance related to livestock. Insurance ratios in Turkey for cattle, and for sheep and goat breeding are, respectively, 9% and 4%. The corresponding ratios in Izmir are 10.3% and 8.2%.

*Figure 19: TARSIM insurance costs in Izmir and the share of the province in agricultural production (2017)*




*Source: TARSİM*

**TARSIM launched a special type of insurance to cover loss of yield directly resulting from drought for the first time in 2017.** This insurance, known as "District-based Drought Yield Insurance", is only for wheat (non-irrigated) production for the time being. Drought insurance is planned to be extended to other cereal crops in 2019, and then to additional products based on the actuarial balance of the organization in the coming years. **If its application is extended to olives grown on dry land and in other industrial areas, this insurance will have greater importance in the Kucuk Menderes River Basin.** The drought yield insurance mechanism takes the form of payments to all insured

[19]Insurance cost in 2018: TRY 34.4bn as of 31.10.2018 Year-end expectation: TRY 38bn.

farmers if the average yield of wheat after harvest in a district is lower than the threshold yield established previously for that province (Figure 20).

*Figure 20: Mechanism for Loss Payments Under TARSIM Drought Yield Insurance*


*Source: TARSİM*

**2. Support provided for the protection of agricultural areas for environmental purposes (ÇATAK):** This support program, entitled ÇATAK, was launched in 2009, with other provinces included later (Izmir was included in 2012). As of 2018, the program is active in 58 provinces. Support per hectare is provided for farmers who are engaged in farming with minimum tillage, terracing, mulching, drainage applications and pressurized irrigation to prevent erosion, evaporation, water loss and loss of biodiversity caused by agricultural activities in the provinces covered by the program. Farmers engaged in these practices, which are classified into three categories, receive support for 3 years. The total payments for 2018 are as follows:

*Table 20: ÇATAK Program Support Amounts (2018)*

| Title of Category | Applications | Amount of Payment (TRY/ha/year) |
|---|---|---|
| Category 1 | Farming with minimum tillage (annual plants) | 450 |
| Category 2 | Performing at least two of the following applications: diking, terracing, curtaining, stone collection, open drainage, gypsum, application of sulfur or limestone, mulching, farm fertilizer and green fertilizing | 600 |
| Category 3 | Performing at least one of the following applications: application of pressurized irrigation systems together with controlled fertilizer and pesticide application, organic/good agricultural practice, closed drainage | 1,350 |

*Source: Ministry of Agriculture and Forestry*

While there is no data on the actual area of agricultural land or the number of farmers supported in the KMRB, it was observed that some farmers in the counties of Beydağ, Tire, Torbalı and Selçuk were recipients of this support.

**3. Disaster support:** Farmers may be entitled to disaster payments if they are affected by natural disasters not covered by TARSIM. This payment is conditional upon a minimum 40% loss of income as a result of the disaster. As the scope of TARSIM is gradually extended, the government is trying to cut down on disaster payments. Nonetheless, demand for disaster payments is expected to continue due to TARSIM's low penetration rates and actuarial capacity.

**4. Rural Development Grants:** Rural development grants covering 40% to 70% of farmers' investment projects in many categories are offered through two main programs: 1) The Rural Development component of the Instrument for Pre-accession Assistance (IPARD) (EU-funded), and 2) Program for Supporting Rural Development Investments (KKYDP). IPARD was launched in 2012 and is being implemented in 42 provinces, whereas the KKYDP has been carried out in all provinces since 2006. Both programs have components providing grants for investments intended to enable agricultural enterprises to generate power to meet their own energy needs through the use of renewable energy sources. The amount of funds earmarked for such investments in both programs represents a very small part of the total support payments. This phenomenon is attributed to low demand and insufficient emphasis placed on those categories in the programs.

**5. Support for Organic Farming and Good Agricultural Practices (GAP):** Farmers who are engaged in organic farming and good agricultural practices, and that ensure the reduction of carbon emissions and environmental pollution by eliminating the use of chemical fertilizers and pesticides receive additional support per hectare. Products to be supported in 2018 and the related amounts are shown below.

*Table 21: Organic and Good Agriculture Support Amounts (2018)*

| Title of Support | Product/Application Detail | Payment Amount (TL/ha/year) |
|---|---|---|
| Organic Agriculture | Products in year 1 (transition process) | 1000 |
| | Products in year 2 (transition process) | 700 |
| | Products in year 3 (transition process) | 300 |
| | Products in the 4th year (organic status) | 100 |
| Good Agriculture | Fruit, Vegetable | 500 (individual), 400 (group) |
| | Ornamental crops, medical aromatic plants | 1000 (individual), 500 (group) |
| | Greenhouse products | 1500 |
| | Rice | 10 |

*Source: Ministry of Agriculture and Forestry*

**Organic farming and good agricultural practice support could be crucial for Izmir and Kucuk Menderes River Basin.** According to statistical data released by the Ministry of Agriculture and Forestry, 4.6% of farmers engaged in organic production in Turkey and 4.1% of the land used for organic farming is located in Izmir, which is rather strong in terms of the key products selected under KAPRA. Izmir produces 18% of organic tomatoes, 22% of organic fig, 8% of organic milk and 6% of the organic olives grown in Turkey (Izmir Directorate of Provincial Agriculture and Forestry, 2018). As regards to good agricultural practices, which are gradually becoming widespread in the country, Izmir's share of total GAP land and GAP production output are 2.5% and 6.2%, respectively.

## 5.2. Loan Facilities for Climate Change in Turkey and the Kucuk Menderes River Basin

**Turkey was introduced to the concept of climate financing in 2010 as a result of funds provided by international organizations.** The developed countries pledged to transfer USD 100 billion in funds[20] per year to developing countries for climate financing until 2020 under the 2009 Copenhagen Agreement. Though some climate and green energy funds were provided prior to 2010, their size and visibility were low. Various international organizations, including the World Bank, European Investment Bank (EIB), European Bank for Reconstruction and Development (EBRD), The Agence Française de Développement (AFD) and German Development Bank (KfW), transferred USD 1.066m and EUR 2.610m to Turkey from 2010 to 2016 to support low carbon investments.

*Table 22: Climate, environment, and green energy financing provided for banks in Turkey (2010–2016)*

| Name of Organization (Title of Project) | Amount of Climate, Environment and Renewable Energy Financing (2010-2016) |
|---|---|
| World Bank (Renewable Energy & Energy Efficiency, SME Energy Efficiency, Geothermal Energy) | USD 1,000m + 201m + 250m |
| EBRD (TurSEFF, MidSEFF, TurEEFF, Resource Efficiency) | USD 500m + EUR 1,170m |
| AFD & Proparco (Climate Turkey) | EUR 300m |

[20] Including public, private, bilateral, multiple and all alternative financing models.

| | |
|---|---|
| KfW | EUR 353m |
| EIB (Energy and Environment Loan, Climate Change Facility, EE Global Loan, EE Co-financing Facility) | EUR 585.4m |
| Green for Growth Fund (RE Projects and EE Equipments Financing) | USD 11m + EUR 140m |
| Dutch Development Bank – FMO (EE Lending Program) | EUR 61.5m |
| Islamic Development Bank | USD 220m |
| JBIC (JBIC GREEN) | USD 250m |
| TOTAL | **USD 2,432m+ EUR 2,610m** |

*Source: Bank and IFI reports*

**International organizations require local finance institutions to include "Environmental and Social Management" (ESM) standards in their own loan procedures and to observe those rules as a pre-condition for making funds available.** For this purpose, international organizations provide technical assistance to local banks and other finance institutions, and they are motivated to improve their resources in order to continue applying ESM to loans extended from their own resources without the involvement of international funds. A large part of the funds referred to above were used to finance investments in renewable energy, while the remaining part was used to finance efficiency boosting investments into construction, mechanization, modernization and isolation, recycling, filtering and treatment that reduce the environmental pollution and carbon emissions; and investments that increase resource efficiency. These finance institutions had the opportunity to increase their capacity in "climate, green energy, environment" financing thanks to those funds.

These efforts yielded the anticipated results in numerous finance institutions. **Based on the "sustainability" concept, Turkish banks have begun reporting[21] on the low carbon financing to the public, enlisting in BIST Sustainability Index[22], the inclusion of the ESM system in their own loan policies, and the application of ESM procedures to large-scale project loans.** Some banks limit their products used for financing investments in low carbon projects to funds provided by international organizations, whereas others are developing types of loans that benefit the environment, and that support renewable energy and energy efficiency, in addition to those funds. The efforts being made by Turkish finance institutions in climate-sensitive financing are limited to "commercial and corporate" levels, and have yet to be applied at the level of micro-, small- and medium-sized enterprises. Almost all of the funds referred to above were lent to commercial and corporate customers of the banks.

There is no financial institution with a dedicated product for financing climate and environment sensitive agricultural production in Turkey, with the exception of one commercial bank. This can be attributed to three reasons:

I. Although agricultural enterprises are being affected by climate change and environmental degradation, there is **low awareness on this issue and hence a low demand for such products. This "insufficient demand" diminishes the desire of banks to develop know-how and products.** The only exception to this is the demand for the "0% interest-bearing" loans offered by Ziraat Bank for financing of pressurized irrigation systems[23].

II. **There is lack of "knowledge and awareness" on adaptation to and mitigation of climate change.** Neither farmers nor financial institutions have sufficient knowledge of methods for struggling with the climate change in agricultural production, or the potential benefits of this struggle. Public agencies and producer organizations do not engage in extensive activities targeting farmers. Efforts are limited to development of "drought-tolerant" seed varieties and other applications undertaken by research institutes controlled by the government.

[21] Banks publishing regular "Sustainability Reports" as of 2017: Garanti Bank, İşBank, Vakıfbank, Akbank, TSKB, and Ziraat Bank. The Turkish Economy Bank has issued only one report, covering the 2014–2015 period.

[22] There were eight banks included in the Sustainability Index as of November 2018.

[23] Ziraat Bank provided 0% interest-bearing loans totaling TRY 818m to 18,525 farmers, providing irrigation to 135,000 hectares of land from 2013 to 2017.

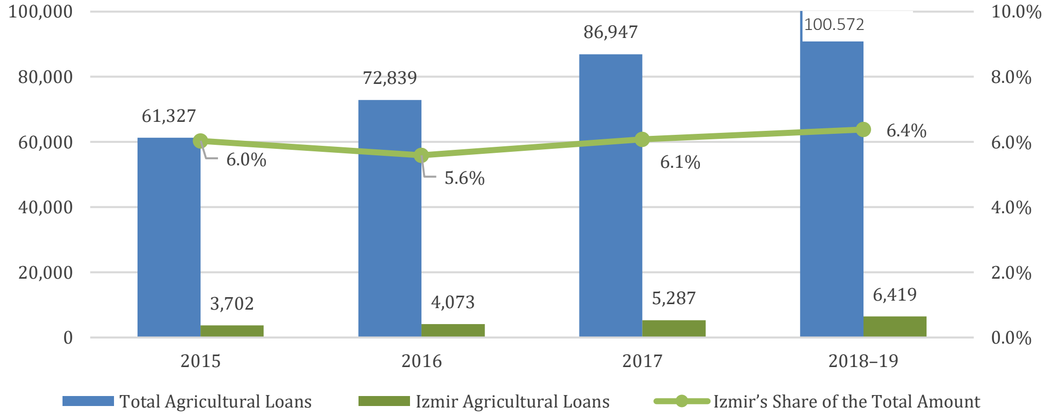
III. The two problems mentioned above are becoming chronic, **in that there is an insufficient number of "result-oriented" researches** on the effects of climate change in Turkish agriculture and on development of suitable coping methods. This shortcoming also restricts the capability and desire of international finance and development institutions to provide funds in such areas.

While the effects of climate change on agricultural production and the climate-smart agricultural practices required to cope with these effects are, at first glance, perceived as an area that should be dealt with by public authorities, **there are also analyses and studies that could be undertaken by all shareholders (producer organizations, input suppliers, buyers, industrialists) in the agricultural sector on their own account.** Accordingly, there are numerous definitions, criteria, and applications set by international organizations in those fields, and such practices can be analyzed and localized for Turkey. **If development agencies approach local financial institutions with concrete results and proposals, a demand and "market" for climate-smart agricultural financing could be created.**

Nevertheless, **it should be borne in mind that financing climate-smart agriculture cannot be expected to develop rapidly, and that a "long term" and "patient" approach is necessary.** The best example in this regard is the agricultural insurance program that enjoys government support (TARSIM). TARSIM was launched in 2006 when the level of awareness of insurance among farmers was very low, with only 12,000 policies per year. By the end of 2017, the number of such policies had reached 1.6 million per year. One of the reasons for this accomplishment was the fact that half of the insurance premium is paid by the government; **while another reason is the fact that banks have included agricultural insurance in their loan policies and requirements, and have engaged in active marketing campaigns in this field. Establishing a similar model for climate-smart agricultural practices among the international banks, and local public agencies and banks may lead to a successful start in this regard.**

**The Kucuk Menderes River Basin has access to sufficient agricultural financing for its agricultural production capacity.** All banks[24] actively marketing agricultural financing in Turkey are operating in the Kucuk Menderes River Basin, which constitutes a major area of competition for them. Such banks are mostly concentrated in Torbalı, Ödemis, Tire and Menderes in the Basin. There are 78 bank branches operating in eight districts in the Basin, and so geographical access is certainly not a problem in the provision of banking services. Meanwhile, statistical data related to the distribution of loans by sectors in Turkey is available at province level, although it is believed that the performance of agricultural loans in the province serves as a key indicator for the Basin, as it is assumed that agricultural loans are concentrated mainly in the KMRB within Izmir. A comparison of the value of agricultural loans in Izmir with the national total indicates that the province accounts for approximately 6%, and this figure is gradually increasing, albeit slowly (Figure 21).

*Figure 21: Agricultural loans in Turkey and Izmir (TRY million)*




*Source: Banking Regulation and Supervision Agency (BRSA)*

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24 There were 13 banks in Turkey offering banking products and services specific to agriculture in June 2018.

**The data presented above indicates that the financial infrastructure, products and services channelled to agriculture in the Kucuk Menderes River Basin are sufficient.** It will, however, be necessary to design an efficient planning and financing model in order to address the other problems mentioned above (creating demand, awareness, cooperation among agencies, etc.) so that the banks can support investments requiring external financing if an agricultural program focusing on climate change is put into operation. In this sense, **it is suggested that technical and financial support should be provided to local development agencies; that the communication and publishing channels of public agencies should be used for this purpose; and that agreements should be concluded with interested banks, based on a specific financing model.**

# 6. Business Cases and Financing Strategies

Section 4 of this report identifies the negative effects of climate change on five key agricultural products selected for the Kucuk Menderes River Basin (KMRB), and outlines the efforts being instigated by agricultural enterprises and other stakeholders in the value chain to mitigate those effects, as well as resilience solutions aimed at minimizing exposure to them. **Some of the actions listed have been accorded priority and transformed into 20 business cases in this section with a detailed analysis of the characteristics of those solutions, their spheres of influence and the implementation steps.** The basic information needed to put each business case into practice, the stakeholders who should be involved in the solution, the implementation steps and cost components of the solution, the financing opportunities and the total financing requirement, and detailed budget estimates were determined as a result of this research, with a business case developed for each resilience solution.

While calculating the total financing needs of the business cases, all expense items were added, notwithstanding the type of financing (grant, loan, own resource, venture capital, etc.) or source (public, private sector, farmer, etc.) and the project implementation period (years) was taken into consideration. This information will need to be reviewed and updated during the implementation phase, having been compiled taking into account the sectoral and market data, policy and financing practices available when the report was drawn up.

## 6.1. Proposed Business Cases Regarding Resilience to Climate Change in the Kucuk Menderes River Basin

The business solutions aimed at providing resilience that were developed under KAPRA were assessed according to various criteria before being turned into business cases:

- ✓ **Implementation scale:** If the stakeholder who will play a primary role in the implementation of the solution is a farmer or an enterprise, it was described as *individual*. If it is a farmer/professional organization, it was characterized as *institutional/organizational,* or *public* if it is a public-invested enterprise.
- ✓ **Effect on key products:** Some solutions provide benefits for more than one key products. Such solutions were prioritized.
- ✓ **Development of adaptation to climate change risks with less uncertainty:** A risk analysis carried out in the KMRB shows that some climate risks will most likely occur before 2050, although others, such as frost, hailstones and the rising sea water could not be fully determined due to a lack of historical data. Thus, the resilience solutions put forward are intended to bolster capacity to adapt to risks associated with climate change, which is less unpredictable.
- ✓ **Affecting different parts of the production chain:** In addition to the solutions affecting the first production phase of key products, the effects of the proposed solutions on the subsequent parts such as processing, marketing etc. were also included.
- ✓ **Its effects going beyond adaptation:** Solutions that enhance the capacity of the related key agricultural product to adapt to climate change while contributing to the mitigation of climate change in the Basin, or the improvement of the existing production infrastructure with visible effects, were accorded priority.

The following table summarizes 20 proposed solutions selected in line with those approaches:

*Table 23: Business solutions selected for resilience to climate risks related to key agricultural products*

| Findings on Climate Change | Business solution | Key product(s) affected | Climate parameter targeted for adaptation | Links of value chain affected | Nature of solution (adaptation/mitigation/ structural improvement) | Scale of implementation |
|---|---|---|---|---|---|---|
| It is predicted that, after 2022, moderate and severe/extreme droughts will be seen continuously, in other words, the likelihood of aridification will strengthen. | Improvements in fig drying systems | Fig | Precipitation anomalies | Production and Product Processing | Adaptation / Mitigation | Individual (Farmer) |
| | Extended use of renewable energy sources for product processing | Tomato, fig, olive (processed products: tomato paste, dried tomato, dried fig, olive oil, and pomace oil) | Very high temperature | Production and Product Processing | Adaptation / Mitigation | Corporate (processing facility) |
| | Improvements in the cold chain for raw milk and the utilization of renewable energy sources in the cold chain | Cattle dairy (raw milk and processed dairy products) | Very high temperature | Production and Product Processing | Adaptation / Mitigation | Corporate (producer organization) |
| Precipitation estimations indicate that the longest drought periods in the Basin will become longer, while the longest rainy periods will become shorter and the number of days with excessive precipitation will increase. | The extended growing of xerophilous outdoor ornamental plant varieties | Outdoor ornamental plants | Very high air temperature, insufficient precipitation | Production and Marketing | Adaptation | Public |
| | Waste management in olive oil facilities and factories | Olive | Very high air temperature, insufficient precipitation | Production, Product Processing and Marketing | Structural | Corporate (processing facility) |
| | Supporting investments in infrastructure preventing the loss of irrigation water (closed system irrigation) | Olive, fig, tomato, outdoor ornamental plants | Very high air temperature, low precipitation | Production (sustainable supply) | Structural / Adaptation | Public |
| Various consequences of climate change, such as an increase in the emission of carbon dioxide into the atmosphere, erosion and floods resulting from sudden precipitation can be observed. | Events intended to raise awareness on climate change at a local and national scale | Olive, fig, tomato, outdoor ornamental plants, cattle dairy and fattening | All components of the climate | All links in the chain | Structural / Adaptation / Mitigation | Public |
| | Collection of animal waste for biogas production | Cattle dairy and fattening | Carbon dioxide emission | Product processing and supply of raw material (sustainable supply of raw milk and meat, reduction in the costs of raw materials / supply of raw materials with a high hygiene ratio) | Mitigation / Adaptation | Individual (Farmer) |
| | Afforestation aimed at mitigating the effects of carbon emission and the intensification of efforts to prevent erosion and floods | Olive, fig, tomato, and outdoor ornamental plants | Carbon emission, erosion, floods | All links in the chain | Mitigation / Adaptation | Public |

| Findings on Climate Change | Business solution | Key product(s) affected | Climate parameter targeted for adaptation | Links of value chain affected | Nature of solution (adaptation/mitigation/ structural improvement) | Scale of implementation |
|---|---|---|---|---|---|---|
| Average annual temperatures in the Basin are expected to increase by 1°C by 2050 and between 2°C and 6°C towards the end of the century when compared to today's temperatures (average for 1986–2005). | Financial support for air-conditioning systems in small dairy cattle farms | Cattle dairy and fattening | Average increase in temperatures | Product processing and supply of raw materials (sustainable supply of raw milk and meat, reduction in the cost of raw materials) | Adaptation | Individual (Farmer) |
| | Implementation of herd management programs in medium-size dairy cattle businesses | Cattle dairy and fattening | Average increase in temperatures | Product processing and supply of raw materials (sustainable supply of raw milk and meat, reduction in the cost of raw materials) | Protection / Adaptation | Individual (Farmer) |
| | Increasing the numbers of manure pits in dairy cattle farms | Cattle dairy and fattening | Average increase in temperatures | Product processing and supply of raw materials | Mitigation | Individual (Farmer) |
| Significant increases in temperatures may lead to a serious rise in diseases and pest propagation. | Extension of efficient and conscious use of fertilization and plant protection (pesticide) methods sensitive to the environment and climate | Olive, tomato, fig and outdoor ornamental plants | Increase in stress, diseases and pest population as a result of temperature rise | Production and product processing (sustainable supply of processed products, reduction of the costs of raw material) | Protection / Adaptation / Mitigation | Individual (Farmer) |
| Cooling needed by olive varieties will fall at a rate up to 50% due to rising winter temperatures, and the cooling requirements of some olive varieties will not be met. This phenomenon will lead to a significant decrease in olive yield. | Extension of new olive varieties high quality, resistant to drought and suitable for machine harvesting | Olive | Cooling need (increase in winter temperatures) and temperature rise during flowering period | Input suppliers, Cooperatives, Sapling growers, Farmers, Processors of Olive for Oil Production, Consumers | Adaptation | Individual (Farmer), Corporate (Producer Organization, Company) |
| | Replacing local olive varieties that are vulnerable to climate change in the region | Olive | Cooling need (increase in winter temperatures) and temperature rise during flowering period | Olive oil processors and exporters | Adaptation | Individual (Farmer) |
| It is anticipated that the total annual variation in precipitation within the Basin will be around 3% until 2050, which is why a significant change in total precipitation is not expected. There may, however, be a decline in the number of days with rain. Precipitation estimations indicate that the longest drought periods in the Basin will become longer, while the longest rainy periods will become shorter and the number of days with excessive precipitation will increase. This factor will mostly affect agricultural production on sloping land. | Extension of practices preventing evaporation in the soil | Tomato, and outdoor ornamental plants | Falling precipitation, increased evaporation | Production and product processing (sustainable supply of processed products) | Adaptation | Individual (Farmer) |
| | Development of efficient irrigation systems in the KMRB | Olive, fig, tomato, and outdoor ornamental plants | Falling precipitation / rising plant water consumption / heat stress | Product processing (sustainable supply of processed products) | Structural / Adaptation | Public |
| | Using domestic wastewater in counties for agricultural irrigation | Olive, fig, tomato, outdoor ornamental plants | Decline in precipitation, retreating water sources | Production and product processing (sustainable supply of processed products) | Structural / Adaptation | Public |
| | Terracing of inclined groves | Olive and fig | Falling precipitation / rising plant water consumption / heat stress | Production and product processing (sustainable supply of processed products) | Structural / Adaptation | Individual (Farmer) |
| | Promoting the use of different materials rather than soil in the production phase | Outdoor ornamental plants grown in pots | Excessive precipitation | Production and natural resource management | Adaptation | Public |

*Source: Frankfurt School studies*

Each business case developed for the implementation of business solutions is shown in detail in the tables in the following section. The financing strategy proposed for the implementation of the solution and the existing and potential factors that may affect the financing of business cases, as well as the existing financing options in the Basin, are outlined and presented in a diagram after each table in order to show the strengths and weaknesses of the existing financing opportunities and to discuss ideal financing strategies regarding the business case. Thus, a preliminary preparation is made for the next step if the business cases are put into practice after KAPRA.

Several fundamental principles were taken into consideration while developing the financing strategies:

- ✓ If there are financing models and instruments that are currently in use in the Basin with which the beneficiaries are familiar, those models and instruments were preferred to the greatest extent possible in order to ensure the smooth implementation of the business solution.
- ✓ If existing models and instruments can be partly used, additional models and instruments were adopted and potential implementing organizations were named, and explanations were made about how the new practices would function.
- ✓ In situations in which public burden can be reduced and private sector investments can be supported, co-financing models in the form of "public-private partnerships (PPP) or "grant+loan" were used. In situations where the business solution required more "public property & service", a grant model involving in-kind or cash grants (without repayment) were envisaged, even if the direct beneficiaries were the farmers and other rings of the chain.
- ✓ If business solutions are to be put into practice, regardless of whether or not the source of financing is private or public, **it needs to be turned into a project that comprises a comprehensive feasibility study, specifications and a business plan, and where the implementing organization guides the other partners and follows the implementation steps during the entire process.** Failure in this regard may lead to serious delays in reaping the benefits targeted by the business solutions pertaining to climate change.
- ✓ Where the business solution requires only public goods / services and its beneficiaries included all segments of society, and did not provide a concrete benefit / revenue to a specific type of beneficiary (6 business solutions), no cost or financing study was carried out, and hence no financing strategy was developed. A table providing detailed an explanation of these business solutions, implementation steps and stakeholders was, however, presented.

A summary table showing the estimated budget needed for the 20 business cases selected in line with the above guidelines, the "proposed ideal financing" models and the prioritization preferences of the consultant team are presented below:

*Table 24: "Ideal Financing" Models Envisaged for Business Cases Developed*

| Case No. | Business Case | Key product(s) affected | Number of Beneficiaries (Individual or Business) | Projected implementation period (year) | Period during which the solution will reduce climate risk for each beneficiary (year) | Ratio of the Solution to be Implemented to Total Capacity in the KMRB (%) | Total financing requirement (USD) | Anticipated Yield Increase / Cost Decrease | Prioritization of Expert Team | Anticipated Ideal Financing Strategy |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Financial support for air-conditioning systems in small dairy cattle farms | Cow's Milk | 1,426 | 3 | 1 | 10% | 2,731,915 | 7% | Priority | Co-financing model |
| 2 | Support for production of xerophilous outdoor ornamental plant varieties | Outdoor ornamental plants | | | | | | | Priority | |
| 3 | Waste management in olive oil facilities and factories | Olive (for oil) | 52 | 5 | 1 | 100% | 1,300,000 | 50% | Low priority | Co-financing model |
| 4 | Extension of new olive varieties of high quality that are resistant to drought and suitable for machine harvesting | Olive (for oil) | 875 | 7 | 6 | 5% | 9,332,625 | 85% | High Priority | Public investment, PPP, grant, loan |
| 5 | Development of efficient irrigation systems in the KMRB | Olive (for oil), tomato (for industry), fig (dry), outdoor ornamental plants, fodder crops (for cow milk) | 2,700 | 7 | 1 | | 1,554,864 | 20% | High Priority | Support for public training, co-financing model |
| 6 | Supporting investments in infrastructure preventing the loss of irrigation water (closed system irrigation) | Olive (for oil), fig (dried), tomato (for industry), outdoor ornamental plants | | | | | | | High Priority | |
| 7 | Events intended to raise awareness on climate change at a local and national scale | Olive (for oil), fig (dried), tomato (for industry), outdoor ornamental plants, cow's milk | | | | | | | High Priority | |
| 8 | Implementation of herd management programs in medium-size dairy cattle businesses | Cow's Milk | 100 | 1 | 1 | | 1,425,000 | 20% | Low priority | Co-financing model |
| 9 | Promoting the use of different materials rather than soil in the production phase of outdoor ornamental plants | Outdoor ornamental plants | | | | | | | Low priority | |
| 10 | Extended use of renewable energy sources for product processing | Tomato (for industry), fig (dried), olive (for oil) | 50 | 2 | 1 | | 4,000,000 | 50% | Priority | Co-financing model |
| 11 | Replacing local olive varieties that are vulnerable to climate change in the region | Olive (for oil) | 875 | 5 | 6 | 5% | 1,190,372 | 25% | High Priority | Multi-stakeholder public support (training, input support, compensatory support) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 12 | Terracing of inclined groves | Olive (for oil) and Fig (dried) | 1000 | 7 | 3 | | 1,287,234 | 15% | Priority | Optional public support (procurement of services / direct public implementation |
| 13 | Extension of efficient and conscious use of fertilization and plant protection (pesticide) methods sensitive to the environment and climate | Olive (for oil), tomato (for industry), fig (dry), outdoor ornamental plants, fodder crops (for cow milk) | 1,600 | 2 | 5 | 6% | 72,000 | 10% | High Priority | Optional public support (procurement of services / direct public implementation |
| 14 | Collection of animal waste for biogas production | Cow's Milk | 100 | 3 | 1 | | 3,319,149 | 25% | Low priority | Co-financing model |
| 15 | Increasing the numbers of manure pits in medium size dairy cattle farms | Cow's Milk | 500 | 5 | 1 | | 6,382,500 | | Priority | Co-financing model |
| 16 | Afforestation aimed at mitigating the effects of carbon emission and the intensification of efforts to prevent erosion and floods | Olive (for oil), fig (dried), tomato (for industry), outdoor ornamental plants | | | | | | | Priority | |
| 17 | Improvements in fig drying systems | Fig (dried) | 5,000 | 1 | | 40% | 210,000 | | Low priority | Public input support |
| 18 | Improvements in the cold chain for raw milk and the utilization of renewable energy sources in the cold chain | Cow's Milk | 20 | 2 | 1 | 23% | 1,600,000 | 50% | Priority | Co-financing model |
| 19 | Extension of practices preventing evaporation in the soil | Tomato (for industry), outdoor ornamental plants | 400 | 5 | 1 | 3% | 88,851 | 20% | High Priority | Public training and input support |
| 20 | Using domestic wastewater in counties for agricultural irrigation | Olive (for oil), fig (dried), tomato (for industry), outdoor ornamental plants | | | | | | | Priority | |

| |
|---|
| Public |

| 1. Business case: Financial support for air-conditioning systems in small dairy cattle farms | |
|---|---|
| A brief description of the solution and its goals | Extension of air-conditioning equipment in small (10–20 milch cow) dairy cattle enterprises. (Small enterprises in the Basin have no air-conditioning equipment). |
| What problem/obstacle does it propose to address in the region? | Low animal welfare caused by heat stress resulting from climate leads to declining yield. Air-conditioning will bring about a 5–7% increase in milk yield and a 5–10% reduction in feed costs. Other benefits are shown in the following table. |
| Scale of implementation of the solution: | Individual (Farmer) |
| Implementation steps: | Development of uniform designs based on the type of barn, completion of the assessment of 50% grant applications, installation of air-conditioning equipment (automatic fan and fogging) in milch cow sheds. |
| What key product(s) will it affect? | Cow milk |
| What other links in the value chain will be affected? | Farmer, Milk Industry |
| Climatic effects for which adaptation is sought: | Average increase in temperatures |
| Examples of best practices/references | http://www.te-ta.com.tr/detaylar/2/makaleler/1061/yaz_aylarinda_sicaklik_stresinin_azaltilmasi.aspx |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Small (10–20 milch cow) dairy cattle enterprises |
| Input providers | Suppliers of Air-Conditioning Systems for Barns and Poultry Houses |
| Technical support services | - |
| Administrative and structural supporters | Provincial and district offices of the Ministry of Agriculture and Forestry, local development agency/organization |
| Finance providers | TKDK, local development agency/organization, Municipality, Banks (for the provision of loans in addition to the grant), Agricultural Credit Cooperatives |
| Incentive providers | Agricultural Development Cooperatives, milk producers' unions, cattle breeders' unions |

| Cost items, unit (per animal)/USD | |
|---|---|
| Labor | 10.6 |
| Materials | 106.4 |
| Training | |
| Other (installation) | 10.6 |
| Total | **127.7** |

| Existing Sources of Financing in the Region |
|---|
| Bank loans |
| Agricultural Credit Cooperatives: |
| Program for the Support of Young Farmers (grant) |
| KKYDP (grant). See "Grant programs" below for details. |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 2,731,915 | Cost per animal (USD 127.7 USD) x total number of animals (21,400 cattle) |
| Investment Capacity of the Business Plan (number of animals) | 21,400 | It is predicted that 10% of milch cows (21,400 cows) in the four districts (Bayındır, Kiraz, Ödemis, Tire) that are home to 81% of the genetically-improved cattle in the province will benefit from this business solution. |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 10% | |
| Project implementation period (years) | 3 | It is estimated that it will be implemented by 500 enterprises every year due to the limited number of suppliers to be involved in this business solution. |
| Period during which the project will reduce climate risk for each beneficiary (year) | 1 | This solution instantly reduces heat stress. |
| Anticipated Yield Increase (%) | 7% | |
| Anticipated number of beneficiaries (enterprises) | 1,426 | Thus, the number of enterprises with 15 milch cows on average is estimated to be 1,426 (21400/15). |

| | |
|---|---|
| Other anticipated results | Increase in insemination yield, decline in the number of somatic cells, lower medical costs |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Minimum USD 1,277 (10 milch cows) and maximum USD 2,254 (20 milch cows) capital investment will be needed per enterprise. | ▶ | One of the two existing grant programs in the region (Young Farmers) provides 50% grants for projects below TRY30,000, while the other offers 50% grants for projects over TRY30,000. The remaining amount can be financed through bank/cooperative loans. |
| Sustainability | Air-conditioning equipment will need to be maintained and repaired. In addition, more cooling fans will be needed in parallel with the increase in the number of animals. | ▶ | When the initial cost of investment is financed for these systems, farmers can take care of maintenance-repair or additional capacity needs. |
| Social | - | ▶ | -- |
| Obstacles related to corporate/regulatory structure | The requirements in existing grant programs offer a limited opportunity for investment in the air-conditioning systems needed by enterprises with 10–20 milch cows. | ▶ | Existing grant programs can be used in part. See "Financing Strategy" below for details. |

| | |
|---|---|
| Priority status in terms of E-S-E (Economic-Social- Environmetal) impact (high priority - priority - low priority) | Priority |
| What Else Can Be Done / Next Steps | Following up on implementation, productivity measurements, ensuring that suppliers offer maintenance-repair support |

## Financing Strategy

The air-conditioning (automatic fan and fogging systems) proposed in this business solution are only available in large husbandry enterprises (generally 10 or more cattle). Small enterprises are vulnerable to low feed yield and low milk yield, which result from rising heat stress in their animals. It is known that roughly 75% of cattle husbandry enterprises in Turkey have 10 or less cattle, and that 15–20% of them have 11–20 cattle. Furthermore, small enterprises in the region are vulnerable to the negative effects of climate change. This poses a risk to the sustainability of "family farming". Potential sources of the financing needed for the support of this business solution are listed in the above table. The characteristics of these sources are detailed below.

### *Grant programs*

Program to "Support the Projects of Young Farmers", one of the two national grant programs in the region, offers grants of up to TRY 30,000 only to farmers in the 18–40 age bracket. Young farmers with 15 or more cattle are, however, not eligible to benefit from this program. Thus, only farmers in the 18–40 age bracket and who have a maximum of 15 cattle (in this case, the number of milch cows may range from 7 to a maximum of 15) will be eligible under the "Young Farmer" Program. The Rural Development Investments Support Program (KKYDP), as the other grant program, only finances projects valued at more than TRY 30,000 that are proposed by enterprises in residential areas with a population below 20,000. In fact, the maximum investment needed for this business solution is USD 2,254 (approximately TRY 13,000–15,000), and so the existing public grant programs are insufficient for this business solution. The "Young Farmers" program may, however, be used in part for this business solution.

### *Bank loans*

Presently, banks in the region offer loans to meet the similar needs of dairy cattle enterprises, including "Dairy Husbandry Loans", "Investment Loans for Dairy Husbandry" and "Agricultural Investment Loans", among others. Those loans are generally repaid in equal or flexible installments over 1, 2 or 3 months. The frequency and amounts of the payable installments are determined based on the cattle capacity of the enterprises and the milk sale cycle. Loans are repaid mostly within 12 to 36 months, depending on the farmer's ability to pay. Bank loans are thus one of the most important options for the implementation of this business solution, although they have recently been reluctant to offer loans to cattle breeding enterprises, and most have even established limits. The reasons for this general attitude of the banks (aside from state-owned banks) is that they do not have access to the husbandry registration system ran by the Ministry of Agriculture and Forestry; the fact that the milk and meat market (and hence prices) has been prone to speculation over the past couple of years; and the failure of the government's attempts to regulate the market to yield satisfactory results. Thus, farmers cannot rapidly adapt themselves to the changing market and price conditions, which, in turn, affects the repayment of bank loans. In addition, the constantly rising interest rates since 2017 have rendered loans "risky" for both banks and farmers.

*Agricultural Credit Cooperatives (TKK)*

There are 23 active TKK's in the Kucuk Menderes River Basin. Cooperatives can offer loans with a maximum term of 4 years to finance investments needed for this business solution.

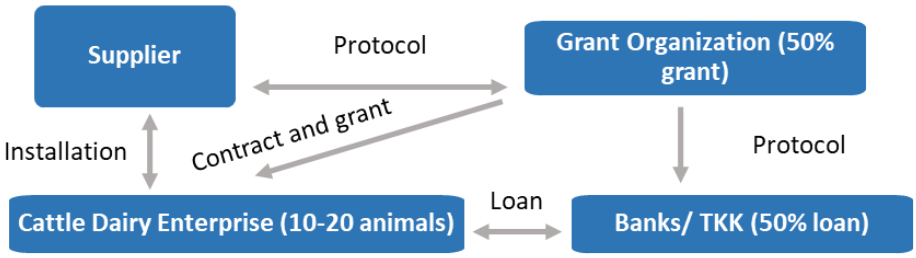
*Proposed financing model*

It is believed that the best financing strategy for Business Solution-1 is co-financing in the form of "grant + loan/own funds." Thus, 50% of the investment cost can be obtained as a grant, while the remaining figure comes from the farmer's own funds or from a bank/TKK loan. This model:

- ensures that a farmer who has provided co-financing will own the investment and assume responsibility;
- reduce the farmer's financing cost; and
- decrease the total grant cost of the project.

The fact that the investment cost of this business solution is not very high permits farmers who have savings to invest 50% of their own funds without having to take out a loan. It is assumed that some of the firms that will install an air-conditioning system will be able to pay the remaining 50% within a certain period or in installments, and hence there will be a limited need for banks for this business solution. Nevertheless, offering a bank loan to farmers as an option is important to farmers who do not have their own funds.

Figure 22: Financing model proposed for Business Case 1



| Business case 2: Support for production of xerophilous ornamental plant varieties | |
|---|---|
| A brief description of the solution and its goals | Identification of seasonal outdoor plants, as well as xerophilous and semi-xerophilous species and varieties that can last longer, and introducing them to local administrations and farmers |
| What problem/obstacle does it propose to address in the region? | Promoting species that need less water, that are more tolerant to heat and that last longer to replace existing varieties that need more water, that are sensitive to heat stress and that have a short life span |
| Scale of implementation of the solution: | Public (academia, agricultural research institute) |
| Implementation steps: | Conducting researches into xerophilous outdoor plants that can adapt themselves to the region, growing them in the tissue laboratory, introducing them to municipalities and farmers' organizations, transferring technical knowledge and know-how for production |
| What key product(s) will it affect? | Outdoor ornamental plants |
| What other links in the value chain will be affected? | Research organizations, farmers' organizations, local administrations |
| Climatic effects for which adaptation is sought: | Mitigating the effects of very high air temperatures and low precipitation |
| Examples of best practices/references | |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Agricultural faculties at regional universities and Bayındır Vocational School, regional agricultural research institutes, Bademli TKK, flower grower cooperatives, unions of indoor and outdoor ornamental plant growers |
| Input providers | Regional universities, regional agricultural research institutes, municipalities, farmers' unions and cooperatives |
| Technical support services | - |
| Administrative and structural supporters | Provincial Agriculture and Forestry Directorate, Izmir Metropolitan Municipality (IBB) |
| Finance providers | Local development agency/organization, IBB, regional universities, agricultural research institutes, farmers' cooperatives and unions |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Insufficiency of public funds earmarked for this area | ► | Ensuring contributions from farmers' organizations and other local sources and beneficiaries |
| Sustainability | Replacing teams conducting R&D activities | ► | Joint execution of the project both in the Ministry's institute and the university |
| Social | Local farmers do not need to change their current production systems | ► | Providing information for proper phased transition |
| Obstacles related to corporate/regulatory structure | Insufficient materials for the plants considered for certification and production | ► | Development of a system that will ensure certification in collaboration with all stakeholders |

| Priority status in terms of E-S-E impact (high priority - priority - low priority) | Priority |
|---|---|
| What Else Can Be Done / Next Steps | Joint efforts to increase demand targeting end recipients (farmers and municipalities) |

No financing strategy could be developed for this solution as it requires large-scale and multi-component investments by the public sector.

| Business case 3: Waste management in olive oil facilities and factories | |
|---|---|
| A brief description of the solution and its goals | Development of systems that will ensure efficient control of black water, pomace oil and similar waste; reduction of water use, and its reuse. Thus, the negative effects on water, soil and the air originating from olive oil processing plants will be reduced, and even eliminated. |
| What problem/obstacle does it propose to address in the region? | Reduced water use and the prevention of the adverse effects of toxic substances and gases that are released into the environment and air |
| Scale of implementation of the solution: | Corporate (processing facility) |
| Implementation steps: | Designing and installing biological treatment pools, promoting flue gas filtering systems in pomace oil plants |
| What key product(s) will it affect? | Olive |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Olive oil and pomace oil facilities |
| Input providers | Biological treatment facility engineering firms, companies installing flue gas filter systems |
| Technical support services | Regional universities, olive research institutes |
| Administrative and structural supporters | Provincial Directorate of the Ministry of Environment and Urbanization, Provincial Directorate of Agriculture and Forestry, olive research institutes |
| Finance providers | Local development agency/organization (50–75% grant), Ministry of Industry and Technology, banks (remaining part in excess of the grant) |

| | |
|---|---|
| What other links in the value chain will be affected? | Olive oil and pomace oil facilities |
| Climatic effects for which adaptation is sought: | Very high air temperature, low precipitation |
| Examples of best practices/references | Fig Research Station Directorate, Use of Olive Black Water for the Production of Dried Fig, https://arastirma.tarim.gov.tr/incir/Belgeler/dergi/39-43.pdf http://www.canakkaleticaretborsasi.org.tr/upload/zeytin-karasuyu-brifingi-ab5f..pdf |

| Annual initial installation cost items, unit/USD | |
|---|---|
| Labor | |
| Materials | |
| Training | |
| Total | 25,000 |

| Existing Sources of Financing in the Region |
|---|
| Bank loans |
| Local development agency/organization |
| KDP by STB, UR-GE Program by TB (grant). See “Grant programs” below for detail |
| Program in Support of Rural Development Investments (grant) |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 1,300,000 | This investment is planned for 50 olive enterprises (performing cold pressing in 3 phases) and 2 pomace oil plants in the basin. |
| Investment Capacity of the Business Plan (tons) | 60,000 | The average capacity of olive processing plants is 1,200 tons/year and 60,000 tons/year for 50 plants. |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 100% | All plants that need this business solution will be included. |
| Project implementation period (years) | 5 | |
| Period during which the project will reduce climate risk for each beneficiary (year) | 1 | The effects of pressure on dwindling water resources and air pollution will be observed in the first year of implementation. |
| Anticipated Yield Increase (%) | Elimination of 50% of black water and 100% of air pollution originating from pomace oil producing plants | |
| Anticipated number of beneficiaries (enterprises) | 52 | 50 olive processing plants and 2 pomace oil plants |

| | |
|---|---|
| Other anticipated results | Facilitation of exports and enhanced competitiveness – global competitiveness in the olive oil industry being related to the environment; using sludge removed from pools as plant nutrients after chemical analyses; reduction of pollution pressure on the limited water sources in the Basin; and declining air pollution and particle rates are expected to yield positive effects on human health. |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | High investment costs | ► | Mixed financial support in the form of grants and loans |
| Sustainability | Problems that may arise from the operating costs of plants to be installed and filtering systems | ► | Technical support for the efficient operation of the facilities |
| Social | Potential disputes over lands on which the pools will be built | ► | Explaining the common benefits |
| Obstacles related to corporate/regulatory structure | Bottlenecks in the implementation of air and soil protection regulations | ► | Effective controls and stakeholder relations |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | Low priority |
| What Else Can Be Done / Next Steps | Examples in areas where best practices are observed must be shared. |

## Financing Strategy

50 of the 106 olive processing plants in Izmir employ the 3-phase press method which generates olive black water as wastewater. Black water discharged from those businesses leads to a major environmental problem. This problem degrades the quality of the air and the ground and surface water in regions where those plants are located. Biological treatment systems are intended to be built as part of Business Case 3, in order to eliminate wastewater discharged by 50 olive oil plants in the region as well as two other businesses processing waste pomace olive.

Potential sources of the financing needed for the support of this business solution are listed in the above table. The characteristics of these sources are detailed below.

*Grant programs*

Olive oil plants in Izmir can benefit from the 3 grant programs being implemented throughout the country. One of these is the Program for Supporting the Development of International Competitiveness (UR-GE) being carried out by the Ministry of Trade, and the other is the Clustering Support Program (KDP) run by the Ministry of Industry and Technology. Both programs support similar investments proposed by a group of businesses engaged in the same business segment under the leadership of a "leading" entity (usually an umbrella organization) by providing grants in the range of 10–75%. The UR-GE program is focused mostly on marketing and foreign trade, whereas KDP promotes also investments aimed at protecting the environment. Both programs require a joint application to be filed by a specific number of enterprises. Thus, serious preparation, cooperation and coordination is needed if these programs are to be used for this business solution.

The Rural Development Investments Support Program (KKYDP) managed by the Ministry of Agriculture and Forestry is the third grant program suitable for the installation of a wastewater system for olive black water. This program requires the enterprise to be based in a residential area with a population of below 20,000. Some olive oil enterprises in the Basin are known to be financing their modernization and black water investments through this program. The grant ratio is equal to 50% of the investment budget. It would seem to be impossible for the 50 enterprises in the region to install a biological treatment system for black water through the KKYDP, as the program has a limited budget and there are many areas for which applications can be submitted.

Izmir Development Agency (IZKA), the only source of grants in the region, is a key financial stakeholder in Business Case 3, and is more familiar with problems peculiar to the Basin than others. Still, it is assumed that designing a model in which the entire financing cost of the business solution can be provided as "grant + loan/own funds" rather than all as a grant.

*Bank loans*

Banks in the region offer loans to olive oil producers under the categories SME Banking or Commercial Banking. Similarly, some banks even market loans with a grace period of one or two years, particularly for investments in environmental management, waste management, renewable energy, etc. under the concept and brand "Environment Banking." Turkish banks can occasionally borrow funds from international finance institutions and can offer more suitable conditions for investments in the environment, or those contributing to the adaptation to climate change. The management of black water is, however, not an investment providing direct profits for olive processing plants, and so financing the entire investment through a loan does not seem feasible.

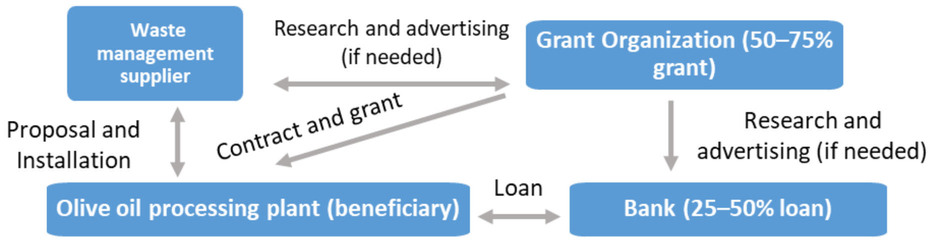
*Proposed financing model*

Co-financing in the form of "grant + loan/own funds" stands out as the best financing strategy for Business Case 3, as was the case with Business Case 1. It is suggested that 50–75% of the investment cost be financed by a grant to be provided by the local development agency/organization (or the Ministry of Industry and Technology) and the remainder by the industrialist's own funds or bank/TKK loan.

The cost of conversion of the extraction technique and waste collection pools that olive oil plants will construct in order to avoid generating black water under the business solution is calculated as USD 25,000 per plant. The grant to be provided for each plant will range from USD 12,500 to USD 18,750 in a program providing a grant in the range of 50–75%. The remaining co-financing USD 6,250–12,500 is an amount that can easily be put up by industrialist from their own funds. The local development agency (or the Ministry) should identify banks that are suitable and desirous for the extension of loans as part of this business case, and shall inform industrialists accordingly when suggesting loan possibilities.

If suppliers that can provide the necessary waste management system required for the business solution to the appropriate standards are identified and announced in advance, it will eliminate the problem of finding a reliable firm, which is a problem that is often faced by olive oil plants. Thus, the standards for the system and the pool to be built, the actions related to defective/deficient goods, and the existence of maintenance-repair facilities will be clearly demonstrated. Establishing a documented relationship between the grant organization and those firms through, for example, a protocol, does not seem to be necessary. Suppliers may submit their proposals to beneficiary olive oil plants and directly conclude agreements with them.

Figure 23: Financing model proposed for Business Case 3



| Business case 4: Extension of new olive varieties of high quality that are resistant to drought and suitable for machine harvesting | |
|---|---|
| A brief description of the solution and its goals | Setting up an *in vitro* laboratory and production station for saplings and virus-free materials of varieties such as Arbeqina I-18 and similar that need less cooling, that provide high quality olive oil and that are suitable for mechanized agriculture (1), providing support to growers to enable them to set up groves and nurseries for saplings to extend production (2) and offering support covering harvesting and pruning machines suited to those species (3). |
| What problem/obstacle does it propose to address in the region? | Plants cannot meet their cooling needs in winter due to the rising average temperature. High periodicity, and hence volatility in olive production in the region. Low olive oil quality as harvesting is not mechanized. Existing olive varieties are not suitable for mechanized agriculture. |
| Scale of implementation of the solution: | Individual (farmer), Corporate (farmers' group, company) |
| Implementation steps: | Supply of initial disease-free varieties, installation of laboratory (or utilization of the laboratories of existing university/research institute laboratories), sapling reproduction, development of a design for a grove facility with clone rootstock, distribution of saplings and allocation of grove facility (including drip irrigation), training of farmers for application and care, procurement of harvesting and pruning machinery (self-propelled) |
| What key product(s) will it affect? | Olive |
| What other links in the value chain will be affected? | Input suppliers, Cooperatives, Sapling growers, Farmers, Processors of Olive for Oil Production, Consumers |
| Climatic effects for which adaptation is sought: | Increase in winter temperatures |
| Examples of best practices/references | http://www.nedimfidancilik.com<br>http://hangizeytinyagi.com/haberoku.asp?id=174<br><br>Machinery picture down:<br>https://pellenc.com/za/produits/mavo-olive-harvester/ |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Olive and sapling growers, production and sales cooperatives, olive research institutes of the Ministry of Agriculture and Forestry and other individuals or company service providers |
| Input providers | Sellers of laboratory materials, raw material and technical equipment providers and operators (laboratory), manufacturers of olive harvesting and pruning machinery |
| Technical support services | Biotechnology departments of universities, olive research institutes |
| Administrative and structural supporters | Provincial and district directorates of the Ministry of Agriculture and Forestry, IBB |
| Finance providers | National and international finance institutions, local NGOs, development agencies |
| Incentive providers | Universities, olive research institutes, olive processing and marketing firms, and national olive and olive oil councils |

| Cost items - USD | |
|---|---|
| Installation of a tissue culture laboratory | 115,000 |
| Sapling production (2 million units) | 851,000 |
| Setting up a new olive grove (decare) | 722 |
| Training for farmers (per enterprise) | 75 |
| Procurement of olive harvesting and pruning machinery (self-propelled) (including training) | 720,000 |

| Existing Sources of Financing in the Region |
|---|
| Bank loans, loan extended by a public bank with interest subsidy |
| Local development agency (grant, project design, coordination) |
| KKYDP (grant) |
| STB, TUBITAK, TOB R&D Support |
| - |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 9,332,625 | Laboratory (115,000) + sapling production (851,000) + setting up groves (722x10,500) + training (75x875) + harvesting and pruning machinery (720.000) |
| Investment Capacity of the Business Plan (da) | 10,500 | Total area of olive groves in the Basin is 210,000 decares. Implementation area has been determined as 5%. |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 5% | Considering the topographic structure of the region and its social/structural dynamics, limiting implementation to 5% of the total area seems to be possible and can be considered as influential. |

| | | |
|---|---|---|
| Project implementation period (years) | 7 | Investments are envisaged to be made on an area of 1,500 decares each year. |
| Period during which the project will reduce climate risk for each beneficiary (year) | 10 | Clone rootstocks will begin bearing fruit in the third year after planting, and shall reach full yield in the fifth year. All groves will start bearing fruit within 10 years. |
| Anticipated Yield Increase (%) | 85% | Average yield of other varieties is 650 kg/da depending on periodicity whereas clone varieties can provide an average yield equal to 1,200 kg/da. |
| Anticipated number of beneficiaries (enterprises) | 875 | The total area of olive groves earmarked for oil production in the Basin is 210,000, and 10,500 decares, designated as the 5% implementation area, has been divided into an average of 12 da/enterprise. |
| Other anticipated results | Global competitiveness in olive oil, increased income for farmers and enhanced plant resilience, increase in oil quality, making product widespread, reduction in unit cost of olive oil | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | High financing need of farmers | ► | Development of investment financing mechanisms subject to appropriate conditions |
| Sustainability | Limited pool of experts specialized in the issue | ► | Training farmers in producing new olive varieties |
| Social | Lack of awareness among farmers, and absence of knowledge about varieties | ► | Awareness training. Demonstration of examples of best practices |
| Obstacles related to corporate/regulatory structure | Lack of materials derived from certified tissue culture and used for breeding, Import duties | ► | Making use of R&D and laboratory capabilities of the public sector |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | High Priority |
| What Else Can Be Done / Next Steps | - |

### Financing Strategy

New dwarf olive varieties with a high yield and low cooling need and that are resistant to heat are rarely seen in the KMRB, as is the case also for the rest of Turkey. In fact, Mediterranean countries that compete with Turkey are now replacing old varieties with these new varieties (mostly Arbequina), and are hence preparing for climatic risks while growing competitive products to meet the rising demand. Turkey, a major producer of olive and olive oil, is also expected to shift to the new olive varieties. The Basin may be transformed into an implementation area, and can serve as an example for the entire country in this regard.

This business solution takes an integrated approach to all phases of a new-to-the-Basin olive variety (Arbequina). The transition may be divided into three main phases. The financing needs for each group are as follows:

- ✓ Establishment of a tissue laboratory for the production of the new variety and the reproduction of saplings: A private company may be supported in the establishment of a laboratory for growing saplings and to grow the new variety through tissue cultures, in that there are already companies growing saplings after being designated as "authorized organizations" by the Ministry of Agriculture and Forestry in our country. The second alternative is to establish such laboratories in universities or olive research institutes in the province. Such laboratories would be able to import first certified rootstock saplings that are free of disease. The laboratory will also be able to set up the first application grove.
- ✓ Distributing the new variety to farmers and establishing new groves: These new varieties will be distributed to approximately 875 agricultural enterprises processing 5% of the area used for growing olive in the Basin. This distribution is proposed to be based on a reasonable fee, calculated taking account the cost of growing saplings. As the saplings are not for free, this will support the establishment of the sapling growing laboratory within the private sector in the form of a Public Private Partnership (PPP). There are activities that should be carried out prior to the distribution of saplings related to this olive variety, which will make a huge difference in terms of production and growth activities when compared to previous varieties:
    - Training of farmers (by the organization operating the laboratory)
    - Development of uniform designs (by the organization operating the laboratory or agricultural engineering-consulting company)

- Development and procurement of designs for a drip irrigation system (by the suppliers of irrigation systems)

- ✓ Procurement of self-propelled harvesting and pruning machinery suited to the new varieties: Another key aspect of the new dwarf olive variety is its suitability for pruning and harvesting with self-propelled machinery. This factor, which is very important in terms of yield and marketing, requires the procurement of harvesting and pruning machinery manufactured especially for the new variety. A machinery to be purchased for harvesting the first group of groves that will bear fruit from the third year of the project will be able to harvest all groves (1,500 decares) by employing a common utilization (leasing) method. Such machinery will need to be purchased and imported from abroad. One of the best methods for the procurement of these machinery, which can cost up to USD 700,000, would be procurement by a public agency and operation by a private sector entity. The machine may be leased out to the company that will operate the machine through a contract to be concluded based on a PPP model with a *purchasing option* (leasing) or *revenue-expenditure partnership,* so that ownership will be retained by the public sector. If the machine is required to be purchased by a venture capital company, it would be sufficient if a long-term loan with a 2-year grace period is lent to the company, removing the need for a PPP. The revenues earned through the use of the machine would serve as funds for the machines to be procured in subsequent years, irrespective of the method selected, including a PPP model based on public ownership or a private ownership-private leasing model.

Roles that different finance institutions may assume in this business solution are detailed below.

*Grants*

The necessary grants for this business solution would be available for public investments and property. Grants and/or support in kind offered by development and research institutions in the region and other national institutions and investment programs can be used for materials, equipment, logistics and the space that may be needed during the establishment of an *in vitro* sapling production laboratory. In addition, the training to be provided to farmers related to new olive varieties may be supported by similar organizations and/or multinational/international development agencies.

While existing agricultural consulting companies are capable of drawing up uniform designs for the new groves to be set up by farmers, this requirement can be easily met through the laboratory's internal resources and efforts, as the most appropriate and healthy technical requirements will be possible based on the information provided by the laboratory. Thus, it is believed that no additional support will be needed for the preparation of such uniform designs and application documents.

*Bank loans*

Banks in the region are capable of providing loans in the following categories for this business solution:

- Procurement of new saplings by farmers: Various banks offer loans with terms of up to 5 years for the financing of new certified varieties of saplings and for the establishment of groves. If the loan is extended by a bank, part of the cost of saplings would need to be supported through a grant based on the invoiced amount or directly at source (tissue culture station) in order to reduce the financial burden on the farmers. Investments such as soil preparation can be handled by the farmers themselves.

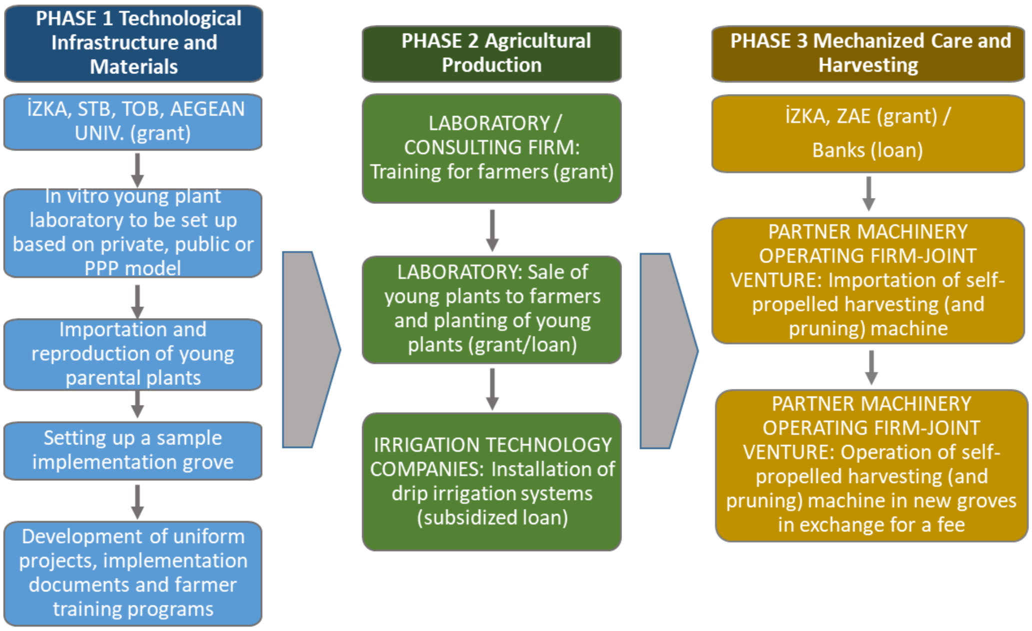
- Financing of drip irrigation systems: The new variety is ideal for drip irrigation systems. The fact that there is a shortage of water in the Basin makes it necessary to irrigate new groves by means of a drip irrigation method. The medium- and long-term investment loans offered by banks for irrigation systems function as insurance for the setting up of irrigation systems.

- Importation of self-propelled harvesting (and pruning) machine: If owned by the private sector, the company that purchases and operate the machine will need a letter of credit and a long-term loan with a low interest rate. It seems unlikely that such an important machine could be purchased without a letter of credit and a loan (a loan-value rate in the range of 50–75%). If the machine is to be purchased by a "*joint venture group*" to be formed by local producer organizations or olive oil companies, the level of company investment may be increased and a smaller loan may be needed. It would also be useful to promote the procurement among *angel investors* as a long-term investment opportunity.

*Proposed financing model*

In the light of the available information, the financing strategy designed for Business Case 4 is shown on the following diagram. All phases of this business solution can be carried out in full by organizations of different types (development agency, academia, ministries, international finance institutions, etc.), or only "Phase 1" can be completed, after which promotional campaigns may be launched to ensure that the other phases are executed by the private sector, farmers, producer organizations and the manufacturing sector. The olive industry is aware of the long-term and multi-faceted opportunities (in regards to climate, competition and profitability) offered by this business solution, and even the supply of certified local saplings subject to suitable conditions is regarded as a great opportunity for the sector. Activities such as the reproduction of saplings and the operation of harvesting machines that may require investments by the private sector or producer organizations will diminish the amount of public funds needed for the business solution, while also making a positive contribution to sustainability.

Figure 24: Financing model proposed for Business Case 4



| Business case 5: Development of efficient irrigation systems and infrastructure in the KMRB | |
|---|---|
| A brief description of the solution and its goals | To support surface and underground drip irrigation, drum drip and sprinkler irrigation systems in small and medium enterprises; establishment and propagation of fully automated irrigation systems; awareness training to promote reliable and efficient irrigation methods |
| What problem/obstacle does it propose to address in the region? | Management of water shortage and reduction of energy consumption through effective and efficient irrigation. Farmers should learn how irrigation should be performed (timing and quantity), depending on plant and soil characteristics rather than using conventional methods |
| Scale of implementation of the solution: | Individual (farmer) |
| Implementation steps: | To identify efficient irrigation methods depending on product, soil and topography; uniform designs for irrigation systems; training for farmers; agreements with appropriate institutions for the provision of grants and loans for farmers; installation and operation of irrigation systems. |
| What key product(s) will it affect? | Olive, fig, tomato, outdoor ornamental plants, fodder crops (for dairy farming) |
| What other links in the value chain will be affected? | Production, supply of irrigation systems |
| Climatic effects for which adaptation is sought: | Decline in precipitation, heat stress |
| Examples of best practices/references | http://www.zmo.org.tr/konular/index.php?kod=111 http://www.netafim.com.tr/story/kabal-projesi-yozgat |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Farmers, Producer Organizations |
| Input providers | Pipe, fittings and systems suppliers and implementers, firms supplying automation systems |
| Technical support services | Firms supplying irrigation and automation systems, provincial organization of the Ministry of Agriculture and Forestry, academia, relevant chambers |
| Administrative and structural supporters | Provincial and district directorates of the Ministry of Agriculture and Forestry, DSI, Municipalities |
| Finance providers | Ministry of Agriculture and Forestry and development agencies (grants), banks and TKK (loans) |
| Incentive providers | Agricultural industry processors and input suppliers, irrigation cooperatives, producer unions |

| Cost items, unit/USD | |
|---|---|
| Drip irrigation (USD/decare) | 138 |
| Sprinkling (USD/decare) | 117 |
| Drum irrigation (USD/decare) | 153 |
| Irrigation Automation (USD/decare) | 82 |
| Training (USD/20-strong group) | 400 |

| Existing Sources of Financing in the Region |
|---|
| Bank loans |
| Agricultural Credit Cooperatives: |
| Program for the Support of Young Farmers (grant) |
| KKYDP (grant) |
| Development agencies |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 1,453,374 | Financing 1,000 drop irrigation, 500 sprinkler and 500 automation systems, 200 drum irrigation systems for 2,700 enterprises through a 50% grant and a 50% subsidized loan; one-day training for 2,700 farmers, 7-day training for 20 agricultural engineers |
| Investment Capacity of the Business Plan (da) | 27,000 | Area of land in which the activities will be applied in each of the 2,700 enterprises: 10 decares |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 2.7% | 27,000 decares of total irrigated area (1,017 thousand decares) is envisaged. |
| Project implementation period (years) | 7 | |
| Period during which the project will reduce climate risk for each beneficiary (year) | 7 | |

| | | |
|---|---|---|
| Anticipated Yield Increase (%) | 20% | Average mixed yield to be provided by efficient drip, sprinkler, drum sprinkler, and automation systems has been calculated. |
| Anticipated number of beneficiaries (enterprises) | 2,700 | Drip irrigation for 1,000 enterprises, sprinkler system for 500 enterprises, automation systems for 500 enterprises, and drum irrigation systems for 200 enterprises are envisaged as part of the support program. |
| Other anticipated results | Higher yield and quality; low labor cost; less trips to and from the field; savings on time; recognizing and understanding harmony between water, plant, and soil; new job opportunities for agricultural engineers | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Financing needed | ► | Public or IZKA funds for training; bank loan for irrigation systems |
| Sustainability | Irregularity of water sources and supply; insufficiency of irrigation projects; lack of agricultural engineers specialized in irrigation | ► | Preparation of existing irrigation infrastructure projects in the region and project designing prior to training; training in irrigation projects for agricultural engineers |
| Social | Lack of awareness among farmers | ► | Awareness and knowledge training for farmers focusing on irrigation |
| Obstacles related to corporate/regulatory structure | - | | - |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | High Priority |
| What Else Can Be Done / Next Steps | Improvement of sources of irrigation water, utilization of filtration |

### Financing Strategy

Like the rest of Turkey, there are serious shortcomings and faults in the design of irrigation systems based on crop, soil composition and topography in the Kucuk Menderes River Basin, and in their implementation by individual farmers. This situation leads to an increase in the quantity of energy (electricity, diesel) used for irrigation, which leads to greenhouse gas emissions and necessitates the efficient use of existing water, which is gradually dwindling as a result of climate change in the region which is already suffering from water shortages. Business Solution-5 intends to resolve these problems permanently and to ensure its implementation in the field. Thus, water stress in plants resulting from climate change will fall alongside water and energy (diesel, electricity, fertilizer) costs while increasing their yield.

The Business Solution has two main components and the following financing methods are envisaged for these components:

- Training: It is envisaged that the first training targeting farmers will cover such topics as the water-soil-product relationship to ensure effective and efficient irrigation, an appropriate type of irrigation for specific products and amount and timing of irrigation, and the relationship between irrigation and the application of fertilizers. This training planned as part of the project is to be structured in one-day sessions for 20-person groups from 2,700 small- and medium-sized farmers (growing crops on 5–50 decares) that make use of irrigation on a total area of 1 million decares in eight districts in the Basin. Training may be provided by one or several consultants specialized in their fields with coordination by development organizations and the Provincial Directorate of Agriculture and Forestry.

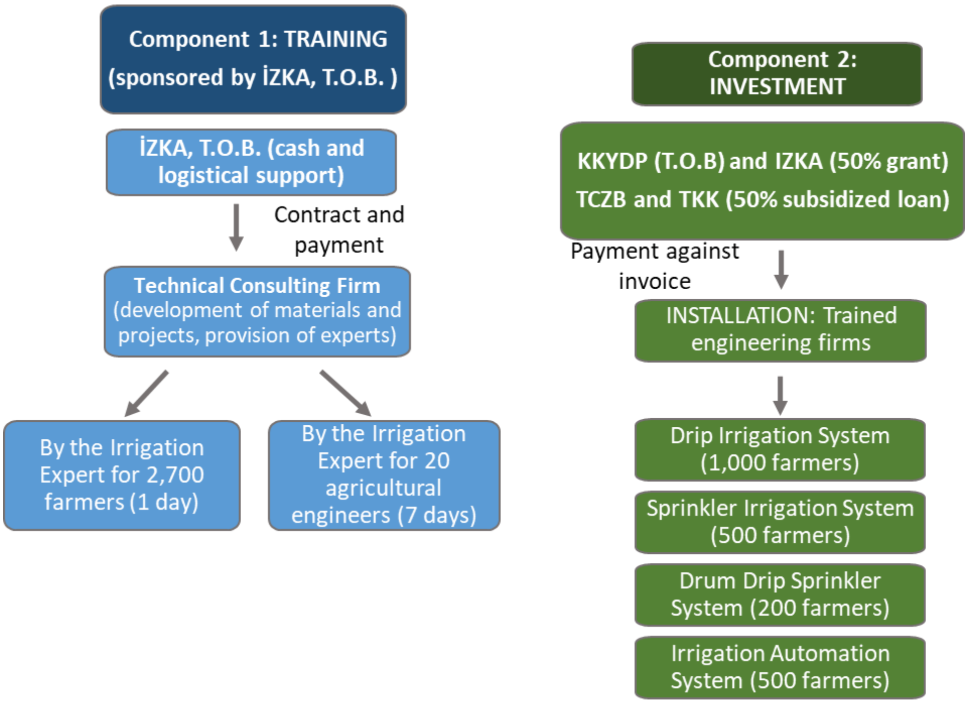
  The second training will target approximately 20 agricultural engineers (preferably graduates of agricultural irrigation departments) who are employed by irrigation system companies or who work independently in the Basin carrying out irrigation system projects for farmers. This training will focus on the drawing and implementation of irrigation system designs and will last 5–7 days. The level of awareness and knowledge among farmers will rise through these two complementary training programs, while enabling engineers selling such systems to farmers to install efficient and effective irrigation systems. The total time required for both training programs is approximately 142 working days (based on 20 participants in each group). Farmer training materials should be developed and irrigation designs should be drawn and prepared for the engineer trainings prior to both trainings.

- Extension of efficient irrigation systems: Farmers who have received training are expected to make the necessary investments required for the shift to modern and efficient irrigation systems, and such investments will be supported. A questionnaire will be applied during the training to farmers who are currently using irrigation in order to identify those who need investment support. A farmer who is currently engaged in modern and efficient irrigation practices will not need new investments. Support will be provided to farmers who use an improper irrigation method (system) or who need an automation system in order to help them switch to the new system. Another possibility is that a system may be set up for farmers who are currently irrigating part of their land, but who cannot do the same for the remaining part, despite their proximity to the water source. The ideal method would be to provide this support based on a co-financing model in the form of partial grant + loan/own funds. The grant may be provided by the KKYDP of the Ministry of Agriculture and Forestry, or jointly with development agencies and the IBB. The mechanization and irrigation system loans currently offered by banks can be considered appropriate financing facilities. A farmer with his/her own funds will not require the loan, and may use his/her own funds to finance the investment. In this context, the total budget proposed for the financing of irrigation systems on the business solution table above represents the cost of irrigation systems, structured as 50% grant + 50% loan. It is, however, estimated that the total financing need will be lower than this amount, as there may be farmers who prefer to use their own funds rather than taking out a loan.

*Proposed financing model*

On the following schema, the financing strategy that seems to be the best option for this business solution is shown as outlined above.

*Figure 25: Financing model proposed for Business Case 5*



| Business case 6: Supporting investments in infrastructure preventing loss of irrigation water (closed system irrigation) | |
|---|---|
| A brief description of the solution and its goals | Converting existing open canals in the Basin into a closed pressurized irrigation system |
| What problem/obstacle does it propose to address in the region? | Water losses resulting from evaporation, limited availability of modern irrigation facilities |
| Scale of implementation of the solution: | Public |
| Implementation steps: | Design - Contract Award - Implementation |
| What key product(s) will it affect? | Olive, fig, tomato, outdoor ornamental plants |
| What other links in the value chain will be affected? | Sustainable supply of processed products |
| Climatic effects for which adaptation is sought: | Temperature rise and declining precipitation |
| Examples of best practices/references | There are ongoing efforts to convert open canal irrigation structures in the region into underground pressurized irrigation systems. |
| Other anticipated results | Modernization of irrigation |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Farmers |
| Input providers | Contractors |
| Technical support services | General Directorate of State Hydraulic Works (DSI) or the IBB Water and Sewerage Department |
| Administrative and structural supporters | Ministry of Finance and Treasury |
| Finance providers | National and international finance institutions, public funds |
| Incentive providers | Local NGOs, Politicians |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Insufficient funds | ► | Long-term financing |
| Sustainability | Farmers' reluctance to pay for irrigation water | ► | Explaining advantages to farmers |
| Social | - | ► | - |
| Obstacles related to corporate/regulatory structure | Temporary uncertainties that may be faced due to a change in the Ministry's structure | ► | Clarification of the flow through protocols to be concluded by DSI and the Izmir Metropolitan Municipality |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | High Priority |
| What Else Can Be Done / Next Steps | Intra-field modern irrigation supports |

No financing strategy could be developed for this solution as it requires large-scale and multi-component investments by the public sector.

| Business case 7: Events intended to raise awareness on climate change at a local and national scale | |
|---|---|
| A brief description of the solution and its goals | Raising awareness on climate change at local and national scales, and extending actions such as public service announcements to raise awareness among individuals, conferences, TV programs and promotional activities |
| What problem/obstacle does it propose to address in the region? | Individuals have knowledge of climate change, but almost no idea or information about what kind of actions they can take. |
| Scale of implementation of the solution: | Public |
| Implementation steps: | Publication services to raise awareness |
| What key product(s) will it affect? | All key agri-products |
| What other links in the value chain will be affected? | All links of the chains |
| Climatic effects for which adaptation is sought: | All effects |
| Examples of best practices/references | - |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Farmers, consumers, input market, buyers, industrialists |
| Input providers | TV and media outlets |
| Technical support services | Publishers |
| Administrative and structural supporters | Public, Municipalities, Cooperatives |
| Finance providers | Public, National and international finance institutions, local NGOs, development agencies, public media outlets |
| Incentive providers | Agricultural sector, public agencies, municipalities, agricultural trade, local NGOs, private TV channels |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Financing needed | ▶ | Support |
| Sustainability | Events that are organized only once, or at very infrequent intervals, may not yield benefits. | ▶ | Long-term and frequent communication in order to raise awareness |
| Social | The society does not put much effort on measures due to the impact of climate change is seen in a long time, lack of awareness | ▶ | Effective and frequent communication in order to raise awareness in society |
| Obstacles related to corporate/regulatory structure | - | ▶ | - |

| Priority status in terms of E-S-E impact (high priority - priority - low priority) | High Priority |
|---|---|
| What Else Can Be Done / Next Steps | - |

No financing strategy could be developed for this solution as it requires large-scale and multi-component investments by the public sector.

| Business case 8: Implementation of herd management programs in medium-size dairy cattle businesses | |
|---|---|
| A brief description of the solution and its goals | Herd management and reproductive planning is a major requirement for sustainable dairy cow husbandry. Herd management involves such components as rumination and monitoring of mobility, milk yield, and reproductive control and monitoring. It is suggested that herd and reproduction management programs should be implemented to monitor and reduce decreases in milk and reproductive yieldresulting from climate change and increase animal health and welfare. |
| What problem/obstacle does it propose to address in the region? | To prevent decreases in milk and insemination yield resulting from climatic effects, to reduce animal diseases |
| Scale of implementation of the solution: | Individual (farmers with 50–100 milch cows) |
| Implementation steps: | Need analysis for individual enterprises, installation of the system, training in the operation of the system |
| What key product(s) will it affect? | Cow milk |
| What other links in the value chain will be affected? | Farmers, Milk Industry |
| Climatic effects for which adaptation is sought: | Average increase in temperatures |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Dairy cattle enterprises with a capacity of 50-100 milch cows (Enterprises with more than 100 cows currently use these programs. It does not seem to be appropriate for enterprises with less than 50 cows) |
| Input providers | Suppliers of herd management programs |
| Technical support services | Zootechnicians and veterinarians |
| Administrative and structural supporters | Provincial and district offices of the Ministry of Agriculture and Forestry, development agencies |
| Finance providers | Development agencies, Ministry of Agriculture and Forestry and IBB (grant), Banks and Agricultural Credit Cooperatives (loan) |
| Incentive providers | Agricultural Development Cooperatives, milk producers' unions, cattle breeders' unions |

| Cost items, unit (USD/per animal) | |
|---|---|
| Labor | - |
| Material, Installation and Training | 190 |
| Other | - |
| **Total** | **190** |

| Existing Sources of Financing in the Region |
|---|
| KKYDP (grant) |
| Bank loans |
| Agricultural Credit Cooperatives: |
| Development agencies |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 1,425,000 | Cost per enterprise USD (190x75) 14,250. |
| Investment Capacity of the Business Plan (number of animals) | 7,500 | The average number of milch cows in each of 100 enterprises is estimated to be 75. |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | | There is no information regarding the distribution of dairy cattle enterprises based on the number of animals in the Basin. |
| Project implementation period (years) | 1 | |
| Period during which the project will reduce climate risk for each beneficiary (year) | | Quantitative data related to decrease in climate risk due to increase in productivity and decrease in input cannot be calculated. |
| Anticipated Yield Increase (%) | 2–10% | A definite figure cannot be given, as it depends on many different variables. |
| Anticipated number of beneficiaries (enterprises) | 100 | This support is proposed to be provided for 100 enterprises in the Basin. |
| Other anticipated results | Farms with a higher level of knowledge and technology will switch to a more modern and efficient farm management method | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Financing needed | ► | Grant + loan model |
| Sustainability | Monitoring the effects of the system | ► | A follow-up report to be received 1 year later through the supplier |
| Social | Low technology used by farmers | ► | Selection of farmers with a high level of knowledge during the application process |
| Obstacles related to corporate/regulatory structure | - | ► | - |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | Low priority |
| What Else Can Be Done / Next Steps | Implementation Monitoring |

### Financing Strategy

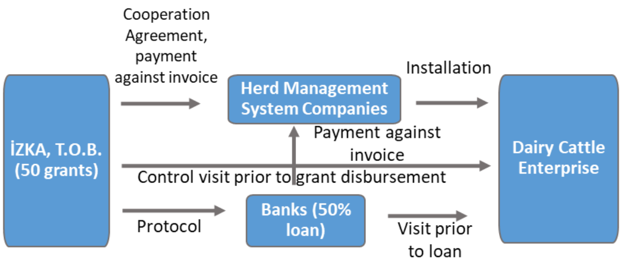
Dairy cattle husbandry is one of the sub-sectors making the highest contribution to greenhouse gas emissions and the greatest utilization of energy and resources in the Kucuk Menderes River Basin, which accounts for 9.5% of total cows' milk produced in Turkey. Thus, the primary objective of this business model is to mitigate the negative effects of climate change in husbandry enterprises using conventional husbandry techniques, while protecting such enterprises against the effects of climate change and benefiting from herd management technologies and encouraging their switch to a sustainable production mode. Herd management systems can monitor animal movements and the number of ruminations via chips planted in the animals, and can aid in the calculation of the nutrition, insemination, disease and stress parameters of animals, while also monitoring milk yield and quality an ensuring the optimum use of feed and other inputs. The software of the system can be downloaded onto computers, tablets or mobile phones.

The two primary costs of this system are the readable chips to be applied to the animals and different sections of the farm (milking system, water bottles, etc.) and the software that compiles and visualize data received from those chips. While the components of the system are priced separately, based on the total size of enterprises, cost per animal was calculated as USD 190 for an enterprise with 50–100 milch cows. Applications are envisaged to be collected by a grant organization as part of a project in the form of grant + loan + own funds and support will be provided for 100 enterprises with the ability to use such technologies.

*Proposed financing model*

It is observed that only farms that keep more than 100 cattle make use of herd management systems due to their sufficient financial resources. In fact, the KKYDP grant program of the Ministry of Agriculture and Forestry can support the cost of this system under heading of "fixed investments in agricultural production" in the Izmir province. However, there has been no project that has received support for a herd management system through this channel among the projects that have received grants in Izmir to date, as there are many different types of support in the KKYDP program. This being the case, development agencies will need to provide special financing for this solution, either alone or with the Ministry of Agriculture and Forestry, and to devise a financing model specific to the Basin. This model can be designed as 50% grant + 50% loan/own funds, and the total grant budget will be USD 712,500. The grant organization (a development agency in this example) is proposed to conclude a protocol with banks specific to this business solution for the remaining amount.

*Figure 26: Financing model proposed for Business Case 8*



| Business case 9: Promoting the use of different materials rather than soil in the production phase of outdoor ornamental plants | |
|---|---|
| A brief description of the solution and its goals | Installation of facilities to increase the production of such materials as turf, perlite, coco peat, etc. that may be used as an alternative to Basin soil for the growth of outdoor ornamental plants grown in pots, and the distribution of such materials to farmers. The Basin's fertile soil is used for growing plants in containers such as pots, and it is transported outside of the Basin with the end product. This loss of fertile soil, which is already depleted due to such factors as excessive production, erosion and floods, resulting partly from the negative effects of climate change, will be prevented. |
| What problem/obstacle does it propose to address in the region? | Prevention of the transportation of fertile soil outside of the Basin, which is of critical importance in terms of sustainability of production in the Basin |
| Scale of implementation of the solution: | Public |
| Implementation steps: | Installation of a facility for the multiplication of alternative materials and their supply to farmers and producer organizations |
| What key product(s) will it affect? | Outdoor ornamental plants |
| What other links in the value chain will be affected? | Suppliers of inputs for outdoor ornamental plants, farmers, producer organizations |
| Climatic effects for which adaptation is sought: | Preventing the loss of fertile soil dwindling because of erosion and irregular precipitation |
| Examples of best practices/references | - |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Cooperatives and producers' unions related to outdoor ornamental plants and their members |
| Input providers | Firm that will install the soil multiplication plant |
| Technical support services | Agricultural faculties of the universities in the region and junior vocational colleges in the region |
| Administrative and structural supporters | Research institutes and provincial/district directorates of the Ministry of Agriculture and Forestry |
| Finance providers | Development organizations, IBB, Ministry of Agriculture and Forestry |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Cost factor | ► | Provision of support for the offsetting of the cost difference with natural soil |
| Sustainability | Inability to ensure the sustainability of organic waste and organic materials | ► | An agreement should be reached with the IBB and all users |
| Social | Odor and preconceptions | ► | Necessary communication and increased awareness |
| Obstacles related to corporate/regulatory structure | Uncertainties that may be witnessed during the operation of the facility and its processes | ► | Cooperation and protocol with the academia and research institutions |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | Low priority |
| What Else Can Be Done / Next Steps | Efforts should focus on appropriate compositions alongside animal manure washed with materials consisting of materials as tundra soil and existing organic waste. |

No financing strategy for this solution could be developed at this stage as large-scale and multi-component investments by the public sector are required

| Business case 10: Extended use of renewable energy sources for product processing |
|---|

| Role in the Solution | Stakeholders Who Need To Play a Role/Cooperate in the Proposed Solution |
|---|---|

| | |
|---|---|
| A brief description of the solution and its goals | Grant support at a pilot stage to encourage the use of solar energy in tomato, dried fig, and olive oil plants due to the rising energy costs that will result from climate change |
| What problem/obstacle does it propose to address in the region? | Reducing costs from energy use |
| Scale of implementation of the solution: | Plants processing tomato for the production of tomato paste and dried tomato, dried fig production plants, olive oil production plants |
| Implementation steps: | Designing 100 kW systems and the installation of PV solar panels |
| What key product(s) will it affect? | Tomato (processed), fig (dried), olive (oil) |
| What other links in the value chain will be affected? | Product Processing |
| Climatic effects for which adaptation is sought: | Rising energy costs as a result of climate change |
| Examples of best practices/references | https://www.karacadag.gov.tr/Dokuman/Dosya/www.karacadag.org.tr_10_TY6E47EI_tarimsal_uretimde_gunes_enerjisi_kullanimi.pdf |

| | |
|---|---|
| Beneficiaries | Tomato, Fig and Olive Oil Processors |
| Input providers | Firms designing and supplying solar energy systems |
| Technical support services | Renewable energy consultancy firms, NGOs promoting solar energy |
| Administrative and structural supporters | Ministry of Agriculture and Forestry, Ministry of Energy and Natural Resources |
| Finance providers | Development agencies, KOSGEB, local NGOs focused on technology development and innovation, development banks, local power distribution company. |

| Annual initial installation cost items, unit/USD | |
|---|---|
| Labor | |
| Materials | |
| Training | |
| Total | 80,000 |

| Existing Sources of Financing in the Region |
|---|
| KOSGEB Energy Efficiency Support (50% grant) |
| TTGV Renewable Energy Support (interest-free loan) |
| Development Bank of Turkey (loan) |
| - |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 4,000,000 | Total investment cost for 50 enterprises (USD 80,000 per enterprise) |
| Investment Capacity of the Business Plan | | Investments in solar energy systems with different capacities will be needed for tomato, dried fig and olive oil enterprises of different capacities. |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | | |
| Project implementation period (years) | 2 | |
| Period during which the project will reduce climate risk for each beneficiary (year) | | |
| Anticipated Yield Increase (%) | 50% | |
| Anticipated number of beneficiaries (enterprises) | 50 | 10 enterprises processing tomato, 15 enterprises producing dried fig and 25 enterprises producing olive oil will be identified. |
| Other anticipated results | Energy costs of the enterprises will fall and a significant contribution to the national economy will be made. The fact that the cost of solar panels tends to decline will extend this activity. | |

| Challenges/obstacles to the solution | | Proposed Solutions |
|---|---|---|
| Economic | Investment costs, which are relatively high | Development of new panels and storage capabilities |
| Sustainability | Lack of efficient maintenance and repair | Possibility of selling surplus energy not used for production |
| Social | Preconceptions regarding the innovative structure | Information regarding awareness and social effects |

| | | | |
|---|---|---|---|
| Obstacles related to corporate/regulatory structure | It may occasionally be necessary to sell generated energy to the national grid | ▶ | Works to be undertaken with the local power distribution company |
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | Priority | | |
| What Else Can Be Done / Next Steps | Carrying out the necessary preliminary studies with the local power distribution company | | |

## Financing Strategy

Rising costs of enterprises as a result of increased demand for energy, and greenhouse gas emissions originating from the generation of power from oil leads to an increased need for closed-circuit renewable energy solutions for individual enterprises. It is proposed that support be provided to enterprises processing key agri-products selected for KAPRA with regard to investments in the generation of power from solar energy in the food processing sector, as the largest industrial branch in the Kucuk Menderes River Basin. Support in the form of grants + soft loans will be provided for 50 food enterprises selected through a call for applications in order to finance their investments in photovoltaic (solar panel) energy investments with a maximum capacity of 100 kW power generation capacity.

The average cost of investment per enterprise was calculated as USD 80,000 for this business solution; this amount includes the costs of studies and system installation.

### *Loan Facilities*

As commercial bank interest will be high for the part of the business solution to be financed through a 50% loan (approximately USD 40,000 per enterprise), medium-long term finance facilities, including low-interest or interest-free facilities lent by international development and finance institutions through banks in Turkey were explored.

The Development and Investment Bank of Turkey (TKB), one of the two leading development banks in Turkey, uses renewable energy funds received from the Japan Bank for International Cooperation (JBIC) and Islamic Development Bank in August 2018 to finance investments into energy efficiency and power generation plants that make use of renewable energy sources to be made by the private sector. The Industrial Development Bank of Turkey, the other development bank, leads the market in renewable energy investments among all the development banks. If the Business Solution can be transformed into a program call and cooperation protocol, financing based on this Business Solution will be possible through development banks.

Another source of funding may be the interest-free Renewable Energy Support Programs offered by local technology foundations. This program intends to contribute to the reduction of greenhouse gas emissions and to support investment projects related to the generation of energy from such renewable energy sources as wind, solar, biomass, biogas and geothermal, subject to suitable conditions. A maximum 50% of this project budget is financed by loans in this product and the line of credit may be up to USD 1 million. The loan can be repaid in 4 years, with a one-year grace period. Technology Development Foundation of Turkey (TTGV) charges 6% commission (service fee) over the loan amount. It is believed that this commission rate can be reduced if a cooperation agreement specific to this Business Solution is concluded.

### *Grants*

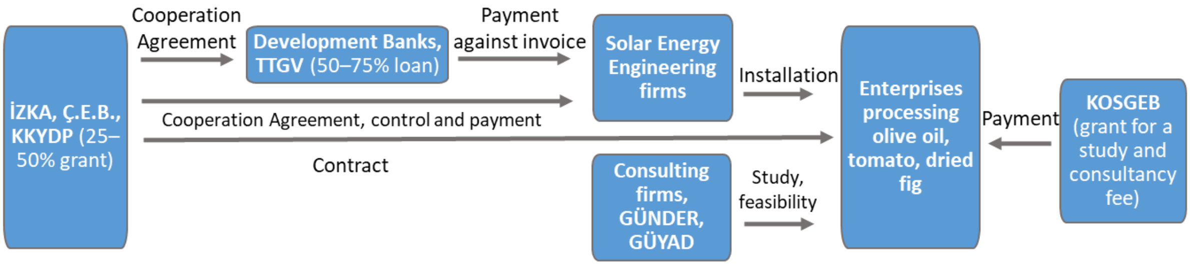
The Ministry of Agriculture and Forestry (TOB) and KOSGEB are the two organizations offering grants to SMEs engaged in the processing of agricultural products that are seeking to finance investments in solar energy, in addition to above listed means available for the Basin regarding loan mechanisms. TOB distributes grants through KKYDP introduced in previous business solutions. Under this program, a maximum 50% (TRY 750,000) grant is provided for projects valued up to TRY 1,500,000 proposed by enterprises engaged in the processing of agricultural products. This maximum amount is more than sufficient for the financing of this Business Solution.

Another grant facility is KOSGEB's SME Energy Efficiency Support, which can be provided not to cover physical investment cost, but for preliminary and detailed studies and consultancy fees that may be required prior to implementation. The maximum grant amount is TRY75,000 for up to 50% of these costs.

*Proposed financing model*

In light of the above information, it is believed that the best financing model for this business solution is a grant covering 25–50% of the project cost (approximately USD 20–40,000) and a loan covering the remaining amount (USD 40–60,000). While the grant organization may be the development agency, which will directly handle project design and call, it is possible to gain additional funding through KKYDP grants provided by the Ministry of Environment and Energy and the Ministry of Agriculture and Forestry. The loan amounts, excluding grants, can be provided by development banks and NGOs with access to the funds offered by international institutions, subject to reasonable conditions. In any case, it would seem feasible that support could be obtained from KOSGEB for costs related to studies and consultancy fees for projects.

*Figure 27: Financing model proposed for Business Case 10*



| Business case 11: Replacing local olive varieties that are vulnerable to climate change in the region | |
|---|---|
| A brief description of the solution and its goals | Transforming existing olive varieties that have a high cooling need, low oil quality and high periodicity into varieties that have lower periodicity, low cooling need and high yield through grafts. |
| What problem/obstacle does it propose to address in the region? | Cooling need and periodicity, flowering period |
| Scale of implementation of the solution: | Individual (farmer) |
| Implementation steps: | Training, awareness activities, grafting on farms |
| What key product(s) will it affect? | Olive (for oil) |
| What other links in the value chain will be affected? | Farmers, Olive oil processors and exporters |
| Climatic effects for which adaptation is sought: | Cooling need (increase in winter temperatures) and temperature rise during flowering period |
| Examples of best practices/references | Araújo M., Santos C., Dias M.C. (2018) Can Young Olive Plants Overcome Heat Shock?. In: Alves F., Leal Filho W., Azeiteiro U. (eds) Theory and Practice of Climate Adaptation. Climate Change Management. Springer, Cham.<br>Josyane Ronchail et al. (2014). Adaptability of Mediterranean Agricultural Systems to Climate Change: The Example of the Sierra Mágina Olive-Growing Region (Andalusia, Spain). Part II: The Future, Weather, Climate, and Society, 6(4): 451-467. https://journals.ametsoc.org/doi/pdf/10.1175/WCAS-D-12-00045.1 |

| Role in the Solution | Stakeholders Who Need To Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Olive Growers |
| Input providers | Olive oil research institutes |
| Technical support services | Olive research institutes, universities |
| Administrative and structural supporters | Provincial and district directorates of the Ministry of Agriculture and Forestry, IBB |
| Finance providers | Olive research institutes, development agency |
| Incentive providers | Companies processing and marketing oils, national olive and olive oil councils, cooperatives |

| Cost items, unit (da) /USD | |
|---|---|
| Labor | - |
| Grafting material and pruning shears | 27 |
| Training (per farmer group) | 400 |
| Other (support for income loss) | 85 |
| Total | 512 |

| Existing Sources of Financing in the Region |
|---|
| Support Provided by TOB |
| KKYDP |
| Young Farmer Support |
| Olive agricultural sales cooperatives (through purchases) |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 1,193,600 | Training for groups of 20 farmers (USD 17,600), grafting for 10,500 (USD 283,500), and support for income loss for the period in which grafted trees will not bear fruit (USD 892,500). USD 238,000 of financing will be needed for each year of the project, to be implemented over 5 years. |
| Investment Capacity of the Business Plan (da) | 10,500 | To be implemented on 5% of the 210,000 decares of olive groves (grown for oil production) in the Basin. |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 5% | Considering the topographic structure of the region and its social/structural dynamics, limiting implementation to 5% of the total area seems to be possible and can be considered as influential. |
| Project implementation period (years) | 5 | The trees in all olive groves, with an average area of 12.5 decares, will be replaced with new varieties in 5 years (2.5 decares per year). |
| Period during which the project will reduce climate risk for each beneficiary (year) | 8 | All trees will reach economic yield in the 8th year. |
| Anticipated Yield Increase (%) | 25% | The average yield of olive oil will rise by 25% in the groves in which the existing varieties are replaced with new varieties. |
| Anticipated number of beneficiaries (enterprises) | 875 | Calculated based on an average area of 12.5 decares |
| Other anticipated results | - | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Income loss incurred by farmer during grafting | ► | Support for income loss |
| Sustainability | Insufficient specialized human resources | ► | Training in grafting and pruning |
| Social | - | | - |
| Obstacles related to corporate/regulatory structure | - | | - |

| Priority status in terms of E-S-E impact (high priority - priority - low priority) | High Priority |
|---|---|
| What Else Can Be Done / Next Steps | Monitoring grafted groves |

### Financing Strategy

The most important requirements of the olives grown for oil sector, selected as one of the key products in the region, is to replace the existing olive varieties in the Basin with varieties that have low cooling needs, that are not significantly affected by periodicity, that have a high oil yield and high quality, and that are suitable for mechanized farming, or to improve the existing varieties for the same purpose. Business Case 4, presented above, involves the growth of new olive varieties in the Basin and ensuring the formation of new groves after the distribution of the new varieties to farmers, whereas this business solution involves grafting existing trees with similar varieties (Arbequina, etc.), avoiding the need to uproot them. This method involves pruning mature trees with a low yield, selected from within existing olive groves, in order to prepare them for grafting, and subsequently grafting new varieties onto the pruned trees.

The program will be implemented on a total area of 10,500 decares owned by approximately 875 farmers, similar to Business Case 4. Business Case 4 is planned to be implemented over a period of 7 years on a total area of 1,500 decares (12.5 decares per farmer) annually, whereas the replacement program will be implemented on a total area of 2,100 decares (2.5 decares per farmer) annually. Only mature trees with a low yield will be pruned and grafted rather than the entire grove, while other trees will continue to bear fruit in their present condition. As a result, farmers will replace their entire groves over an approximate period of 5 years, without losing income as a whole. That said, a grant of USD 85 per decare is anticipated as "*support for loss of income loss due to grafting"* in order to encourage farmers to take advantage of this business solution, as farmers will suffer a loss of income during the process of replacement through grafting.

The grafts to be used for new varieties and the pruning shears to be used prior to grafting are the main items to be financed in this business solution. In fact, many farmers in the basin already have grafting shears. As this business solution provides an opportunity to teach proper grafting techniques for new olive varieties, in addition to grafting, which is its primary objective, pruning shears will be distributed to farmers for the partial pruning and replacements to be made each year. The necessary grafts will be multiplied and provided by olive research institutions. Pruning shears can also be purchased by the same institute(s) or development agencies. The total cost envisaged for grafts and pruning shears is USD 27 per decare.

The success of this business solution will depend on the proper grafting and the training of farmers in new varieties. Thus, the cost of one-day training for 20 farmers in groups, to be provided by an institute or another organization, is calculated as USD 400 per group.

#### *Existing Public Support*

The Ministry of Agriculture and Forestry (for 2018) makes the following support payments to olive farmers upon their applications for different purposes. Payments for the rehabilitation of conventional gardens, as one such support payment, are paid in return for rejuvenation pruning on a minimum of 1/5 of an olive grove, whereas support payments for diesel oil-fertilizer and olive oil differential are paid in all cases. The Ministry provides support for entities authorized by the Ministry on a per sapling basis for the production of young grafted plants and grafts. The table below indicates that the costs involved in grafts and grafting are almost paid for in full under a business solution aimed at replacing trees with new varieties capable of adapting to climate change. Thus, no additional source of financing will be needed to cover grafting costs, aside from funds to cover the cost of the pruning shears.

*Table 25: Type of Government Supports and Amounts of Payments*

| Type of Support Payment | Amount and Unit of Support Payment |
|---|---|
| Support Payment for Diesel Oil and Fertilizer | TRY 14/decare |
| Basin-based Differential Payment Support | 80 kurus/kg (olive oil) |
| Setting up a Grove with Dwarf and Semi-dwarf Sapling Varieties | Standard sapling TRY 100/da<br>Certified TRY 400/da |
| Setting up a Grove with Other Sapling Varieties | Standard sapling TRY 100/da<br>Certified TRY 280/da |
| Rehabilitation of Traditional Olive Groves | TRY 100/da |
| Support for the Production of Young Locally Certified Plants (for authorized organizations) | Grafted sapling TRY 1/unit<br>Non-grafted sapling TRY 0.5/unit |

There are three items for which additional financing is needed in order to put the business solution into practice and to achieve its objectives: pruning shears (total amount approximately USD 11,812), practical training to be provided to farmer groups (total amount USD 17,600), and additional support to be provided to compensate for loss of income resulting from grafting (total amount USD 892,500). The first two costs will need to be financed as a lump-sum amount in the first year of implementation, whereas 5 years of financing for loss of income, as the third and highest need, be in the form of equal amounts each year (USD 178,500). Thus, additional financing to the tune of USD 207,912 in the first year and USD 178,500 in each of the subsequent 4 years will be needed for this business solution, which is crucial for the sustainability of olive growing for the production of olive oil in the Basin, and this is in addition to the support provided by the Ministry of Agriculture and Forestry.

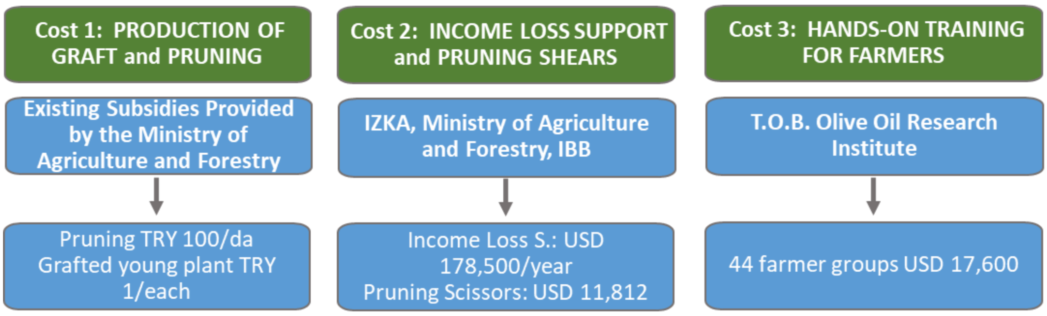
*Proposed financing model (Multi-Stakeholder Public Funding)*

As shown below, a model in which multiple public agencies or entities with the status of a public agency share different costs is proposed for this business solution. According to this, graft and pruning supports pursuing the same objective as this business solution, and which the Ministry of Agriculture and Forestry uses to encourage farmers to replace their trees with new varieties, can be successfully implemented by combining them with;

- ✓ support payment for loss of income, distribution, distribution of pruning shears (by the development agency and/or IBB)
- ✓ the training of farmers (by olive research institutes reporting to the Ministry)

. Thus, the rehabilitation of olive groves through pruning and graft support payments provided by the Ministry of Agriculture and Forestry is moving forward very slowly in the Basin.

*Figure 28: Financing model proposed for Business Case 11*



| Business case 12: Terracing of existing inclined groves | |
|---|---|
| A brief description of the solution and its goals | Terracing of olive groves and fig orchards on hilly areas. Olive and fig are mostly grown in the region's hilly areas. Dikes and terraces will be formed in both existing and new orchards in inclines of between 21 and 60% in order to hold precipitation water. |
| What problem/obstacle does it propose to address in the region? | Erosion, failure to make efficient use of precipitation water |
| Scale of implementation of the solution: | Individual (farmer) |
| Implementation steps: | Designing, terracing |
| What key product(s) will it affect? | Olive, fig |
| What other links in the value chain will be affected? | Farmer |
| Climatic effects for which adaptation is sought: | Irregular precipitation, decline in precipitation, heat stress |
| Examples of best practices/references | http://www.dunyagida.com.tr/haber/cevre-dostu-zeytin-yetistiriciligi-ve-zeytinyagi-uretimine-bir-model/8280 |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Olive and fig growers |
| Input providers | Contractors |
| Technical support services | Development agency, provincial/district agriculture and district directorates |
| Administrative and structural supporters | Provincial and district directorates of the Ministry of Agriculture and Forestry, IBB |
| Finance providers | Development agency, Ministry of Agriculture and Forestry, IBB |
| Incentive providers | Agricultural industry processors and input suppliers, producer unions, chambers of industry |

| Cost items, USD/unit | |
|---|---|
| Labor (USD/decare) | 127.7 |
| Materials | - |
| Training in Erosion and Irrigation (USD/person) | 10.6 |
| Other | - |
| Total | **138.3** |

| Existing Sources of Financing in the Region |
|---|
| Support Provided by TOB, KKYDP |
| Young Farmer Support |
| Development agencies |
| Banks |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 1,287,234 | Total cost of terracing: USD 1,277,000<br>Total cost of training: USD 10,600 |
| Investment Capacity of the Business Plan (da) | 10,000 | 1,000 enterprises with an average grove area of 10 decares |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | | |
| Project implementation period (years) | 7 | To be implemented on approximately 1,400 decares |
| Period during which the project will reduce climate risk for each beneficiary (year) | 10 | |
| Anticipated Yield Increase (%) | 15% | Effective and balanced irrigation, increase in product yield as a result of dwindling loss of fertile soil |
| Anticipated number of beneficiaries (enterprises) | 1,000 | 1,000 enterprises with groves on inclines of between 21 and 60% in the Basin |
| Other anticipated results | Effective weed control, facilitation of harvesting and transportation, reduction of erosion | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Financing needed | ► | A model with multiple stakeholders and co-financing |
| Sustainability | - | | - |
| Social | Lack of awareness among farmers | ► | Awareness training |
| Obstacles related to corporate/regulatory structure | - | | - |

| Priority status in terms of E-S-E impact (high priority - priority - low priority) | Priority |
|---|---|
| What Else Can Be Done / Next Steps | Awareness raising with support from producer organizations and chambers of industry |

## Financing Strategy

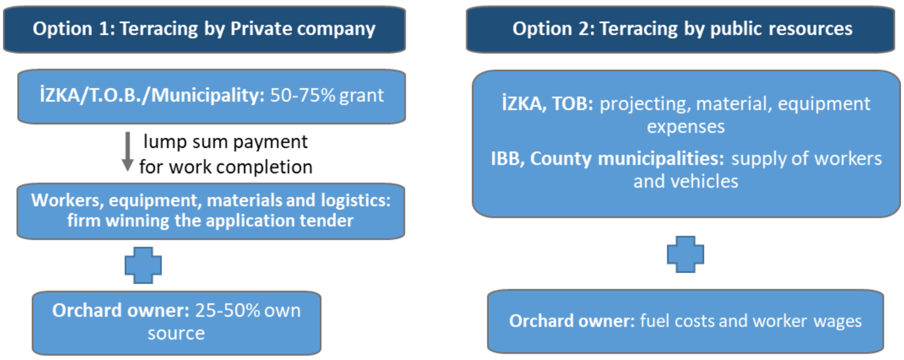
A significant proportion of the olive groves and fig orchards in the Kucuk Menderes River Basin are located on hilly areas, and their soil suffers from serious erosion. If these areas, which rely mostly on natural rainfall for irrigation, can make maximum use of the dwindling precipitation as a result of climate change, it would be a crucial factor for the sustainability of production in these areas. Terracing is proposed for existing and new groves with inclines of between 21 and 60% in order to hold rainfall through this business solution. The objective of this project is to terrace olive groves and fig orchards with an average area of 10 decares per grove, owned by approximately 1,000 enterprises in the Basin, in order to protect around 10,000 decares against erosion and drought.

The main cost component of terracing is labor and the timber posts that will be needed to form the terraces. This may occasionally involve also the use of machinery. There are engineering companies that can provide services for the formation of terraces. Another cost component foreseen for this business solution is one-day awareness raising training for enterprises in the Basin that do not presently consider terracing necessary and are insufficiently aware of erosion and the benefits of efficient irrigation.

### *Proposed financing model*

The total financing required for terracing and awareness training, as the two main components mentioned above, have been calculated as USD 1,277,000 and USD 10,600, respectively. As it is assumed that it will take seven years to complete the terracing of the entire implementation area, and so 1/7 of this amount (USD 182,428) will be needed every year. It has been concluded that the chance of finding a source of funding for this business solution would be slim, in that terracing activities would not be seen by the banking community as an activity generating a direct and visible source of revenue. Thus, terracing carried to prevent erosion may be considered as both a commercial investment, in that it would increase farmer revenues, and a public service. The provision of more than half of the terracing cost (e.g. 50–75%) in the form of a grant, with the balance covered by farmers keen of taking on this solution, therefore, seems to be a "feasible" approach. If this seems infeasible, the second option would be for the design, labor, tools, equipment and materials needed for terracing to be provided directly by the project's public stakeholders, implementing a model in which the enterprise owner would be required to pay only the workers' wages and the fuel costs pertaining to the terracing activity.

*Figure 29: Financing model proposed for Business Case 12*



| Business case 13: Extension of efficient and conscious use of fertilization and plant protection (pesticide) methods sensitive to the environment and climate | |
|---|---|
| A brief description of the solution and its goals | Development and promotion of environment-friendly fertilizers specific to individual products and suitable for soil structures; utilization and propagation of plant protection products in accordance with a cultural and chemical pesticide prospectus; minimizing the effects of climate change and environmental pollution by raising farmer awareness and knowledge in these activities that generate greenhouse gas emissions and that requires high energy use, and thus preventing drops in agricultural yield |
| What problem/obstacle does it propose to address in the region? | Loss of yield, energy, and resources resulting from excessive or insufficient use of fertilizers, pests, greenhouse gases originating from the production and use of granulated fertilizers |
| Scale of implementation of the solution: | Individual (farmer) |
| Implementation steps: | Training (1 day) |
| What key product(s) will it affect? | Olive, fig, outdoor ornamental plants, tomato, fodder crops for cow milk |
| What other links in the value chain will be affected? | Farmer, input market, all other segments of society |
| Climatic effects for which adaptation is sought: | Increase in plant stress, diseases and pest population as a result of rises in temperatures and precipitation |
| Examples of best practices/references | EFSE Farmer Training: http://www.profitraktor.com/icerik/11776/qnb-finansbanktan-ciftcilere-tarimsal-okuryazarlik-egitimi |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Farmers |
| Input providers | - |
| Technical support services | Universities, consulting organizations |
| Administrative and structural supporters | Provincial and district directorates of TOB, IBB |
| Finance providers | Development agencies, local NGOs and professional organizations, IBB |
| Incentive providers | Fertilizer and pesticide industrialists, producer unions, cooperatives, chambers of commerce |

| Cost items, USD/unit | |
|---|---|
| Labor | - |
| Material (per group) | 100 |
| Training (per group) | 400 |
| Other (travel, accommodation, per diem) | 400 |
| Other (development of training materials) | - |
| Total | **900** |

| Existing Sources of Financing in the Region |
|---|
| Publication Support Provided by the Ministry of Agriculture and Forestry |
| Regional Development Agencies |
| - |
| -- |
| |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 72,000 | Preparation of materials, training and other costs for 80 training groups |
| Investment Capacity of the Business Plan (da) | | As the farmers in very different profiles and that grow different products will benefit from the program, no capacity measurement could be made |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 6% | Calculated taking into account all 26,944 active farmers in the Basin. |
| Project implementation period (years) | 2 | |
| Period during which the project will reduce climate risk for each beneficiary (year) | 5 | |
| Anticipated Yield Increase (%) | 10% | |
| Anticipated number of beneficiaries (enterprises) | 1,600 | |
| Other anticipated results | Reduction of environmental pollution, lesser degradation of ecological equilibrium | |

| Challenges/obstacles to the solution | | Proposed Solutions |
|---|---|---|
| Economic | Financing and logistical needs | Support from public agencies and NGOs |
| Sustainability | - | - |
| Social | Inviting farmers to take part in training and travel required | Professional agricultural organizations, cooperatives and unions |
| Obstacles related to corporate/regulatory structure | - | - |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | High Priority |
| What Else Can Be Done / Next Steps | - |

### Financing Strategy

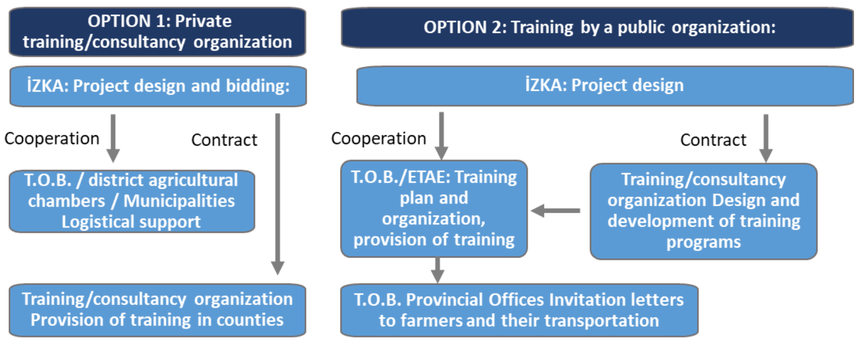
Plant nutrition (artificial fertilizer) and plant protection (pesticides) are the two indispensable inputs in conventional agriculture. The fact that climate change leads to temperature rise, dwindling precipitation, and irregular atmospheric events makes it vital that these products be used in a conscientious manner. Energy used during the production of artificial fertilizers and pesticides and the resulting emissions and gases released during their application, along with the related environmental pollution, bring about climate change and serious threats to human and environmental health. Accordingly, raising awareness and increasing knowledge among farmers is essential for the Basin.

Farmer training is the only component requiring financing in this business solution. Training will be provided for a total of 1,600 farmers, with approximately 200 farmers engaged from each of the eight districts in the Basin. Twenty farmers will attend each training session. Training is proposed to be provided by a specialized consulting and engineering firm or by organizations engaged by the project owner. Training may also be provided by making use of the publication services of public agencies (TOB and its sub-divisions). In such cases, hiring a professional organization experienced in agricultural training for the development of the content, methodology and training materials will enhance the effects and memorability of training.

*Proposed financing model*

As mentioned above, it is envisaged that all the necessary financing will be provided by public agencies or entities with the status of a public agency, as the provision of such training may be regarded as a public service. Obtaining support from an organization specialized in the training of farmers in the design, preparation and provision of training is seen as an effective method. It would be beneficial to obtain consulting services from a private company for the design of the training, materials and methodology, even if the training is to be provided by the publication and training department of the Ministry of Agriculture and Forestry or agricultural research institutes in the region. In conclusion, USD 72,000 will be spent within the 2-year implementation period if training is provided based on Option 1 below, or approximately USD 8,000 will be spent for the design, methodology and material development if Option 2 is preferred, with the remaining costs (instructors, logistics, etc.) funded by existing public agencies. Meeting/conference rooms in the premises of public agencies in the counties may be used as classrooms for the provision of training, without incurring additional costs.

*Figure 30: Financing model proposed for Business Case 13*




| Business case 14: Collection of animal waste for biogas production | Role in the Solution | Stakeholders Who Need To Play a Role/Cooperate in the Proposed Solution |
|---|---|---|

| | |
|---|---|
| A brief description of the solution and its goals | Reducing environmental pollution and greenhouse gas (methane) emissions by providing financial support for the installation of a small-sized biogas collection units that meet the energy (gas) needs of small- and medium-sized enterprises (30–100 milch cows) |
| What problem/obstacle does it propose to address in the region? | Greenhouse gas (methane) emissions, environmental pollution, rising energy costs of farms |
| Scale of implementation of the solution: | Individual (farmer) |
| Implementation steps: | Design, Installation and Implementation Training (provided by the installation company) |
| What key product(s) will it affect? | Milk (cow) |
| What other links in the value chain will be affected? | Dairy Husbandry Enterprises, Enterprises in the Vicinity of Animal Husbandry Enterprises, Individuals, Consumers |
| Climatic effects for which adaptation is sought: | Greenhouse gas (methane and carbon dioxide) emissions, environmental pollution |
| Examples of best practices/references | http://www.enerjigunlugu.net/icerik/20895/izmire-4-mwlik-biyogaz-elektrik-santrali-kurulacak.html |

| | |
|---|---|
| Beneficiaries | Dairy Husbandry Enterprises |
| Input providers | Biogas Collection and Energy Generation Plant Engineering Firms |
| Technical support services | - |
| Administrative and structural supporters | Provincial and district directorates of the Ministry of Agriculture and Forestry, Ministry of Energy and Natural Resources, provincial and district directorates of the Ministry of Environment and Urbanization, Municipalities |
| Finance providers | Banks, development agencies, Ministry of Agriculture and Forestry |
| Incentive providers | Ministry of Energy and Natural Resources, Ministry of Environment and Urbanization |

| Cost items, USD/unit | |
|---|---|
| Labor (per enterprise) | 4,255 |
| Material (mixer, separator, discharge pump) (per enterprise) | 16,170 |
| Training | - |
| Other (manure pits and gas storage) (per enterprise) | 12,766 |
| Other | - |
| Total | **33,191** |

| Existing Sources of Financing in the Region |
|---|
| KKYDP (grant) |
| Development agencies |
| - |
| - |
| - |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 3,319,149 | A third of the total investment cost (approximately USD 1.1 million) will need to be financed every year |
| Investment Capacity of the Business Plan (number of animals) | 6,500 | An average of 65 animals was calculated for each of the 100 enterprises |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | | |
| Project implementation period (years) | 3 | It is envisaged that approximately 33 enterprises will be included within the scope to the program each year. |
| Period during which the project will reduce climate risk for each beneficiary (year) | | |
| Anticipated Yield Increase (%) | | |
| Anticipated number of beneficiaries (enterprises) | 100 | Biogas collection plants are envisaged for 100 enterprises willing to participate in the project in the Basin. |
| Other anticipated results | - | |

| Challenges/obstacles to the solution | Proposed Solutions |
|---|---|

| | | | |
|---|---|---|---|
| Economic | As the recovery of the cost of investment through operation will take years, financing of the investment costs | ► | Part of the project (preferably 50%) should be supported by means of a grant |
| Sustainability | Maintenance of a biogas collection system | ► | A long-term maintenance commitment by the firm that will install the plant |
| Social | - | | - |
| Obstacles related to corporate/regulatory structure | - | | - |

| | |
|---|---|
| Priority status in terms of climate adaptation (high priority - priority - low priority) | Low priority |
| What Else Can Be Done / Next Steps | Informing farmers about the utilization of waste animal manure after its use in the biogas facility as an organic fertilizer for cultivated land |

## Financing Strategy

According to statistical data from European Union countries, almost 60% of the greenhouse gas released by the agriculture sector is emitted from husbandry enterprises, and 26% of the greenhouse gas they emit is generated by animal manure and released in to the atmosphere (EuroStat, 2017). Accordingly, controlling the manure generated by the dairy cattle husbandry sector, as a producer of a key product in the Basin, and converting the methane gas released by the manure into energy that can be used on farms is of crucial importance in mitigating the effects of climate change and cutting the rising energy costs resulting from climate change. In addition, there are many cross-benefits, in terms of eliminating the adverse effects of environmental pollution and manure on soil and water, in taking manure to a closed system to generate biogas.

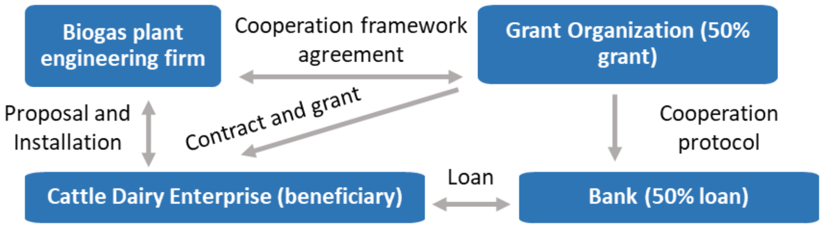
This business solution involves the installation of a small biogas collection unit that will ensure the gases generated by small- and medium-sized dairy cattle enterprises (with 30–100 milch cows) are collected and stored for the farm's own consumption. Plants that convert biogas into electrical energy may be more attractive for larger farms. The initial investment costs of such facilities are, however, very high, and a large quantity of manure is required. In addition, other vegetative ingredients may be needed in order to increase the quality of gas obtained from manure, which can then be transformed into electrical energy. Thus, Business Case 14 proposes an investment only for collection and storage of biogas for small- and medium-sized enterprises.

### *Proposed financing model*

The recovery of investments made for the installation of a biogas collection plant depends on the quantity of gas that can be collected, but it can take many years (8–12 years). Thus, a partial grant is needed to encourage farmers to make such an investment, amounting to USD 33,191 per enterprise. A grant could be considered meaningful based on the potential climatic and social benefits of such an investment. Banks in Turkey, however, are only experienced in and willing to finance large biogas plants for the generation of power. It is anticipated that banks would be reluctant to provide loans unless public agencies offer coordination and grants for the establishment of small scaled biogas facility. Taking all of these reasons into account, it is suggested that existing or potential sources of grants be mobilized to make this business solution possible. KKYDP, which is, as previously mentioned, funded by the Ministry of Agriculture and Forestry (TOB), offers grants to agricultural enterprises in the Izmir province to finance up to 50% of the costs of renewable energy generation projects costing less than TRY 2 million. Obtaining $16,595 from the KKYDP, and cooperating with a bank willing to finance the remaining 50% of the investment under an agreement between the bank and the entity that will translate the business solution into a program (development agency and/or TOB) is considered to be the best means of implementing this business solution. Determining the nature and standards of investments to be made under such a cooperation program, as well as the companies that will install the system, and establishing the terms and conditions of the grant are of crucial importance to banks.

For all the reasons given above, a mixed financing strategy in the form of grant + loan/own funds was devised for Business Case 14, as shown in the following diagram.

*Figure 31: Financing model proposed for Business Case 14*




| Business case 15: Increasing the numbers of manure pits in medium size dairy cattle farms | |
|---|---|
| A brief description of the solution and its goals | Support for installation of environment-friendly manure pits in cattle husbandry enterprises with herds of 30–100 cattle |
| What problem/obstacle does it propose to address in the region? | Storage of animal waste in open areas causes environmental pollution and greenhouse gas (methane) emissions. Enterprises are facing difficulties in the management and disposal of manure. |
| Scale of implementation of the solution: | Individual (Farmer) |
| Implementation steps: | Design, construction |
| What key product(s) will it affect? | Dairy Farming |
| What other links in the value chain will be affected? | Dairy Farming Enterprises, Vegetative Production Enterprises, other users of groundwater in the vicinity |
| Climatic effects for which adaptation is sought: | Reduction of greenhouse gas (methane), prevention of environmental pollution |
| Examples of best practices/references | https://www.sutdunyasi.com/makaleler/ teknik/ gubre-yonetimi-sistemleri/ |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Dairy husbandry enterprise |
| Input providers | Firms that construct manure pits, suppliers of loading and unloading equipment. |
| Technical support services | - |
| Administrative and structural supporters | Provincial and district directorates of TOB, provincial and district directorates of the Ministry of Environment and Urbanization, Municipalities |
| Finance providers | TOB, Banks, development agencies |
| Incentive providers | - |

| Cost items, USD/unit | |
|---|---|
| Labor | - |
| Construction (per enterprise) | 9,575 |
| Pump and mixer | 3,190 |
| Other | - |
| Total | 12,765 |

| Existing Sources of Financing in the Region |
|---|
| Bank loans |
| Agricultural Credit Cooperatives: |
| Program for the Support of Young Farmers (grant) |
| Rural Development Investments Support Program (KKYDP) (grant) |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 6,382,500 | Total financing needed over 5 years |
| Investment Capacity of the Business Plan (da) | 32,500 | It is assumed that there will be 65 animals per enterprise |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | | No information is available regarding the number of animals held by dairy cattle enterprises in KMRB. |
| Project implementation period (years) | 5 | 100 enterprises will be supported every year |

| | | |
|---|---|---|
| Period during which the project will reduce climate risk for each beneficiary (year) | 5 | The effects of manure on emission and environmental pollution will be reduced once manure pits are put into operation. |
| Anticipated Yield Increase (%) | | |
| Anticipated number of beneficiaries (enterprises) | 500 | It was envisaged that the solution will comprise a total of 500 enterprises with between 30 and 100 animals |
| Other anticipated results | | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Farmers will need to obtain grants, as the business solution does not affect the profits of enterprises directly | ▶ | Support |
| Sustainability | - | ▶ | - |
| Social | - | ▶ | - |
| Obstacles related to corporate/regulatory structure | - | ▶ | - |

| | |
|---|---|
| Priority status in terms of climate adaptation (high priority - priority - low priority) | Priority |
| What Else Can Be Done / Next Steps | Monitoring Implementation |

## Financing Strategy

As explained in the previous business solution, around 26% of greenhouse gas (methane) released from cattle husbandry enterprises originates from animal manure and is emitted to the atmosphere. In the dairy cattle husbandry sector, which produces a key product in the Basin, animal manure needs to be stored in a controlled manner and turned into organic fertilizer to be used in the fields after separating the stored liquid and solid waste. Each phase in this process has been documented in developed countries. These rules are strictly implemented in enterprises with more than 100 cattle in Turkey, whereas manure management is mostly uncontrolled in enterprises with less than 100 cattle, representing almost 98% of all enterprises. Collecting a sufficient quantity of manure for a manure pit is not feasible for enterprises with below a specific number of cattle. The construction of "manure pits" for the collection of animal manure in a manner consistent with the capacity of enterprises with 30–100 cattle is the goal in this business solution. A milch cow produces 25–30 kg of manure per day, equating to approximately 9–10 tons of manure per year, on average. It is necessary to calculate how many times a manure pit will need to be emptied in one year in order to build a manure pit of the right capacity. Systems such as pumps, conveyors and mixers involved in the transfer of manure from the sheds to the pit, the homogenous mixing and the loading of the manure collected in the pit onto trucks, are installed after the construction of the manure pit.

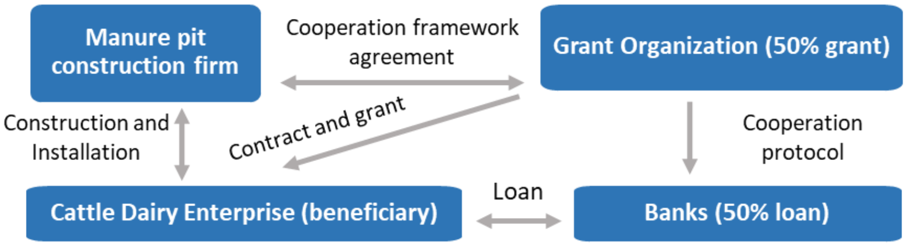
### *Proposed financing model*

The cost of a manure pit, including the construction and machinery/equipment needed for an enterprise with 30–100 cattle (65 cattle on average) has been calculated as USD 12,765. The precise number of cattle kept by dairy cattle enterprises in the Basin is not known, though 500 enterprises with approximately 32,500 cattle will be included in the scope of the business solution and will receive support over 5 years (100 enterprises every year) in order to significantly reduce the adverse effects of climate change and environmental pollution.

Considering the social benefits of the prevention of greenhouse gas emissions and the contamination of soil and water through manure pits, it is proposed that the cost of investment under this solution be financed in the form of the 50% grant + loan/own funds model that is gradually gaining popularity in Turkey. KKYDP, which was highlighted in previous business solutions, offers a 50% grant for the construction of manure pits in Izmir under the heading of "Processing, packaging and storing animal manure and vegetative waste." Given the many categories of grant in the KKYDP, the entity that will design the business solution (e.g. development agencies) should use its own funds to finance the part that the KKYDP cannot finance, and so the objective should be to build the maximum number of manure pits as a cooperative effort between the Ministry's program and the program specific to this particular business solution.

Banks can apparently finance the 50% not provided through grants. The business solution should be converted into a program, and the implementing agency should conclude a cooperation agreement with banks to maximize the number of farms able to make use of such loans. Enterprises that have no access to loans should be asked to cover 50% of the co-financing (approximately USD 6,382) through their own funds. Many enterprises in the Basin are ready to use their own funds to contribute to a program for the construction of manure pits with a 50% grant, recognizing that manure management is a big problem for enterprises and an obstacle to capacity expansion.

*Figure 32: Financing model proposed for Business Case 15*




| Business case 16: Afforestation aimed at mitigating the effects of carbon emission and the intensification of efforts to prevent erosion and floods | |
|---|---|
| A brief description of the solution and its goals | The afforestation of areas in the vicinity of cultivated lands and forests in order to reduce carbon emissions, and extending support to programs aimed at preventing erosion |
| What problem/obstacle does it propose to address in the region? | Afforestation and terracing while preventing erosion and reducing of carbon emissions |
| Scale of implementation of the solution: | Public |
| Implementation steps: | Design - Implementation |
| What key product(s) will it affect? | All key products |
| What other links in the value chain will be affected? | A sustainable environment |
| Climatic effects for which adaptation is sought: | Climate change |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Public |
| Input providers | - |
| Technical support services | Forest Engineers |
| Administrative and structural supporters | Provincial and district directorates of TOB, Municipalities, Cooperatives |
| Finance providers | Public, national and international finance institutions, local NGOs, development agencies |
| Incentive providers | Agricultural industries, public agencies, municipalities, agricultural trade, local NGOs |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Financing needed | ► | Support |
| Sustainability | Climate change at a glance | ► | Awareness |
| Social | - | ► | - |
| Obstacles related to corporate/regulatory structure | - | ► | - |

| | |
|---|---|
| Priority status in terms of climate adaptation (high priority - priority - low priority) | Priority |
| What Else Can Be Done / Next Steps | Monitoring Implementation |

No financing strategy could be developed for this solution as it requires large-scale and multi-component investments by the public sector.

| Business case 17: Improvements in fig drying systems | |
|---|---|
| A brief description of the solution and its goals | Promoting the distribution of platforms (kerevet) to farmers to help cope with problems faced in fig dehydration. Aflatoxin will be prevented in fig, which is an important export item. |
| What problem/obstacle does it propose to address in the region? | Aflatoxin |
| Scale of implementation of the solution: | Individuals (dried fig growers) |
| Implementation steps: | Procurement of platforms and distribution to farmers |
| What key product(s) will it affect? | Fig |
| What other links in the value chain will be affected? | Farmers, Exporters |
| Climatic effects for which adaptation is sought: | Food hygiene problems encountered in dehydration of fig due to precipitation and temperature anomalies |
| Examples of best practices/references | https://www.haberler.com/kaliteli-incir-icin-devlet-destekleri-suruyor-11135858-haberi/ |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Farmers |
| Input providers | Manufacturers and suppliers of platforms |
| Technical support services | Fig research institutes |
| Administrative and structural supporters | Provincial Directorate of Agriculture and Forestry, Chambers of Agriculture, IBB |
| Finance providers | Development agencies, IBB, Provincial Directorate of Agriculture and Forestry |

| Annual initial installation cost items, unit/USD | | | Existing Sources of Financing in the Region |
|---|---|---|---|
| Labor | - | ► | - |
| Materials | 7 | ► | - |
| Training | - | ► | - |
| Total | 7 | ► | - |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 210,000 | Six platforms are planned to be delivered to each of 5,000 enterprises producing dried fig in a manner similar to the current practices of the Provincial Directorate of Agriculture and IBB. |
| Investment Capacity of the Business Plan (tons) | 1500 | Each platform is used for the drying of approximately 50 kg of fig per season. 30,000 platforms will be used to dry 1,500 tons of fig |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 4% | Approximately 40,000 tons of fresh fig is grown in KMRB. 1,500 tons will contribute to an additional 4% of this capacity. Some enterprises already have platforms, although the total number is unknown. |
| Project implementation period (years) | 1 | |
| Period during which the project will reduce climate risk for each beneficiary (year) | | |
| Anticipated Yield Increase (%) | 50% | |
| Anticipated number of beneficiaries (enterprises) | 5,000 | |
| Other anticipated results | 90% of dried fig produced in the Basin is exported. The value of product that is free of aflatoxin and other pests will go up in the export markets and exported products will not be returned, making a positive contribution to the national economy. | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Existence of many enterprises in which investments can be made | ► | Development, starting with those who contribute |
| Sustainability | Failure to use provided platforms efficiently, and covering labor costs in particular | ► | Allocating part of the economic benefit derived from the dehydration system to operating expenditures |

| | | | |
|---|---|---|---|
| Social | Doubts about innovative dehydration systems | ► | Sharing implementation examples involving such forms of investment |
| Obstacles related to corporate/regulatory structure | - | ► | - |

| | |
|---|---|
| Priority status in terms of climate adaptation (high priority - priority - low priority) | Low priority |
| What Else Can Be Done / Next Steps | Ensuring cooperation between farmers-processors-consumers-exporters and public regulatory bodies |

### Financing Strategy

Aflatoxin resulting from errors in the growing, harvesting and storage of fig, which is a key export product of our country, is a major problem. Turkey's market share of dried fig is around 55–60%, while it is 80–85% in exports. Exporting figs infected with aflatoxin results in the return of dried fig lots from the export markets to customs offices. Thus, growing dried figs, as a key product in the KMRB, is as important as its harvesting, drying, and storage without compromise on quality. Dried fig is harvested by picking up the dried fruits that fall on the ground after being partly dehydrated on the tree. The subsequent dehydration process should continue in plastic boxes called "platforms (*kerevet*)" which prevent contact with the ground and which ensure air circulation around the fig through the holes within them, rather than drying figs on the ground, on dried plants or on fabric/plastic sheets. The platforms are anticipated to be distributed to fig growers free of charge under this business solution, aiding dried fig growers who grow figs on small and generally sloping land that cannot afford platforms.

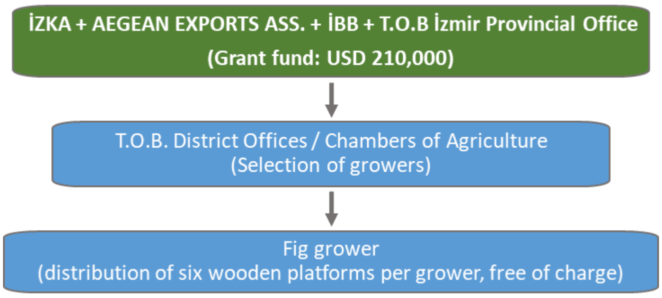
*Figs dried on a platform (left), figs infected with aflatoxin in purple light*

#### *Proposed financing model*

The Izmir Provincial Directorate of the Ministry of Agriculture and Forestry (TOB) and the Izmir Metropolitan Municipality (IBB) occasionally distribute platforms to fig growers in the Basin. The number of platforms distributed by both organizations using their own funds cannot satisfy total demand. This business solution intends to totally eradicate the aflatoxin problem in figs by distributing 6 platforms to 5,000 (63%) of the total 8,000 fig growers in the region within a year (30,000 platforms in total). It is estimated that the remaining fig growers (a third of the total) in the Basin already own a sufficient number of platforms.

Development agencies, organizations representing exporters of dried fruit and related products in the region, TOB and IBB, based on the importance to sustainability of fig production in the Basin, should join forces and create a grant budget for the purchase of 30,000 platforms, each worth approximately USD 7, in order to put the business solution into practice. It will be thus be possible for these organizations to share the financing costs, totaling USD 210,000. The registry systems of the provincial and district directorates of TOB, or the chambers of agriculture in counties may be used to draw up a list of farmers who lack a sufficient number of platforms.

*Figure 33: Financing model proposed for Business Case 17*




| Business case 18: Improvements in the cold chain for raw milk and the utilization of renewable energy sources in the cold chain | |
|---|---|
| A brief description of the solution and its goals | Using solar (PV) panels to provide energy to the cold chain in raw milk collection centers (cooperatives, unions); to provide financing for solar energy systems to be installed for such a purpose. Milk collection centers will thus be protected against any rise in energy costs resulting from climate change. |
| What problem/obstacle does it propose to address in the region? | Increase in energy costs as a result of climate change |
| Scale of implementation of the solution: | Corporate (Producer organization) |
| Implementation steps: | Design, implementation |
| What key product(s) will it affect? | Milk (cow) |
| What other links in the value chain will be affected? | Product collection (producer organization) |
| Climatic effects for which adaptation is sought: | Very high temperature |
| Examples of best practices/references | https://www.wur.nl/upload_mm/2/5/e/74d1fe3f-303b-4a4e-bea7-0fc5e3e7af05_Digitale_brochure_Solar_Cooler_Ethiopia_%28DEF%29.pdf<br>https://www.energymatters.com.au/renewable-news/milkpod-solar-chilling-em5544/ |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Cooperatives and unions collecting raw milk in the Basin |
| Input providers | Firms installing solar energy systems |
| Technical support services | Local power distribution company |
| Administrative and structural supporters | Provincial/District Directorates of TOB, General Directorate for Renewable Energy |
| Finance providers | Development agencies, Ministry of Agriculture and Forestry, Banks |

| Initial annual installation cost items, unit/USD | |
|---|---|
| Labor | |
| Materials | |
| Training | |
| Total Solar Energy System | 80,000 |

| Existing Sources of Financing in the Region |
|---|
| KKYDP (grant) |
| Program for the Support of Young Farmers (grant) |
| Banks |
| Agricultural Credit Cooperatives |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 1,600,000 | Investments into 100 kW solar energy systems are planned for 20 milk collection centers in the region. |
| Investment Capacity of the Business Plan (tons) | 21,600 | Average daily capacity of each milk collection center is 3 tons. Thus, 60 tons of milk per day and 21,600 tons of milk per year will be cooled using solar energy. |

| | | |
|---|---|---|
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 23% | There are a total of 193 registered milk collection centers in the Basin, 86 of which are run by producer organizations (cooperatives/unions). The business solution will cover 20 (23%) out of 86 potential beneficiaries. |
| Project implementation period (years) | 2 | |
| Period during which the project will reduce climate risk for each beneficiary (year) | 1 | |
| Anticipated Yield Increase (%) | 50% | Almost half of the energy needed by the collection centers is used for cooling milk. There will be an approximately 50% cut in energy costs even if the generated solar energy is used entirely for cooling purposes. |
| Anticipated number of beneficiaries (enterprises) | 20 | |
| Other anticipated results | Energy costs of the enterprises will fall and a significant contribution to the national economy will be made. As the cost of solar panels tends to decline, the extension of the pilot implementation will widen the scope of this activity. | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Relatively high investment costs / bottlenecks faced by local cooperatives related to investment costs | ► | Boosting storage capacity through new panels, windmills, and bio-waste processing plants / promoting investments through the funds to be provided |
| Sustainability | Efficient maintenance and repairs / inability to pay operating expenditures of installed plants | ► | Possibility of selling surplus energy not used for production / support for operating expenditures and contributions of milk collectors |
| Social | Insufficient awareness on energy efficiency | ► | Awareness and social information / sharing best practices |
| Obstacles related to corporate/regulatory structure | It may occasionally be necessary to sell generated energy to the national grid | ► | Works to be undertaken with the local power distribution company / ensuring the effective enforcement of current regulations |

| | |
|---|---|
| Priority status in terms of climate adaptation (high priority - priority - low priority) | Priority |
| What Else Can Be Done / Next Steps | Positive and constructive communication between farmers, collectors and power distribution companies will gain importance. It will be easier for farmers to join the system as part of the current cooperative organization. |

### Financing Strategy

Directive dated 27.04.2017 issued by the Ministry of Agriculture and Forestry requires raw milk to be transported in Turkey after it has been cooled to 4ºC. To comply with this rule, a large number of grants were provided from public funds to finance the procurement of milk cooling tanks used by milk collection centers located in villages and counties over the past 3–4 years, and there is now almost no milk collection center without a cooling tank. The majority of these centers are run by agricultural cooperatives and unions the represent milk producers. This development has led to a significant increase in the quality of raw milk in Turkey, but has also brought about a significant increase in electricity consumption. This rise in energy costs is the greatest cost related to the operation of tanks, which consume a considerable amount of electricity in order to cool the milk.

Under this business solution, solar energy technologies and photovoltaic panels are planned to be installed for milk collection tanks in the milk collection centers operated by agricultural cooperatives and unions involved in the collection of raw milk. There are a total of 193 milk collection centers in the basin, 86 of which are run by producer organizations. Others are owned by firms processing milk and are generally in the same location as the milk processing plant. In all instances, the business solution is designed to strengthen the organizations founded by producers, and hence to contribute to the sustainability of milk production as a widely debated topic in Turkey. A solar energy system with a maximum capacity of 100 kW will be installed for each organization to ensure that the energy required for both milk tanks and other systems owned by the cooperative will be met through the business solution.

*Existing Sources of Financing*

The Rural Development Investments Support Program (KKYDP) managed by the Ministry of Agriculture and Forestry is the only source of financing in the form of a grant used for financing investments in solar energy systems to be installed in agricultural enterprises in the Kucuk Menderes River Basin. As mentioned earlier, this program provides a 50% grant for projects costing up to TRY 2 million (approximately USD 350,000) for new investments, and also covers investments into renewable energy. Thus, the solar systems (solar collectors (panels), energy converters, solar batteries (accumulator, batteries) and charge control device) to be purchased for the treatment of collected milk are financed in full. The number of solar energy systems funded through KKYDP in the Basin so far is, however, very limited. Cooperation with Provincial Directorate of Izmir of the Ministry of Agriculture and Forestry will be needed in order to make more use of KKYDP funds by designing a special program as part of this business solution.

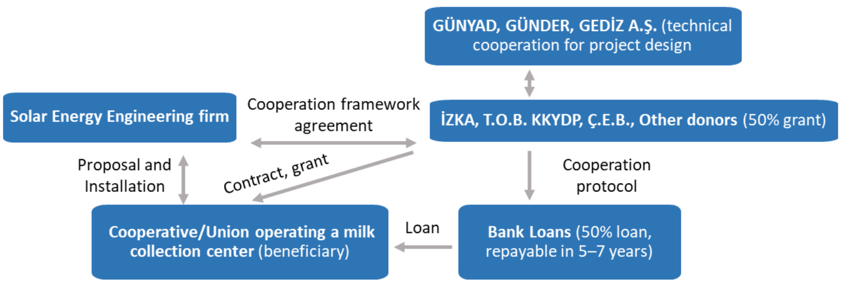
Bank loans represent another source of financing in the Basin. Banks have financed a significant number of investments into solar and other renewable energy systems in the Basin, although these investments have been large schemes that have been established to sell power to the national grid. Negotiations should be held with banks for the funding of small (max. 100 Kw) solar energy systems that meet the energy needs of the cooperatives or unions as part of this business solution.

*Proposed financing model*

It is proposed to install solar energy systems at 20 out of the 86 milk collection centers owned by cooperatives and unions in the basin over a period of two years (10 milk collection centers every year) as part of this business solution. The average cost of a system with a maximum capacity of 100 kW is around USD 80,000, and hence the total financing needed for this business solution is USD 1,600,000. As cooperatives and unions in villages and counties cannot afford to pay this amount, it is suggested that a solar energy system be installed based on a co-financing model in the form of a "50% grant + 50% own funds/loans" model, which is a model that these organizations and their members are familiar with, having used the model for the purchase of animals and milk tanks. It will be possible to seek grants from the KKYDP for 20 investments or it can be partly financed from KKYDP and the remaining part from contributions to be provided by other organizations carrying activities covering the Basin (development agency, Ministry of Environment and Energy, other donors) through cooperation between the agencies concerned (e.g. development agency, Izmir Provincial Directorate of the Ministry of Agriculture and Forestry, unions of cattle breeders and milk producers) for this business solution.

It is anticipated that cooperatives and unions with sufficient funds will provide the remaining 50% in from their own funds or savings, or from milk revenues (in installments), while others who lack sufficient funds but are successful in their operations will be able to access bank loans.

*Figure 34: Financing model proposed for Business Case 18*



| Business case 19: Extension of practices preventing evaporation in the soil | |
|---|---|
| A brief description of the solution and its goals | Encouraging plantation by establishing mulching and small bumps |
| What problem/obstacle does it propose to address in the region? | Insufficient irrigation water |
| Scale of implementation of the solution: | Individual/collective |
| Implementation steps: | Training, procurement of services for implementation, implementation |
| What key product(s) will it affect? | Tomato for the production of tomato paste, outdoor ornamental plants |
| What other links in the value chain will be affected? | Farmer |
| Climatic effects for which adaptation is sought: | Falling precipitation, increased evaporation |
| Examples of best practices/references | http://www.sanliurfaolay.com/gap-ve-tarim/dsi-genel-muduru-acikladi/24216 |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Farmers |
| Input providers | Input suppliers manufacturing and selling mulch plastic |
| Technical support services | Technical instructors |
| Administrative and structural supporters | Provincial and district directorates of TOB, Municipalities, Cooperatives |
| Finance providers | National and international finance institutions, local NGOs, development agencies, producer organizations |
| Incentive providers | Agricultural industry processors and input suppliers, producer unions |

| Cost items, unit (da)/USD | |
|---|---|
| Labor | 10.6 |
| Materials | 29.8 |
| Training (per 20-strong farmer group) | 400 |
| Other | - |
| Total | **440.4** |

| Existing Sources of Financing in the Region |
|---|
| KKYDP (grant) |
| Program for the Support of Young Farmers (grant) |
| Other types of support provided by TOB |
| Banks |

| | | |
|---|---|---|
| Investment Needed for the Business Plan (USD) | 88,800 | Cost of labor and materials for 20,000 decares (USD 80,800), cost of training for a 20-strong farmer group (USD 8,000) |
| Investment Capacity of the Business Plan (da) | 2,000 | Mulching on an average area of 5 decares for each of the 400 enterprises |
| Ratio of the Implementation to Total Capacity (KMRB) (%) | 2.9% | 2.9% of the area (68,121 da) used for growing tomato for industry and outdoor ornamental plants in the Basin |
| Project implementation period (years) | 5 | 400 decares (80 growers) will be included within the scope of the program every year. |
| Period during which the project will reduce climate risk for each beneficiary (year) | 1 | Evaporation and heat stress will have been reduced after implementation |
| Anticipated Yield Increase (%) | 20% | Reduced evaporation, weeds and pests will increase tomato yield |
| Anticipated number of beneficiaries (enterprises) | 400 | |
| Other anticipated results | Promotion of mulching | |

| Challenges/obstacles to the solution | | | Proposed Solutions |
|---|---|---|---|
| Economic | Financing needed | ► | Support |
| Sustainability | Insufficient number of mulching machines | ► | Support for mulching machine |
| Social | Lack of knowledge and awareness among producers | ► | Awareness training |
| Obstacles related to corporate/regulatory structure | - | | - |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | High Priority |
| What Else Can Be Done / Next Steps | Monitoring the effects of mulching, providing support for mulching machines commonly used in the Basin |

## Financing Strategy

Mulching techniques used in agricultural production to prevent evaporation from the soil as a result of the rising temperatures brought by climate change, and to prevent the growth of wild plants and weeds requiring the use of pesticides is a method that has been known for centuries. Mulching is, briefly, a process of covering the surface of the soil around the plant and its root area with natural materials (stems, wood chips, residue harvested products, etc.) or a thin plastic sheet (generally for vegetables and fruits planted in rows). Tomatoes grown for industrial purposes and outdoor ornamental plants, both of which have been selected as key products for the Kucuk Menderes River Basin, are threatened by very high temperatures and evaporation, and by the weeds and pests that are gradually proliferating. This situation has led to an increase in the need for irrigation and the application of fertilizers and pesticides, with an adverse effect of the quality of the tomatoes. Companies engaged in the processing of tomatoes for industrial purposes in the Basin are concentrated in a specific area, and the sustainability problem in the production link of the value chain endangers not only farmer revenues, but also the continued supply tomato-processing industries. Indeed, the area cultivated for the sowing of tomatoes for industrial purposes in the basin has been reduced by 22% between 2012 and 2016. Actions to be taken at the level of farmers will contribute to the sustainability of the tomatoes grown for industrial purposes chain thanks to this business solution, which has been developed specifically to address these problems. The growers of tomatoes for industrial purposes and outdoor ornamental plants will be trained in mulching techniques as part of the business solution, with demonstrations held (on 5 decares per enterprise) in order to disseminate the knowledge.

Costs incidental to mulching including mulching materials, labor and mulching machinery capable of applying mulch rapidly and automatically over wide areas. Examples of mulching materials include dried grass, waste stems and wood chips in small gardens used for subsistence. Agricultural enterprises growing produce for the market use thin mulching plastics, which can rapidly decompose in nature. The average area of land used for growing tomatoes for industrial purposes and outdoor ornamental plants is between 5 and 100 decares. As it is not possible to mulch such large areas manually, it is planned to provide mulching support for 400 holdings for 5 decares (2,000 decares in total) per enterprise for demonstration purposes in order to show the benefits of mulching, as part of this business solution.

### *Existing Sources of Financing*

The costs related to mulching comes from working capital, and thus requires short-term operating expenditures. Presently, there are 13 banks in Turkey offering special working capital loans to the agricultural sector, satisfying all of the working capital requirements of registered farmers. Thus, it can be said that banks would be ready to provide financing if the mulching technique is widely applied to the production of tomato for industrial purposes, which is facing climate-related threats in the Basin. In some countries in the world (e.g. China), governments are providing mulching materials and/or mulching machines (through grants, common use) that can be fitted to tractors in order to promote mulching in the initial phases when farmers have yet to be familiarized with mulching techniques.

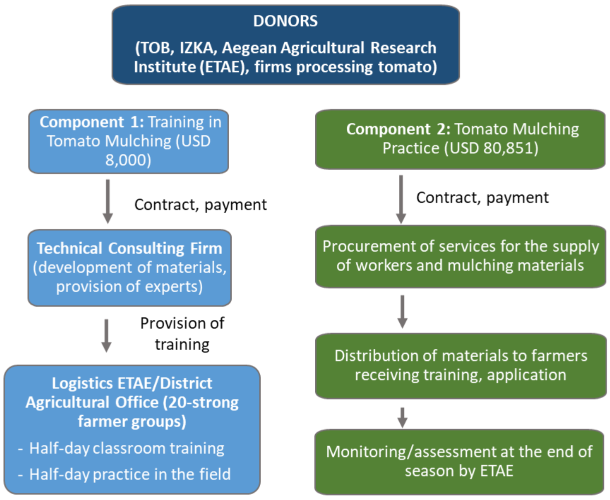
The input support provided by the government for farmers in Turkey is mostly in the form of cash (direct payments to the farmer's bank account) or in kind (supply of seed, saplings). If input support is provided for mulching, the costs incurred by a farmer for the purchase of mulch may be fully or partly supported upon the presentation of an invoice, as is the case in many other examples of support.

### *Proposed financing model*

In the light of the explanations provided above, firstly, training and demonstrations are needed to promote and disseminate mulching, which can provide significant resilience to the effects of climate change, but is not yet widely applied in Turkey or the Basin. Thus, the benefits and economic benefits reaped by farmers through mulching can be proven, and farmers will be able to use their own budgets for mulching without requiring constant support if demand is created in the future. It is therefore suggested that the costs of mulching of a total area of 2,000 decares, including 5 decares on 400 enterprises, and awareness and technical training be funded by the public agency concerned (Ministry of Agriculture and Forestry), development agencies or the tomato industries in the Basin. Classrooms or implementation areas within the agricultural research institutes under TOB, or district agricultural directorates can be used for the training component. The participation of employees of the district agricultural directorates and research institutes of the Ministry in the training programs, after which support can be provided by that personnel to farmers on implementation, are of crucial importance in terms of sustainability.

The costs incidental to this business solution include labor, calculated as approximately USD 10.6 per decare; materials, calculated at USD 29.8 (mulching nylon); and USD 400, representing the cost of one day of awareness and technical training for each 20-strong group of farmers. The total financing needed for the entire implementation period (5 years) withing the business solution is 88,851. The needs outlined above are classified into two main components (training and implementation), as shown in the following diagram. Other details can be found in the above table showing the Business Solution.

*Figure 35: Financing model proposed for Business Case 19*




| Business case 20: Using domestic wastewater in counties for agricultural irrigation | |
|---|---|
| A brief description of the solution and its goals | Utilization of urban wastewater in densely populated areas of the Basin for agricultural irrigation |
| What problem/obstacle does it propose to address in the region? | Insufficient irrigation water |
| Scale of implementation of the solution: | Public |
| Implementation steps: | Design - Implementation |
| What key product(s) will it affect? | Olive, fig, tomato, outdoor ornamental plants |
| What other links in the value chain will be affected? | Sustainable supply of processed products |
| Climatic effects for which adaptation is sought: | Falling precipitation |
| Examples of best practices/references | http://www.milliyet.com.tr/yalova-da-atik-sular-sulamada-kullanilacak-yalova-yerelhaber-2230984 |

| Role in the Solution | Stakeholders who need to Play a Role/Cooperate in the Proposed Solution |
|---|---|
| Beneficiaries | Farmers |
| Input providers | Contractors |
| Technical support services | Environmental Engineers |
| Administrative and structural supporters | Ministry of Environment and Urbanization, Municipalities, local NGOs, national and international finance institutions, international NGOs. |
| Finance providers | National and international finance institutions, local NGOs, development agencies |
| Incentive providers | Civil society organizations, municipalities, producer organizations |

| | |
|---|---|
| Priority status in terms of E-S-E impact (high priority - priority - low priority) | Priority |

| | |
|---|---|
| What Else Can Be Done / Next Steps | - |

No financing strategy could be developed for this solution as it requires large-scale and multi-component investments by the public sector.

# 7. Limitations of the Study and Suggested Further Studies on Increasing Adaptation to Climate Change in the Kucuk Menderes Region

- ✓ The climate change risk analysis carried out for Kucuk Menderes River Basin was limited by the lack of real exposure data and the socioeconomic and ecological indicators used in calculating the vulnerability indexes. While Kiraz county station is with the highest altitude of 310 meters among the meteorological stations utilized in the Basin for climate risk assessment, agricultural activity is also possible in mountainous areas. It is known that there are significant changes in wind direction and intensity as well as temperature in these regions. For this reason, it is necessary to establish meteorological observation stations in the mountains and hilly areas surrounding the Basin to be able to project the climate change in the Basin more accurately and its impacts on agriculture in those areas.

- ✓ For an accurate climate change risk analysis, the data used in the vulnerability analysis must be county-based. However, the data listed below could not be provided on county basis:
  - Indicators of adaptive capacity
  - Unemployment rate
  - Social aid payment
  - Farm land
  - Farm income
  - Number of farms
  - Number of elderly workers
  - Dependency rate
  - Internal migration
  - Average output of all crops
  - Storm forecasts

- ✓ Exposure indicators which are not available with climate projection models are as follows:
  - Change in snow depth in winter
  - Change in storm frequency
  - Change in ground water levels

  Additionally, the following indicators of exposure could not be provided on county basis:
  - Number of affected farmers
  - Affected farm houses, equipment and infrastructure

  Sensitivity indicators which could not be provided on county basis :
  - Employment rate in agriculture
  - The stage of plant growth during storms
  - Soil degradation / Erosion risk

- ✓ Another major shortcoming in terms of climate projections is the lack of adequate high-resolution climate change projections (through a regional climatic model, or downscaling), and therefore no further elaboration of the study in the Basin. Instead of high-resolution regional model projections with high uncertainty and low number of parameters; lower-resolution global model projections were preferred which are more in number but with low uncertainty and larger number of parameters. The biggest challenge with working with one or a few regional model projections is that precipitation-like outputs may have inconsistencies for the same basin (for example, one projection may result in precipitation rise while the other points decreases). Sufficient number of regional climate projections are needed to ensemble.

- ✓ As there are hundreds of kinds of outdoor ornamental plants and the lack of data on regional, national and international basis for these varieties, economic indicators such as the production value, the effects of climate change and resulting expected loss could not be calculated.

Besides the aforementioned constraints, following suggestions should be considered in order to develop adaptation strategies for climate change in the region:

- ✓ Preparing a climate change adaptation strategy specific to KMRB: There is no impact assessment conducted against the climate change strategy for KMRD due to the absence of a responsible body. In order to minimize the potential negative impacts of climate change, a comprehensive and efficiently coordinated action plan should be developed with multiple interlocutors in the public domain with well-defined processes.

- ✓ **Determining the adaptive capacity of the fig wasp to climate change and conducting academic research for mapping risks:** Scientific research is needed for determining the effects of climate change to the fig wasp that is vital for the production of dried figs, selecting the resilient species (if any), identifying the adaptation capacity of these species for sustainable dried fig production in the region.
- ✓ **Investigating cow breeds resistant to heat stress resistant and with high yield:** The absence of cow breeds resistant to high temperature occurring with climate change reduces the sustainability of dairy farming. In order to develop specific species for the Basin, it is necessary to carry out researches for this purpose.
- ✓ **Creating an action plan for the prevention of excessive use of groundwater and raising awareness:** Inefficient use of groundwater exploits underground water reserves and decreases water quality. There are thus needs for awareness raising trainings for the farmers and other actors of the value chains.
- ✓ **Extensification of agricultural insurance:** It is recommended to increase the awareness on the effects of climate change on agriculture and the importance of agricultural insurance for climate change adaptation.
- ✓ **Establishment of a climate monitoring, evaluation and information system:** The data to be received from the MGM stations established in 2012 will provide increased reliability of climate forecasts. The system will provide early warning about the phenological needs of the plant during the production process, thus avoiding yield and quality reduction.
- ✓ **Establishment of a climate change decision support system:** Developing a system that predicts the impacts of climate change on farm income will provide forecasts on cash flow, savings and credit needs of small farmers and will improve farm management.
- ✓ **Developing practices to reduce calf deaths in small businesses:** High temperature can cause nutritional deficiencies by stressing calves and their mothers. In addition, high calf mortality rates negatively affects the productivity in the Basin. Practices should be developed and disseminated in the Basin for increasing animal welfare and decreasing calf deaths.
- ✓ **Supporting research and development studies to develop a high value-added processed product range:** Innovative product processing systems should be adapted to the structure and standard of the raw material coming to the factory due to the changes in climate for high quality and sustainable production.
- ✓ **Improvement of agricultural lands with high salinity and alkalinity:** In order to overcome the salinity caused by climate change and irrigation water in areas with high salinity risk, land reclamation projects should be supported. Due to the decrease in water resources; methods such as land slope change, land improvement wash, deep tilage, water supply management, changing the style of sowing etc. should be applied (Ayers and Westcot., 1989).

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# ANNEXES

# Annex-1: Summary of current climate events witnessed in KMRB

## Sequences of News

---------------------------------------------------------------2017-2018-------------------------------------------------------------------------

Saturday, March 3, 2018, 11:32 am

### The water report that gladdens İzmir!

**The Second Regional Director of State Hydraulic Works (SHW), Ali Fuat Eker said that, in İzmir, the expected precipitation did not fall during January and February of 2018, but considering recent rains, there has been an increase of about 10 percent. Eker expressed that he has lost his sleep at nights over thinking that there would be a drought problem despite the necessary measures.**


Irregular rains led to drought concerns. While it has been thought that Turkey is getting prepared for a drought summer, the Second Regional Director of SHW, Ali Fuat Eker made a relieving statement for İzmir. Eker stated that **2017 was recorded as the driest season of the last 44 years**, and explained that the expected precipitation did not occur during January and February of 2018, but with the slight increase in precipitation in the last days of February, there has been an increase of some 10 percent in the reservoirs. Eker told that they expect the March to be a rainy month and said: "Thus, our reservoirs will be full and we will be able to get over this year without having a water problem in lands. **Considering its location, İzmir is not a wetland area in its basin. When we calculate based on the number of population in İzmir, the water per capita seems to be around 750 cubic meters. When we look at the average in Turkey, the water per capita is 1.500 cubic meters.** The overall water reservoir of Turkey is some 110 billion cubic meters. In fact, İzmir is a different location in terms of water. On the top of it, when there is less precipitation, it is adversely affected". Eker expressed that they have taken necessary measures in despite of unfavorable conditions, and said that he has lost his sleep over thinking that there would be a drought problem after all.

EVERLASTING UNCONTROLLED IRRIGATION

**Ali Fuat Eker quoted that, since 2013, they have been building substantial permanent reservoirs in Kucuk Menderes,** and stated that, in this manner, they have taken necessary measures. Eker emphasized that, by constructing dams such as Aktaş, Rahmanlar, Burgaz, Bademli, Beydag, they stored those irregular streams during winter and presented for use in summer and said:

"Within this context, there have been serious investments. In parallel to these projects, irrigation channels have been built, thus water is properly supplied to our citizens' lands. We little bit misuse water. **We irrigate fields and wait until it gets quite ponding. Uncontrolled irrigation is a serious problem for us.** Therefore, we plan to overcome this issue by using closed systems which we call prepaid meters. We make an effort to establish the same system in the field as in our houses where we use water passing through meters. Works are ongoing. We continue to work about this in the Gediz, Kucuk Menderes, Bakırçay Basins and all other basins. **From now on, we hand over our irrigation projects with a pressurized piping system and prepaid meters. At this point, our aim is to have no water loss."**

…

WATER WARNING FROM EKER
Ali Fuat Eker quoted that the entire world is facing a serious drought problem, and referred to the importance of water and made a suggestion for the careful use of water. Eker expressed that the problem can be overcome if citizens give up their old habits and use water carefully and said: “Think about the water flowing from the tap in our houses. **Just like we feel uncomfortable when water is dripping from the tap, people should feel uncomfortable when they give excess water in the field. The more irrigation doesn’t result in more yield, but the land becomes barren.** We will gradually be aware of it”. (DHA)

*Source:* *http://mobil.egedesonsoz.com/haber/Izmir-de-uyku-kacirtan-kuraklik/977043*

# Farmlands in the villages of İzmir were flooded

## Heavy rain and storm in İzmir struck the farmers.

January 18, 2018, 2:20 pm


In İzmir, the storm which started in the early hours of the morning and the heavy rainfall and hail continuing for a while, flooded agricultural lands. Media Ege publisher Arif Çayan visited some farmers in **Torbalı, Bayındır, Odemis, Tire, and Kiraz** that are struck by the storm and heavy rain, and he displayed the disaster experienced in the fields and agricultural lands.

The picture shows **the loss caused by the heavy rainfall that damaged the agricultural lands in particular in the Kucuk Menderes region**.

*Source:* *http://www.medyaege.com.tr/izmirin-koylerinde-tarim-arazileri-su-altinda-kaldi-67903h.htm*

# İzmir would be most affected city due to drought, experts explained

The Chairman of the Environmental Engineers Chamber, Bozoğlu told that debates regarding the global climate change is once again on the agenda for Turkey and said: **"There is a risk of drought in Central Anatolia, and a risk of flood in Aegean and Mediterranean regions"**. Baran Bozoğlu pointed out that Turkey is the country that would be most affected due to the climate change in the world and said: "Because, it is surrounded on three sides by the sea and it is in the Mediterranean Basin. In scientific modelling studies, the greatest effect in terms of the flood disasters, drought in some regions and drop in agricultural production, seems to be on Turkey. And an academic study was newly published regarding the fact that İstanbul and İzmir are leading cities that would be most affected."

*Saturday, July 29, 2017, 09:22 am*

The flood and storm that took place in İstanbul in high summer brought the debates regarding global climate change which is globally emphasized, once again to the agenda of Turkey. The Chairman of the Environmental Engineers Chamber, Baran Bozoğlu stated that the world is facing a rapid climate change problem and said: "This situation affects our lives sometimes directly and sometimes without feeling it. When it comes to climate change, usually the first thing we think about is a polar bear on a small floe. We visualize an image that it became lonesome, the ice is melting and it faced with the danger of death. However, climate change also means people who are stranded on the top of cars in İstanbul in the wake of a flood disaster. So, not only polar bears but we are all in danger".

## Risk of drought and flood

Bozoğlu made the following evaluations:

"We observe a temperature increase of around 1.1 degrees Celsius on the earth's surface after the Industrial Revolution. The meaning of climate change is the melting of glaciers, the increase of flood disasters, the concentration of drought in various regions, the species, which we call biodiversity, in danger of extinction, the deterioration of the ecological balance and the problem of access to food. The whole system is disrupted when the temperature balance in the world is broken, just like how an increase of 2-3 degrees in our body makes us sick. When we look at the earth's warming potential, we need to see that we would encounter much bigger disasters. And specific to Turkey, we are confronting with the risks of serious drought and inaccessible fresh potable water in Central Anatolia, and the risk of flood in Aegean and Mediterranean regions."

…

## Public transit suggestion

Bozoğlu continued as follows: "One of the main reasons of climate change is vehicle use. Reports indicate that more than 33 percent of the air pollution in Ankara is stemming from vehicles. We do not breathe fresh air in İstanbul, Ankara and İzmir. Vehicle use should be decreased and public transit should be improved. **The fact that, along with global warming, there is an increase in forest fires** has already reflected in scientific reports. Cigarette butts thrown around in the summer months, glass pieces, unauthorized dumping of excavation materials to the forest lands by excavation trucks are big problems. The perpetrators of environmental crimes should definitely be judged before the law. Responsible bureaucrats and politicians should be accountable in this regard." …

*Source:* https://www.egehaber.com/gundem/uzmanlar-kurakliktan-en-cok-izmir-in-etkilenecegini-acikladi-h177933.html

June 05, 2017, 2:48 pm

# Heavy Rain and Hail in İzmir

## The Chairman of Tire Chamber of Agriculture, İbişoğlu: “About two thousand decares of agricultural land were damaged”

İZMİR (AA) - The Chairman of Tire Chamber of Agriculture, İbişoğlu **stated that about two thousand decares of agricultural land were damaged due to hail and heavy rain that influenced the district.**
In his statement to journalists, İbişoğlu stated that, due to the walnut-sized hail that lasted for 10 minutes yesterday evening and heavy rain started subsequently, **streams overflowed in Doyranlı, Yiğrenli, Peşrefli and Kahrat neighborhoods, and cultivated lands and nursery gardens in the region were damaged**.
İbişoğlu noted that they have examined the areas damaged due to precipitation and said:
“We are carrying out examinations for the damage assessment, along with the District Directorate of Agriculture And Forestry. Two thousand decares of agricultural land were damaged due to heavy rain and hail. There have been floods in certain lands because of blocked stream beds in the wake of heavy rain. **It is seen that agricultural tools and equipment were also drifted in certain regions. The loss in the region is huge and our farmers are sad. Fortunately, there is no loss of life.”**
**İbişoğlu said that they will apply for the deferment of farmers’ credit debts to Ziraat Bank and private banks.**
Chairman of Derebaşı Agricultural Development Cooperative, Halil Acü uttered that approximately 50 farmers in the village made application on the grounds that their products have been damaged, and that **they estimate that the total loss amounts to 5 million liras.**
Hatice Zan who is engaged in arboriculture in the region noted that **more than half of the ornamental plants in her garden of 4 decares were damaged, and that they expect support from the state.**

*Source:* *http://www.milliyet.com.tr/izmir-deki-saganak-ve-dolu-izmir-yerelhaber-2087863/*

# Hail and heavy rain hit agricultural lands and nursery gardens

06.05.2017 11:25

Hail and heavy rain damaged to the cultivated lands and nurseries while many houses flooded.

Heavy rain and hail that started yesterday afternoon in İzmir’s Tire district adversely affected the life. Cultivated lands and nurseries were damaged due to hail and floodwaters while many houses flooded.

Yesterday at around 4:00 pm, the hail started in Tire. The hail lasted for ten minutes was replaced by heavy rain. Rainwaters coming down from high altitudes due to the nonstop heavy rain that lasted for half an hour caused floods in the Derebaşı Stream which passes through the rural Derebaşı neighborhood. **Floodwaters from the overflowed stream turned the fruit gardens, cultivated fields, and nurseries, which are below the stream due to the elevation difference, into a lake. The streets turned into rivers while many houses flooded.**

The Founder and Former Chairman of Derebaşı Agricultural Development Cooperative, Mehmet
Çakırer told that a sudden downpour of hail and heavy rain caused a severe damage to cooperative members' products and his own nurseries. Çakırer told: **"Hailstones were walnut-size. Then, along with the wind, heavy rain started and lasted 30 minutes. The stream in our village overflowed. The fruit saplings of 20 members of our cooperative were wasted. Floodwaters knocked down, swept, and dragged pots. Our loss is at least 2 million liras according to the initial reports".** (DHA)

*Source: https://www.birgun.net/haber-detay/dolu-ve-sagnak-yagmur-tarim-arazileri-ve-fidanliklari-vurdu-162847.html*

# Greenhouses were Hit by Snow in Aegean Region and by Flood in Mediterranean Region

*01-12-2017 2:21 pm*

Dead of winter boosted the fruit and vegetable prices. Greenhouses in the Aegean region were hit by snow and those in the Mediterranean region by flood. **Greenhouses in the Menderes region froze** while Izmir is experiencing the coldest and most snowy winter in years. Severe damage occurred in the greenhouses submerged by floodwaters in the Mediterranean region, particularly in Mersin.

In İzmir's Menderes district, snow hit the region where 63% of the vegetable, fruit and flower greenhouses of the town are located. Greenhouses could not bear the weight of the snow over them and nylon covers of some were tattered and ironworks of some were collapsed.

Out of 17,650 decares of the land where vegetables, fruits, and flowers are produced in greenhouses, 11,911 decares, i.e. 63%, are located in Küner, Değirmendere, Sancaklı, Çileme, Develi, Çamönü villages in the Menderes region. Most of these greenhouses were damaged by 10-80 percent. Greenhouses collapsed due to snow fallen on nylon covers and ironworks. Products that are mostly lettuce and cucumbers, as well as flowers such as rose, carnation, etc. in greenhouses froze. Producers who are scraping through in 2016 and whose whole effort froze under the snow cried out saying "We are scattered, we are ruined".

DECLERATION OF AGRICULTURAL DISASTER ZONE WAS REQUESTED

Chairman of the İzmir Branch of the Chamber of Agricultural Engineers, Ferdan Çiftçi stated that the region should be declared as an agricultural disaster area. Ferdan Çiftçi remarked that the greenhouses could not carry the weight of the snow, and said:
"Greenhouses collapsed, the products remained unprotected outdoor and froze. Farmers are in loss in two aspects. Products for this year were ravaged as well as they need finance to rebuild the collapsed greenhouse. They are already in debt, most of them run this business with bank loans. The cost of greenhouse also increased due to the rise in exchange rates of the dollar and euro. The farmers, who bought the seed and seedling on credit, reacted to the loss of their efforts.
Agricultural insurance policies should be taken out. Farmers don't allocate money for insurance because they don't earn money. "Snow" clause should be included in the insurance policy. Its risk is low, but its loss is huge when it happens. There was a similar frost event in 2001, but the loss was not as severe as today's. We will live through similar events due to global climate change. In recent years, we have been experienced extreme situations such as unseasonable hail, unseasonable snow, extreme rainfall or drought. Measures and policies related to this should be developed. There should be support mechanisms to compensate for such losses. This region should urgently be declared as disaster region, and the damage of the farmer should be met."

*Source:* *http://www.tarimpusulasi.com/tarim/seralari-egede-kar-akdenizde-sel-vurdu/16989*

----------------------------------------------------------------2016--------------------------------------------------------------------

# Hail damaged agricultural products

August 21, 2016, 10:07 pm

Agricultural products reportedly damaged by hail in Kiraz district.
In his statement to an AA reporter, Mukhtar of Kaleköy, Durmuş Seçkin remarked that the hail along with the heavy rain fallen yesterday adversely affected the cultivated lands in Haliller, İğdeli, Akpınar, Sarıkaya, Çayağzı, Sırımlı, Gedik, Tek Bıçak, Kaleköy neighborhoods.
Seçkin told that approximately half an hour lasted hail lead to damage to 85 percent of gherkins sown in about 150 decares of land in Kaleköy, and noted that mostly cucumbers and olive trees were affected by precipitation.
Seçkin cited that teams from both Kiraz District Directorate of Agriculture and İzmir Metropolitan Municipality have carried out damage assessment studies.

*Source: http://www.haber7.com/izmir/2087289-dolu-tarim-urunlerine-zarar-verdi*

# Hail fallen in İzmir. Agricultural products were damaged.

Heavy rain that was effective in the town center of İzmir's Odemis district replaced by hail in environmental neighborhoods. Many agricultural products, in particular, olive, vegetable and watermelon plantations were damaged due to the walnut-sized hail.

*Wednesday, June 29, 2016, 6:15 pm*


Heavy summer rain that came at the end of June was effective for 10 minutes in the center of the Odemis, while hail fallen during 40 minutes in Bülbüller Neighborhood which is 12 kilometers from the center. Neighborhood residents expressed that they didn't expect a severe hail in June and that the hail which was effective in the afternoon damaged vegetable gardens, olive trees, and watermelon fields. It was reported that walnut-sized hail mostly damaged olives on olive trees.

"IT DROPPED OLIVES DOWN"

The mukhtar of the neighborhood, Süleyman Çoban, who made evaluations about the natural disaster, stated that 60 percent of the olive grove of 20 hectares in the neighborhood were damaged and said: "The summer rain started at noon today turned to hail as of 1:30 pm and lasted approximately 40 minutes. The hail completely wasted our products such as eggplant, tomato and pepper while dropping down the fruits on our olive trees. It also wasted watermelon seedlings which we were preparing to harvest".

60 PERCENT LOSS

Çoban stated that olive is the most important means of livelihood in the neighborhood and mostly the olive groves were damaged and said: "60 percent of trees were damaged in the olive grove of 20 hectares". Suleyman Çoban voiced that they expect aid from the government, and continued his speech as follows: "We have nothing to say in the face of this natural disaster from God. However, we reached to the District Directorate of Food, Agriculture and Livestock, and we told our situation. Teams from the District Directorate of Food, Agriculture and Livestock came to our neighborhood and reported the situation. We request assistance and support from the government for the damage of our citizens. We also thank to the District Directorate of Food, Agriculture and Livestock. Inshallah, we won't live through such a situation."

"MY TOMATOES WERE RAVAGED"

A farmer from Yusufdere Neighborhood, Talat Gülhan told: "Bülbüller and Yusufdere are side by side neighborhoods. The hail happened was somewhat effective in our neighborhood. I am farming tomato, we have been in a struggle to grow our tomatoes for the last two months. However, the hail today was devastated our tomato seedlings. The remained without tomatoes grown on them. We expect authorities to help".

*Source:https://www.egehaber.com/izmir/izmirde-dolu-yagdi-tarim-urunleri-zarar-gordu-h105846.html*

---------------------------------------------------------------2015---------------------------------------------------------------------------------

# Risk of drought in İzmir. If it won't rain…

İzmir is experiencing the worst drought of the last 60 years. There will be no precipitation according to the Meteorology Department. If the risk of drought will continue, seeds planted would face the risk of deterioration.


According to the forecast of İzmir Second Regional Directorate of Meteorology, there will be no precipitation until December 25th, 2015. This situation will mostly influence the farmers who planted wheat, lentil, and chickpea. **Due to the lack of rainfall in November and December, which is of great importance for production, seeds sown in fields face to risk of deterioration.** Chairman of the İzmir Branch of the Chamber of Agricultural Engineers, Ferdan Çiftçi stated that a large number of farmers are in difficulty because of the lack of rain and said: "There was no rainfall in December during which we most needed. This shows that the seeds sown will be at risk of deterioration".

"SEEDS ARE AT RISK OF DETERIORATION"

Chairman of the Branch, Çiftçi noted that untimely lack of rain will seriously harm the production and said: "The fact that there has been almost no precipitation in December, which means lifeblood, may lead to a situation that is too risky for the farmers who planted. Seeds, in particular, wheat seeds sown by farmers are in growing process under the soil. If there will be no precipitation, seeds under the soil in the field may face at the risk of deterioration". **He pointed out that along with climate change, the precipitation regime has also changed and said: "Unfortunately, climate change has an influence also on precipitation regimes. The precipitation which the farmer needs for three months long period falls within three days. This situation does not benefit, but quite the contrary harms the soil".**

"NEVER SEEN AS SUCH SINCE 1954"

Meteorological experts stated that the first half of December passed without precipitation and that no precipitation is forecasted for at least 10 days more. **They pointed out that it is the driest December since 1954.** Given the last 60 years' December data of İzmir, the average precipitation per square meter is 141 kg whereas no precipitation has fallen this year. Experts informed: "From 1954 to 2014, the average amount of the precipitation fallen per square meter in

December in İzmir is 141 kg, but this year no precipitation was recorded. Thus, we can say **the least rainy month of the last 60 years**. No precipitation is forecasted at least for ten days".

*Source: Cihan,* *http://www.haberekspres.com.tr/izmir/izmirde-kuraklik-tehlikesi-yagmur-yagmazsa-h84403.html*

# Agricultural products were again hit by frost

**Frost caused to a production loss of up to 30 percent according to the initial reports.** The Central Bank worried about food inflation and asked for actions be taken.

April 29, 2015

ALİ EKBER YILDIRIM

İZMİR - **Just like it caused severe loss last year, the frost disaster will adversely affect the yield in many products this year.** The Central Bank (CB) consistently bring up **the negative impact of this situation on inflation**. Authorities from CB requested, during the presentation to the Council of Ministers, measures to be implemented. The institution established for intervention is working on the topic. **Frost event has adversely affected many fruits such as apple, cherry, pomegranate, plum, pear, and peach. According to estimates, there will be a loss of 30 percent in the production. Damage assessment studies continues.**

Bad weather conditions continue to adversely affect agricultural products. Just like last year, **the frost disaster caused damage to many fruits, in particular, apricot, grape, walnut and hazelnut, also in this year. It is estimated that the frost disaster experienced in April was effective in 5 regions and that the damage was 30 percent on average. Due to frost, for many fruits, in particular, apricot, hazelnut, grape and walnut, the production will decrease and prices will be high again. Just like last year, it is expected that the increase in prices of unprocessed agricultural products and food will trigger inflation.**

...

**AEGEAN REGION:** In Denizli, 80 percent of persimmon trees and 70 percent of pomegranate trees and shoots were damaged. In the vineyards, drying is expected with a ratio of 20 percent. Apple, peach, apricot, almond and walnut trees were also damaged by frost. In Manisa, there are damages to vineyards, vegetable seedlings, tomatoes, and peppers. In particular, the damage in vineyards is expected to rise up to 70 percent. **In İzmir, some fruit trees, particularly cherry trees, and vineyards, in high places suffered 20 percent damage.** 80 percent of almond and plum trees in Afyon's city center and Şuhut district were damaged. There is also damage to cherry trees.

Damage assessment studies continues
Efforts continues to determine the damage to agricultural products due to frost disaster and other adverse weather conditions. Chairman of the Chamber of Agricultural Engineers, Özden Güngör stated that the exact loss rates will be announced in the coming days after the completion of studies of insurance adjusters and damage assessment commissions, and said: **"Seasonal conditions changed as a result of global warming adversely affect agricultural production. Unusual frost disasters in different regions in April caused severe damage in hazelnut, apricot, walnut, and other fruit trees and vineyards. It is estimated that the loss ratio throughout Turkey reached 30 percent. Farmers that were worried for this year due to the calamity in the last year were unfortunately faced with the frost again. As the Chamber of Agricultural Engineers, we warn in advance, and appeal to urgently take action, the government, for problems to be seen on the decrease in farmers' revenues, the increase in consumers prices, and the export, due to the lack of production in 2015".**

…

Debts of those who suffered a loss of 30 percent are to be deferred
According to the statement from the Ministry of Food, Agriculture and Livestock, **agricultural credit debts of farmers who suffered from natural disasters are to be deferred for a period of one year applying an interest rate of three percent.** The statement of the Ministry is briefly as follows: "Based on the "Decree of the Council of Ministers No. 2015/7510 regarding the Deferment of Credit Debts, that have been Facilitated within the Scope of Decrees of the Council of Ministers regarding Providing Credit Facilities with a Low Interest Rate, of Natural and Legal Persons, who have Suffered Loss due to Various Disasters, to T.C. Ziraat Bankası A.Ş. and Agricultural Credit Cooperatives" which was published in the Official Gazette No. 29322 dated April 10, 2015, **debts of farmers, who suffered a loss of 30 percent or more according to the damage assessment reports by provincial/district damage assessment commissions, are deferred for one year with an interest rate of three percent. Losses due to disasters of frost, hail, drought, excessive rainfall, flood, fire, excessive heat damage, simoom, avalanche, landslide, groundwater rise, storm, excessive snowfall, snowstorm, hoarfrost, lightning, and whirlwind, that have been occurred or would occur between January 1, 2015 and December 31, 2015 shall be within the scope of debt deferment.**

It may trigger inflation
Due to drought and other natural disasters happened last year, agricultural production largely decreased, and the sector shrank last year for the first time since 2007. Agricultural sector, which grew 3.1 percent in 2012 and 2013, shrank by 1.9 percent last year. The shrinkage in agriculture adversely affected the growth in the economy. In 2015, given the precipitation fallen so far, the drought was not considered as a threat, but the frost disasters in the beginning of the year and in April affected some products negatively. Therefore, even there is an increase as compared to last year, production is expected to decrease as compared to the general average. Prices of apricot, hazelnut, grape, walnut, and other fruits, that are harmed by frost are expected to remain high in this year as well. Therefore, just like last year, the price increase in agricultural and food products will trigger inflation again.

…

In the Aegean Region, a loss occurred that equals to about 100 thousand tons of dry grapes
The frost event, which was effective in the Aegean Region during last week, was the most important agenda topic at the Assembly Meeting of İzmir Commodity Exchange. Assembly Member of Izmir Commodity Exchange (ICE), Mehmet Esmer explained that a loss equivalent to approximately 100 thousand tons of dry grapes has occurred due to frost. He stated that this amount can be resolved by taking measures against frost and said: "We faced with an agricultural disaster in our region. Today, grape farming is the livelihood of about 100 thousand families. If we say: there is nothing to do, it is destiny, it is nature, we will remain with our loss. But if we say: no, this is not a destiny in developed countries, there is a solution for all these, and then we will take measures accordingly. The cost of preventing agricultural disasters is much cheaper than the cost of resolving the consequences of these disasters. If measures had been taken on the night of April 24th, the cost corresponding to 100 thousand tons of dry grapes would not arise. Although these methods are known, they are not applied in our country".

*Source:* *https://www.dunya.com/sektorler/tarim/tarim-urunlerini-yine-don-vurdu-haberi-278400*

## İzmir: Erosion Threat in Kucuk Menderes Plain

**It was reported that Kucuk Menderes Plain, which is one of the three most productive plains of the world, is under risk because of the erosion in the region.**

Saturday, July 2, 2006, 12:43 pm

It was reported that Kucuk Menderes Plain, which is one of the three most productive plains of the world, is under risk because of the erosion in the region.
A geological engineer Ertuğrul Basma, who informed about the issue said: "I remind you that the Kucuk Menderes Plain is faced with a threat to which nobody is paying attention. The plain includes Aydın mountains in the south, and Bozdağlar, Kiraz, and Beydag regions in the north, and due to the lack of sufficient forestation in the mountains, the soil comes down from the mountains to the plain, together with streams and floods. The ground have raised 3 centimeters. The fact that, every year, a soil layer of 3 centimeters is accumulating on the plain, requires us to take the size of threat into consideration. In the future, we won't be able to find a place to plant crops due to the fact that, along with precipitations, surface soils of the mountains drift and come down to the plain. In an area with a size of 576 square kilometers in the plain whose surface area is 107,900 hectares, danger approaches to us by 3 centimeters each year, even though it is not visible. If we will not complete an intensive forestation, Kucuk Menderes basin will rise up by 30 meters after a hundred years and will be at the same level as Bozdağ. In this instance, there will be a water shortage and we will have to pump water from Selcuk to this region. From now on, We should urgently accelerate the forestation. Danger is coming obviously."

Source: https://www.haberler.com/izmir-kucuk-menderes-ovasi-nda-erozyon-tehdidi-haberi/

## Reports and Official Publications

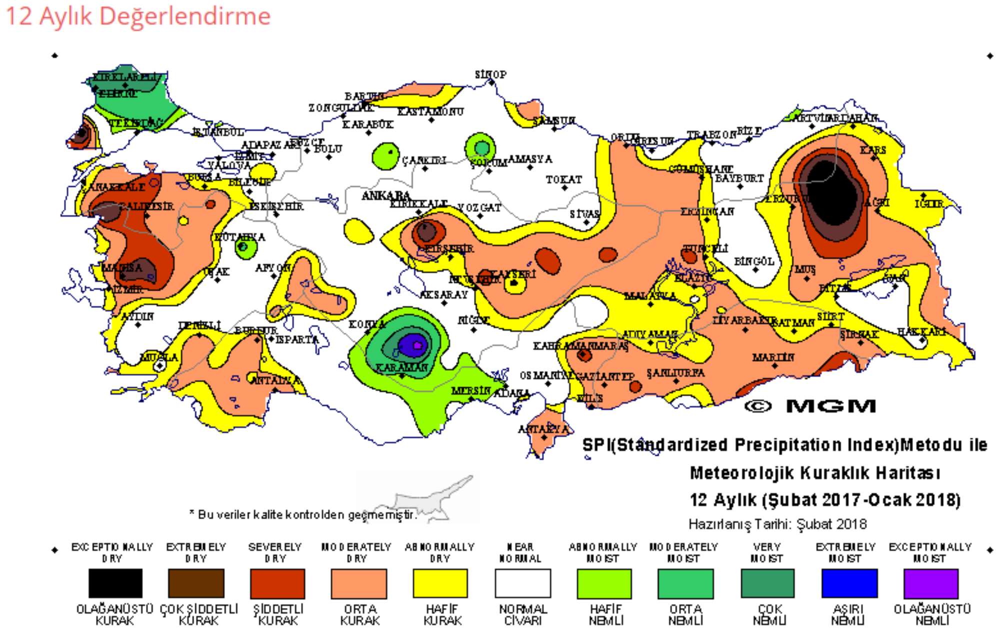



**Figure 1:** 12 Monthly Turkey-wide drought map

According to the current data of the General Directorate of Meteorology, İzmir and KMRB are under drought threat in a 12 month long period as of February 2017.

*Source: MGM (General Directorate of Meteorology)*

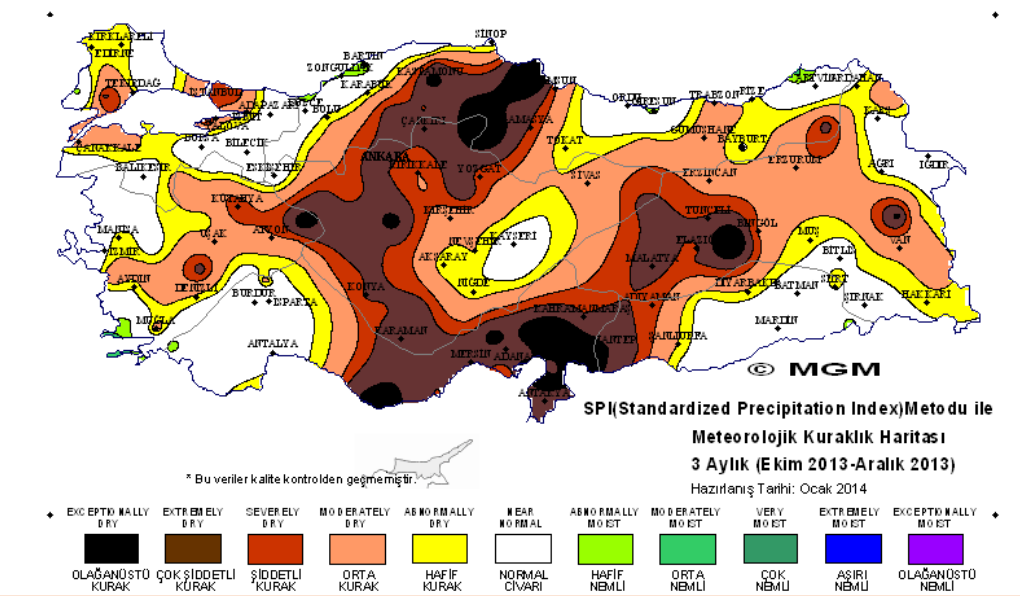



**Figure 3:** 3 monthly Turkey-wide drought map

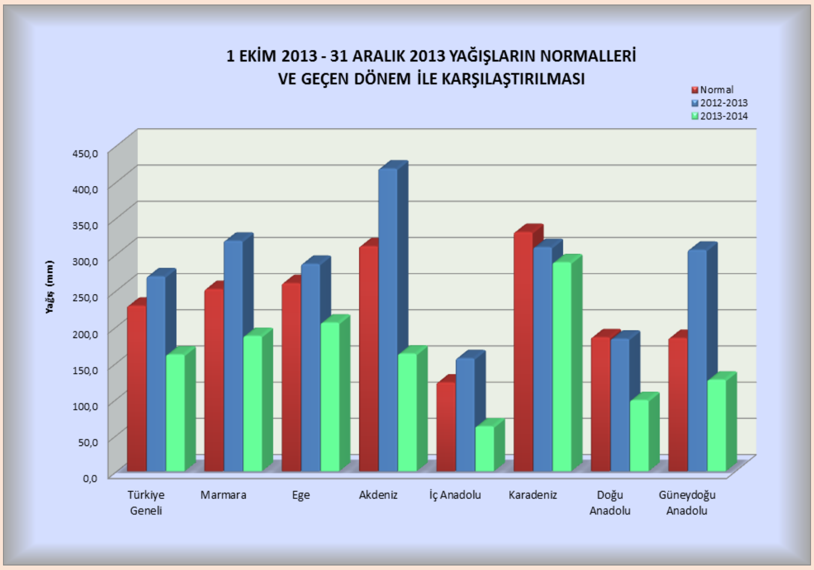



**Figure 4:** Comparison of precipitation (2012-2013)

Aegean Region

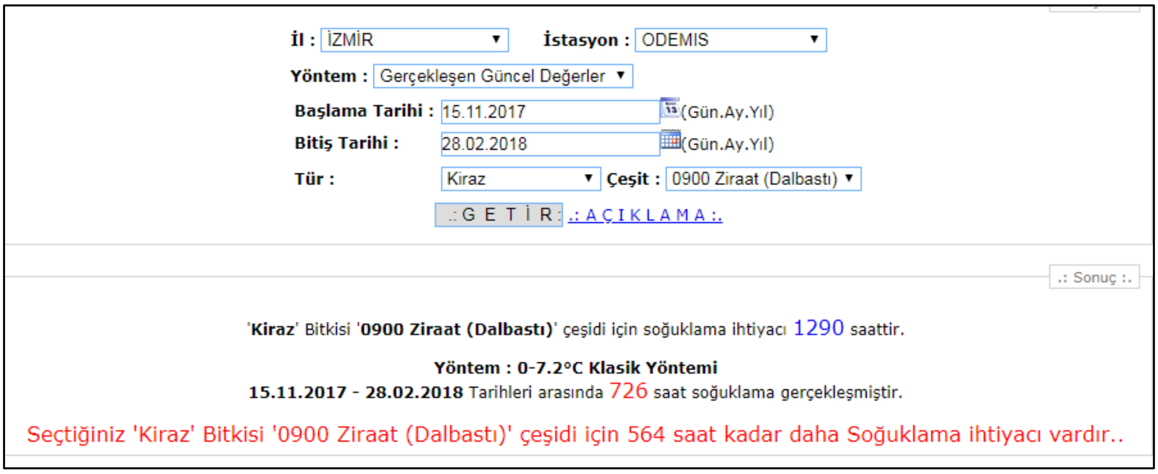
In terms of cumulative precipitation, the average of the region is 199.8 mm, normally it has to be 246,1 mm, and the average of the last year for the same period is 266.8 mm. A decrease of 18.8% as compared to the normal and 25.1% as compared to last year was observed in cumulative precipitation.

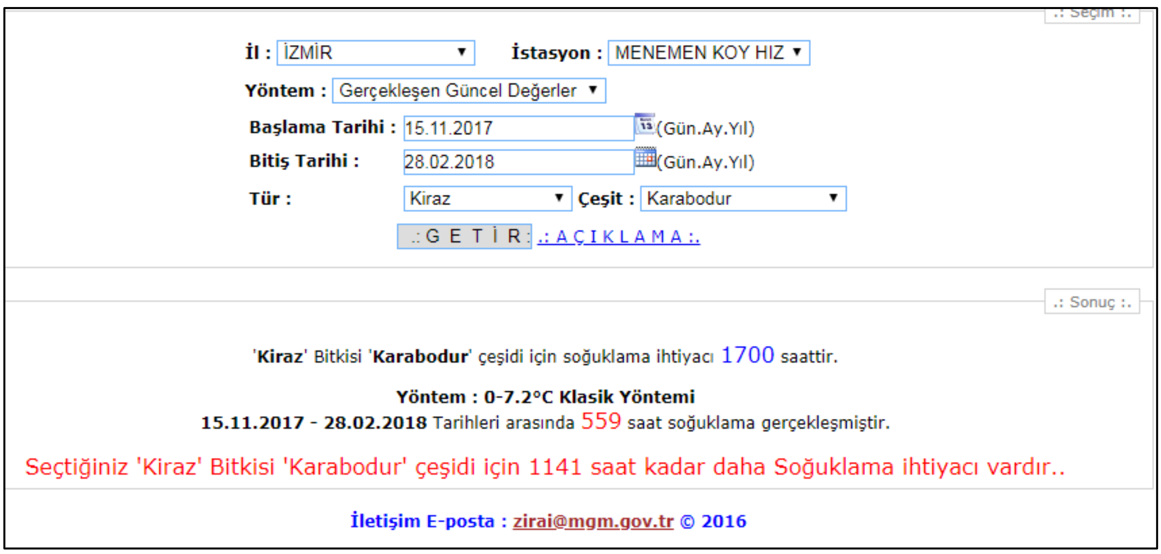
*Source: Frankfurt School of Finance & Management*

Average total number of days with frost during February and March in the KMRB districts *(Source: MGM)*

| Year | Average Number of Days with Frost (February+March) (≤ -1 °C) |
|---|---|
| 2012 | 9.8 |
| 2013 | 4 |
| 2014 | 5.8 |
| 2015 | 7.4 |
| 2016 | 3.69 |

According to the following results, for example, it is seen that 47.5 day long cooling need of Karabodur type cherry plant is not met. This means that the tree will not produce fruit even if it blossoms. The fact that plants can not sufficiently cool in the range of 7-7.2 °C in winter is only one of the results caused by climate change.

2015 Climate Assessment by MGM

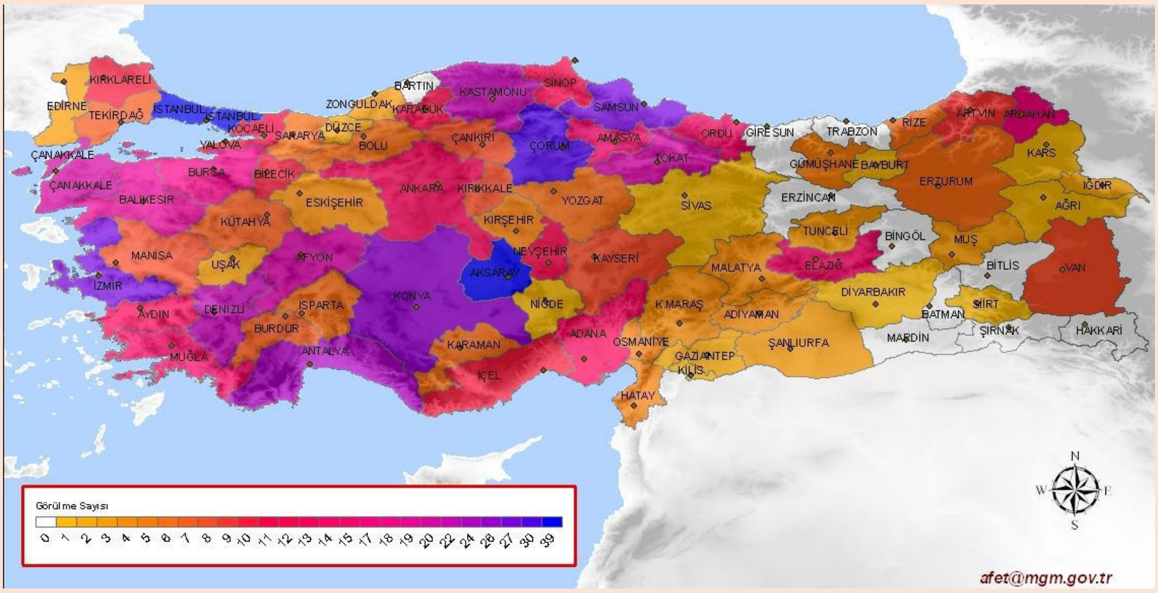



**Figure 5:** Number of extreme events occurred in cities

Most of the events were observed in Marmara, eastern Black Sea, Mediterranean, Central Anatolia, and northern side of the country. In 2015, İstanbul, Aksaray and Çorum had the highest number of disasters which was 39. **27 events happened both in İzmir and Antalya**, and 30 events in Konya.

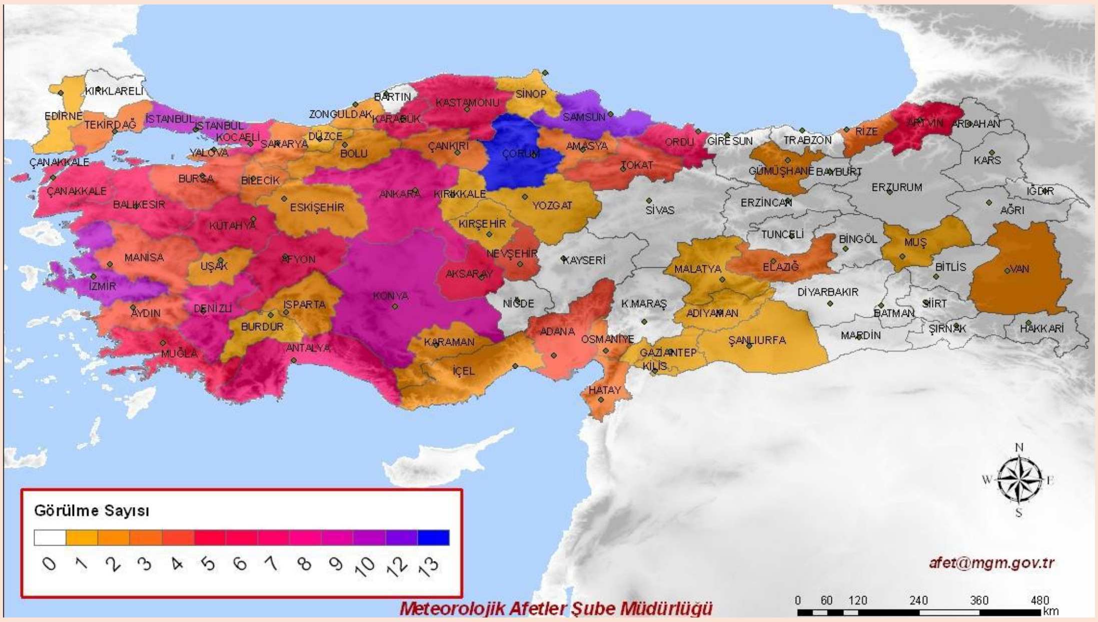



**Figure 6:** Numbers of heavy precipitations and floods in cities

In 2015, the most frequently observed extreme event was heavy precipitation and flood with a rate of 26%, and İstanbul was the city at which these events occurred at most. 13 flood events were occurred in Çorum which is followed by İstanbul, İzmir and Konya.

*Source: MGM Climate Report 2015*

# Annex-2: Climate Risk Assessment of KMRB

## 2.1. Purpose and Scope

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2013) addresses the main risks from climate change for the European region including Turkey under the following three topics:

1) Increase both in the number of people affected and in economic losses, from floods and overflows in river basins and coasts due to increased urbanization, rising sea level, coastal erosion, and peak river flows;

2) Increased water constraints (especially in Southern Europe): significant decrease in the amount of existing water as a result of increased water demand (for agricultural irrigation, use in energy and industry, and domestic use), reduced water drainage and flow due to increased evaporation demand, as well as extraction from rivers and underground sources; and

3) Increase in the number of people affected by extreme hot weather events, and in economic losses: Impacts on health and well-being, labor productivity, air quality and increased forest fire risk in southern Europe.

This report highlights one of the major future risks of Europe's Mediterranean countries (including Turkey) as the decrease in water resources. The decrease in water resources is associated both with the decrease in the first grade precipitation and the increase in evaporation-transpiration. This negative aspect of climate change will be felt firstly in agricultural sector compared to other sectors due to the fact that this sector is dependent on precipitation both directly (rainy) and indirectly (irrigation). Moreover, the increase in extreme hot weather events has the potential to adversely affect both the agricultural yield and the productivity of labor, which requires working outdoors, in the agricultural sector.

On the other hand, increases observed in air and sea temperatures due to global warming increase the likelihood of extreme weather and climate events (IPCC, 2012). Climate change leads to significant changes in the inherent variability of the climate and increases both the frequency of extreme weather events and the severity of weather- and climate-related events. Therefore, in this project, weather- and climate-related agricultural vulnerability and risks were identified considering the effects of climate change. For this purpose, firstly the current climatology of the study area was determined and then the risks arising from climate change until 2050 were evaluated. The better known today's climatic conditions, the better the effects of future climate change can be identified. Data from the General Directorate of Meteorology (MGM) were used to determine the current climatic conditions of the study area.

Since a wide variety of and significant risks are encountered in agriculture, weather- and climate-related risks should be determined very well. In this project, the weather- and climate-related risks that were taken into account within the scope of the available data are as follows:

- Changes in the precipitation regime;
- Changes and variations in air temperatures (e.g. extreme and high minimum and maximum temperature records, etc.);
- Hailstorms;
- Drought events;
- Frost events.

An agricultural vulnerability assessment was conducted using the weather- and climate-related risks identified as well as economic and social indicators. In addition, the "Temperature Index" proposed by the United States (US) National Weather Service (NWS) and the National Oceanic and Atmospheric Administration (NOAA) was used for the possible impacts of climate change in terms of occupational health in future. In order to examine the future drought situation, the standardized precipitation index (SPI) was used which is recommended by the World Meteorological Organization (WMO) for use in drought studies. In order to determine the sea level rise, Digital Surface Model (WorldDEM) obtained by TanDEM-X satellite group was used.

## 2.2. Current Climatology of Kucuk Menderes Basin

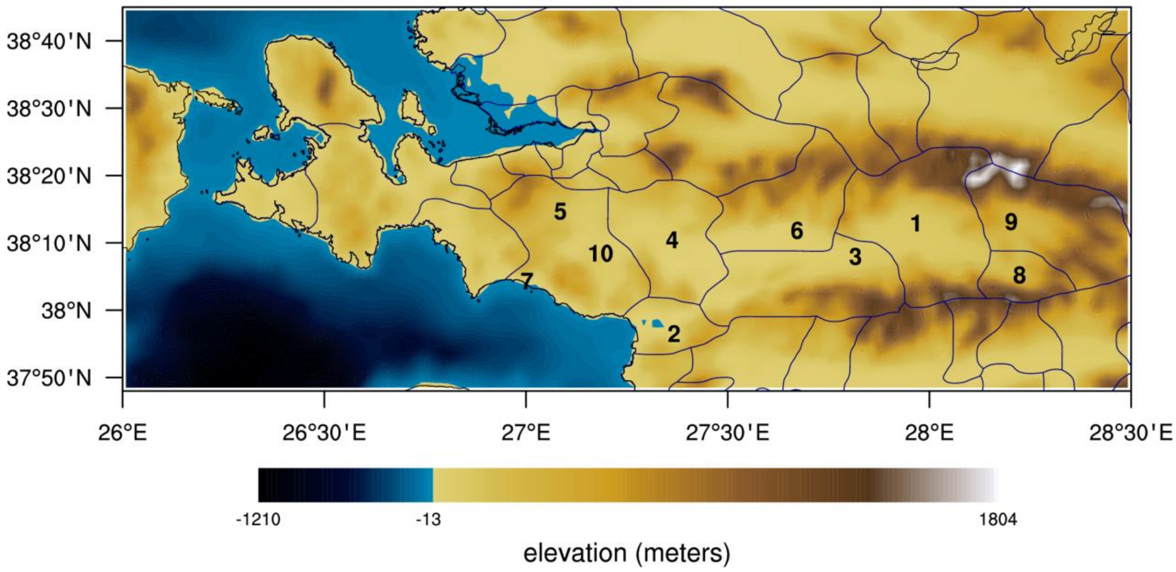
The Kucuk Menderes Basin is under the effect of Mediterranean Climate. It is under the influence of large-scale pressure systems and upper atmosphere circulations, such as Atlantic mid-latitude and Mediterranean cyclones and dynamically generated subtropical anticyclones from the Azores region. The Mediterranean climate exhibits a very wet, mild winter and a hot dry summer, as well as real seasonal humid and semi-humid subtropical climatic characteristics (Türkeş, 1996, 1999). The Mediterranean climate region has the characteristics, in terms of weather conditions, of both the polar (cold) and temperate zone and the tropical (hot) zone (Türkeş, 2017a). In winter, temperate zone-specific, wet, cold, windy, and occasionally frontal stormy -generated by mid-latitude low pressures- weather conditions are dominant. In summer, torrid zone-specific, hot, arid, and calm weather conditions are dominant. In spring and autumn, weather conditions specific to both major climatic zones can have influence. Weather types are very diverse and unsettled in spring and autumn, especially in spring. In short-term weather circuits where moving mid-latitude low pressures are effective, sometimes, in the same day, snowy, cold and windy, then warm and sunny and then heavy rainy, even thundery showers and stormy weather conditions can be experienced. In summer, longer-lasting and stable weather types are dominant. There are also changes in weather and wind conditions that are not dependent to general weather circulation.

Table 1: MGM stations used in the study

| No | Station No | Station Name | Latitude | Longitude | Elevation (m) |
|---|---|---|---|---|---|
| 1 | 17822 | Odemis | 38.2157 | 27.9642 | 111 |
| 2 | 17854 | Selcuk | 37.9423 | 27.3669 | 18 |
| 3 | 18029 | Tire | 38.133 | 27.8165 | 70 |
| 4 | 18030 | Torbalı | 38.1743 | 27.3623 | 60 |
| 5 | 18034 | Menderes | 38.2447 | 27.0849 | 145 |
| 6 | 18049 | Bayındır | 38.1975 | 27.6719 | 70 |
| 7 | 18050 | Menderes/Gümüldür | 38.072 | 27.0026 | 70 |
| 8 | 18441 | Beydag | 38.0872 | 28.2233 | 215 |
| 9 | 18447 | Kiraz | 38.2192 | 28.2028 | 310 |
| 10 | 18449 | Menderes/Çileme | 38.1408 | 27.1858 | 63 |

In Table 1, the list and location information of 10 stations used in the study are given. Odemis station numbered 17822 and Selcuk station numbered 17854 are synoptic weather observation stations. The remaining 8 stations are automatic weather observation station (AWOS). Elevations of stations vary from 60 meters to 310 meters.

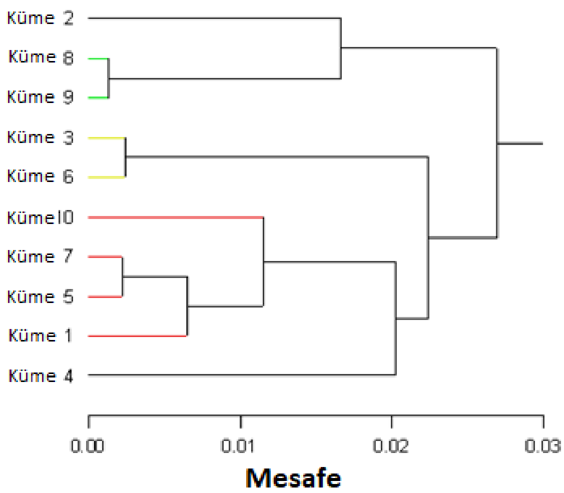
Figure 1: Generalized elevation map of the study area, and geographical distribution of the 10 stations selected and used as representative of the Kucuk Menderes Basin




In Figure 1, the geographical distribution map of 10 stations located in the Kucuk Menderes basin is given. The numbers representing the stations in Figure 1 are taken from the station sequence given in Table 1. As seen in the figure, the stations used in the study very well represent the Kucuk Menderes Basin in terms of spatial distribution.

In order to determine the current climatic characteristics of the Kucuk Menderes Basin, monthly total precipitation (mm), monthly average temperature (°C), monthly average maximum temperature (°C), monthly average minimum temperature (°C), monthly relative humidity (%), monthly number of days with frost (<-0.1 °C), monthly number of days with precipitation, and monthly cooling days (<7,2 ° C) data from the General Directorate of Meteorology (MGM) were used. Since the measurement start date of the AWOS stations used is in 2012, the statistics given in Table-2 involve the measurements between 2012-2016. The measurements of Odemis and Selcuk stations start before 1970. Data from these stations will be used to compare climate projection data.

Figure 2: Dendrogram calculated by Ward's Method




In the first stage, stations that indicate similar climate characteristics will be determined by the cluster analysis. Cluster analysis is the determination of groups or clusters formed by similarly characterized data in a measured data set. The purpose here is to create a set of clusters by identifying climatic characteristics that are more similar to each other. In this study, Ward's clustering method (1963) which was revealed by various studies (Ünal, 2003; Şahin and Cığızoğlu, 2012; İyigün et al., 2013) Ward (1963) that it gives the best results for the determination of climatic regions in Turkey, was used. The matrix composed of correlation coefficients of monthly average temperature, monthly total precipitation, and monthly relative humidity data measured between 2012 and 2016 was used as an input for the cluster analysis (Şahin and Cığızoğlu, 2012). Cluster analysis results are given in Figure 18 as a dendrogram.

According to the results of the cluster analysis, 3 clusters can be mentioned. The stations in cluster 1 are stations 5, 7 and 10, stations in cluster 2 are stations 2 and 4, and stations in cluster 3 are stations 1, 3, 6, 8 and 9. Station 1 has been included in the cluster 3 due to its position. Table 1 shows information of the stations listed according to the number sequence.

Table 2: Seasonal climatic characteristics between 2012 and 2016 of climatic clusters determined in the study

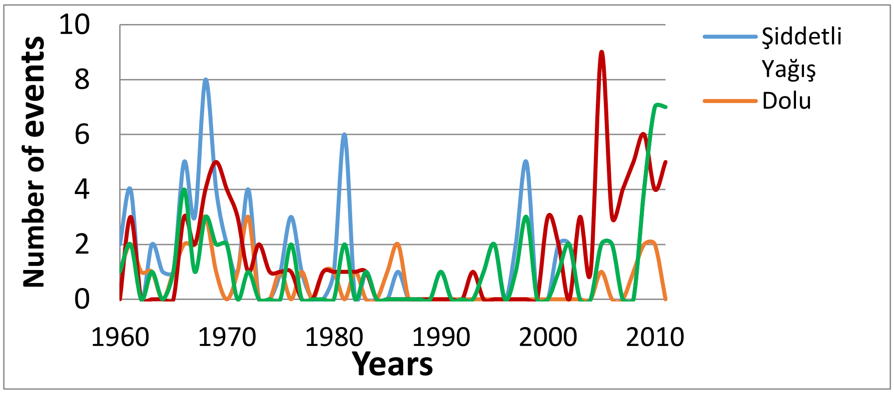
| | Winter | Spring | Summer | Autumn | Annual |
|---|---|---|---|---|---|
| Precipitation (mm) | | | | | |
| Cluster 1 | 369.78 | 157.04 | 22.47 | 132.17 | 681.45 |
| Cluster 2 | 363.02 | 154.23 | 24.59 | 130.45 | 672.28 |
| Cluster 3 | 249.29 | 153.28 | 45.21 | 109.67 | 557.46 |
| Average Temperature (°C) | | | | | |
| Cluster 1 | 9.00 | 15.87 | 26.96 | 18.75 | 17.65 |
| Cluster 2 | 8.81 | 16.40 | 27.05 | 18.57 | 17.71 |
| Cluster 3 | 8.03 | 15.62 | 26.74 | 18.35 | 17.18 |
| Max Temperature (°C) | | | | | |
| Cluster 1 | 20.71 | 30.01 | 38.14 | 30.82 | 29.92 |
| Cluster 2 | 20.54 | 29.71 | 38.10 | 30.75 | 29.78 |
| Cluster 3 | 19.87 | 28.38 | 38.13 | 30.51 | 29.22 |
| Min Temperature (°C) | | | | | |
| Cluster 1 | -2.17 | 4.82 | 15.64 | 8.21 | 6.63 |
| Cluster 2 | -2.78 | 4.66 | 15.50 | 6.43 | 5.95 |
| Cluster 3 | -3.59 | 3.55 | 14.67 | 5.89 | 5.13 |
| Relative Humidity (%) | | | | | |
| Cluster 1 | 79.17 | 67.13 | 52.11 | 64.59 | 65.75 |
| Cluster 2 | 78.19 | 65.74 | 53.57 | 67.13 | 66.16 |
| Cluster 3 | 78.32 | 66.85 | 53.35 | 65.52 | 66.01 |
| Number of days with frost (<-0,1 ˚C) | | | | | |
| Cluster 1 | 18 | 1 | 0 | 1 | 20 |
| Cluster 2 | 18 | 2 | 0 | 1 | 21 |
| Cluster 3 | 25 | 2 | 0 | 2 | 29 |
| Number of Days with Precipitation | | | | | |
| Cluster 1 | 30 | 25 | 7 | 13 | 75 |
| Cluster 2 | 35 | 24 | 8 | 13 | 80 |
| Cluster 3 | 32 | 26 | 10 | 16 | 84 |
| Monthly Cooling Durations (<7,2˚C) (hours) | | | | | |
| Cluster 1 | 771 | 158 | 0 | 78 | 1007 |
| Cluster 2 | 823 | 134 | 0 | 88 | 1045 |
| Cluster 3 | 920 | 190 | 0 | 126 | 1236 |

Table 2 shows the seasonal distribution of the data used to the clusters determined. In fact, it was stated that the study area shows the characteristics of the Mediterranean climate, which can also be understood from the seasonal distribution of the precipitation and temperature values given in Table 2. Although all clusters indicate the Mediterranean climate, some differences may be mentioned.

For example, the annual total precipitation difference between cluster 1 and cluster 3 is 124 mm, and the average temperature difference is 0.97 °C for winter months. In terms of maximum and minimum temperatures, cluster 3 is colder than cluster 1. This is also evident in the data of number of days with frost (<-0.1 °C) and of monthly cooling days (<7.2 °C). Although all clusters show almost similar behavior in terms of the number of days with precipitation, it can be said that heavier precipitation is seen in cluster 1 since the precipitation difference, especially in winter, between cluster 1 and cluster 3 is 120 mm. Relative humidity data, which has less variability as compared to other climatic variables, shows similar values in all three clusters.

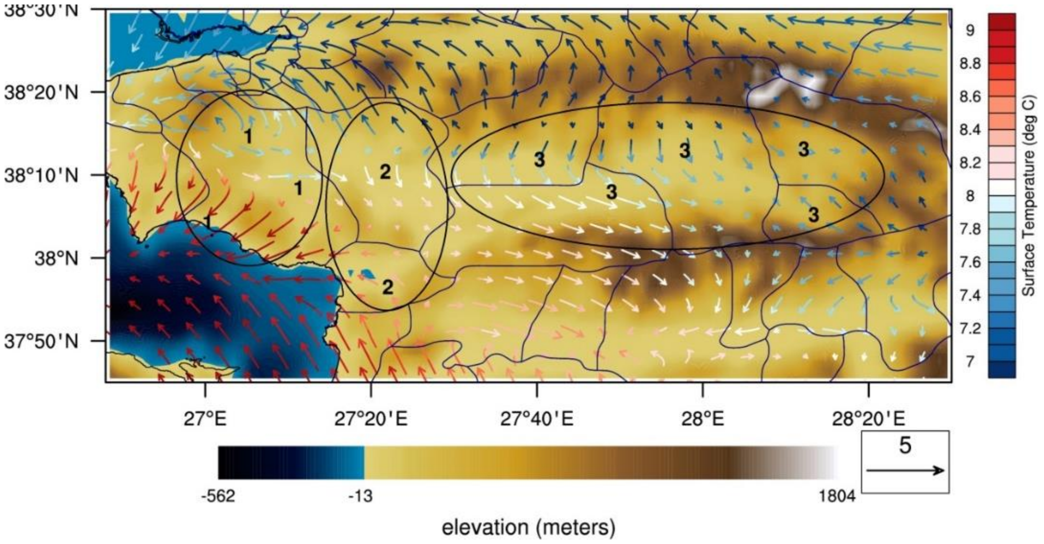
Cluster 2 shows the characteristics of a transition region between cluster 1 and cluster 3. However, the rapid loss of the effects of the northern winds in almost all seasons makes the climate of the region different from the other clusters. Particularly the fact that the correlation (Pearson's correlation coefficient *r*) of both temperature and precipitation data with other clusters is lesser, confirms this situation. In other words, the correlation between cluster 1 and cluster 3 is higher as compared to cluster 2. Since it is expected that the effect of surface air masses coming from the sea can be minimum in cluster 2, it is thought that the fact that the dominant wind direction seen in all seasons in cluster 2 is the north is effective on this situation. In other clusters, there is a very complex pattern in terms of wind direction and intensity due to the predominant effects of land-sea interactions, land-sea breezes and mountain-valley breezes, respectively.

Figure 3: The temporal distribution graph of superior data of İzmir between 1960 and 2010



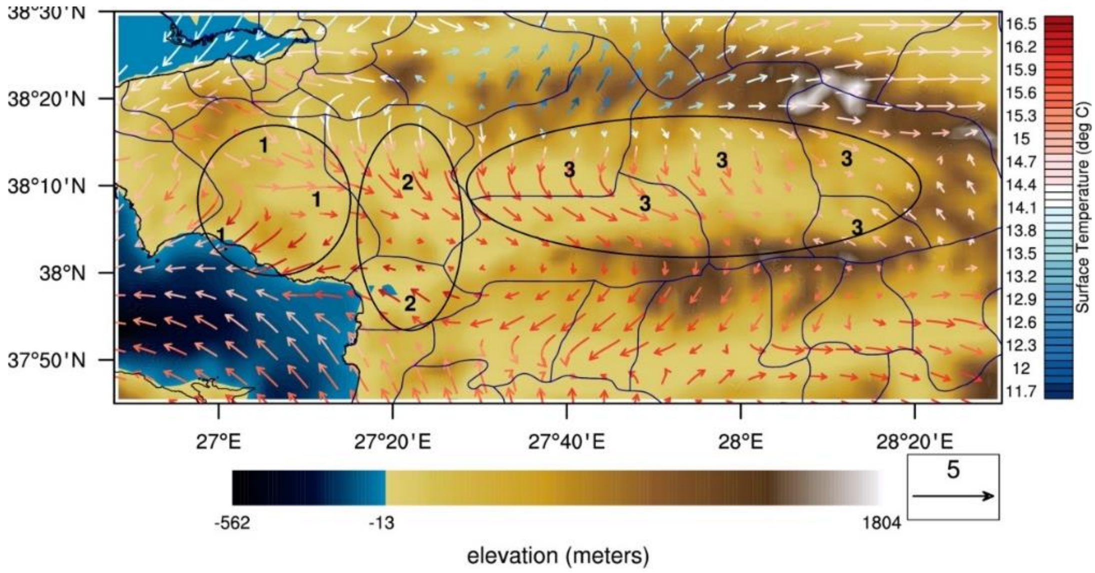

Superior data is the record of events occurring in the vicinity of the station.  For recording, each event is coded as 1 (happened or damaged) and 0 (not happened or not damaged) according to subheadings of flood, storm, hail and heavy precipitation. The number of heavy precipitations, hail, storm and flood events by years is given in Figure 3. Superior data in Figure 19 that belongs to İzmir could unfortunately not be obtained on the district basis but can be generalized for the Kucuk Menderes Basin. As seen in Figure 3, there is a gradually increase to the present in the number of flood and storm events. When Table 2 and Figure 3 are examined together, it can be said that storm, flood and hail events are the main risks considering the agricultural risks such as cold spell, cool days, humidity, wind, urban heat island.

Figure 4: The map of average air temperature, prevailing wind direction and intensity for the month of January between 2012 and 2016



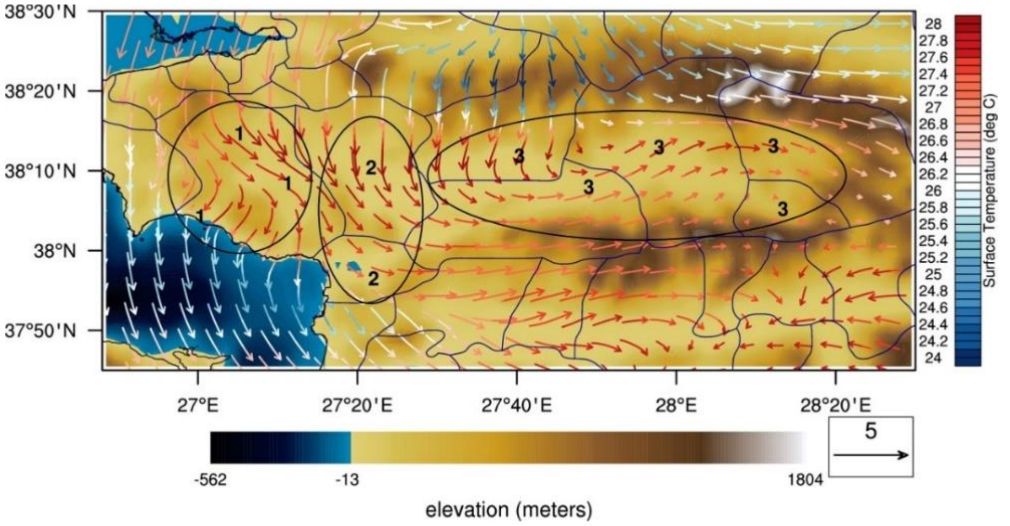

In this project, the mid-season months are used to represent the seasons. It is thought that the mid-season months well represent particularly the wind climatology and seasonal wind characteristics of the region. Figure 4 shows the prevailing wind direction and intensity as well as the average temperature values of wind vectors colors calculated for the month of January as a representative of winter months. The dominant wind direction and intensity are the values measured at a height of 10 m for synoptic meteorological purposes and are the winds blowing over the surface. In other words, as the effect of friction is important, these winds are not the real geostrophic or gradient winds, but the boundary layer gradient winds. As lands are cooler and seas are cool but warmer than lands in winter, winds blow from lands to seas. This situation is clearly seen in Figure 3. In the Kucuk Menderes Basin, the wind blows in almost every direction. Specifically, cluster 1 displays a very dynamic view in terms of wind formation and the most severe winds are in this cluster. Winds are more severe in cluster 1 as compared to cluster 2 and cluster 3. Cluster 3 is surrounded by the Bozdağlar sequence and the mountains to the south. Therefore, weak winds blow up in cluster 3, especially in Beydag and Kiraz districts. This situation is seen in all seasons of the year.

Figure 5: The map of average air temperature, prevailing wind direction and intensity in the month of April between 2012 and 2016.




The map of average temperature, prevailing wind direction and intensity in the month of April as a representative of the spring season is seen in Figure 5. Due to the decrease in the temperature difference between seas and lands, relatively lighter winds, as compared to January, blow over the Kucuk Menderes Basin. However, the wind direction in coastal regions is still from the land to the sea. Especially the norther winds are seen in the whole basin. As in January, the strongest winds are seen in cluster 1. In April, the dominant wind direction pattern in cluster 3 is almost the same as in January, although it is slightly weaker.

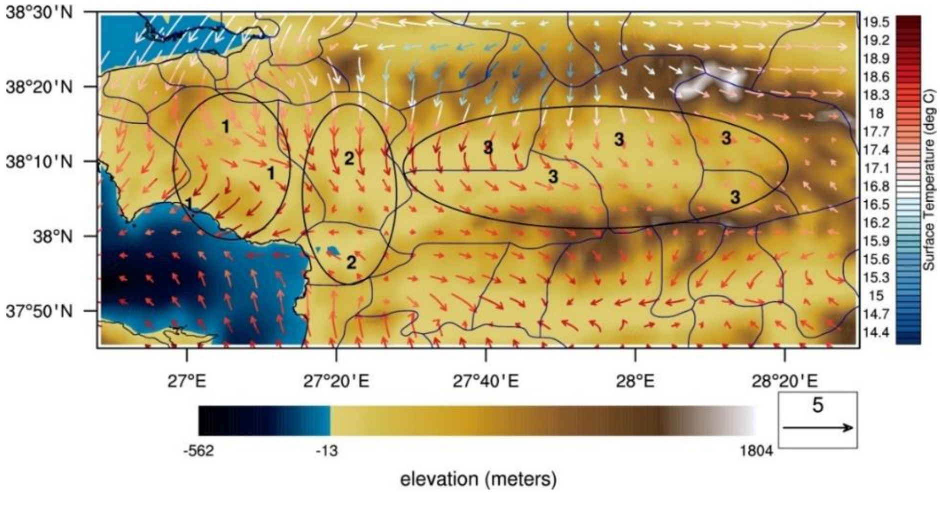
Figure 6: The map of average air temperature, prevailing wind direction and intensity in the month of July between 2012 and 2016.




The map of average temperature, prevailing wind direction and intensity in the month of July as a representative of the summer season is seen in Figure 6. As expected, the strongest winds blow in July just like throughout Turkey, and the wind direction in coastal regions tends to be from the sea to the land. Since the hot and strong wind blowing during this month in which the surface temperature also reaches the highest levels will increase the value of the heat index described in section 1.4.1, it can be expected that it will directly affect human health by reducing climate comfort.

The map of average temperature, prevailing wind direction and intensity in the month of October as a representative of the autumn season is seen in Figure 7. The wind pattern distribution seen in April in Figure 5 is quite similar to the wind pattern seen in Figure 7. However, as is seen, the surface air temperature in October is about 3 °C higher than in April.

Figure 7: The map of average temperature, prevailing wind direction and intensity for the month of October between 2012 and 2016.




Based on the maps of prevailing wind direction and intensity in January, April, July, and October, which were prepared as the representatives of the seasons, the strongest wind is seen in cluster 1 while the weakest wind is in cluster 3. The temperature distribution over the basin shows that the relatively terrestrial interiors are always cooler than in regions close to the sea, in all seasons. The fact that, in cluster 2, norther winds blowing in all seasons weaken and change their direction towards the sea except summer makes this cluster slightly different, in climatic terms, from the other clusters, and ensured it to be a transition zone between cluster 1 and cluster 3.

## 2.3. Agricultural Vulnerability Assessment

In order to determine the climatic impacts on agriculture, the composite (combined) indexes will be calculated, and the results will be shown by means of charts. When evaluating and mapping the agricultural vulnerability, utmost care should be taken because of uncertainties regarding the method. According to a recent study (Wirehn et al., 2015), 34 of the 36 method combinations used gave results quite different from each other. Nevertheless, none of the vulnerability approaches should be considered better or worse than any other (Fellman, 2012). In this study, a combined index approach involving an indicator set will be carried out for the digital analysis and evaluation of the vulnerability. This kind of indicator approach enables the calculation of many aspects of vulnerability such as biophysical, socioeconomic etc. (e.g. Eakin and Luers, 2006; Füssel and Klein, 2006).

### 2.3.1. Components of Vulnerability

***Exposure (be influenced, impression)*** is related with "the nature and degree to which a system is exposed to significant climatic variations" (IPCC, 2001).

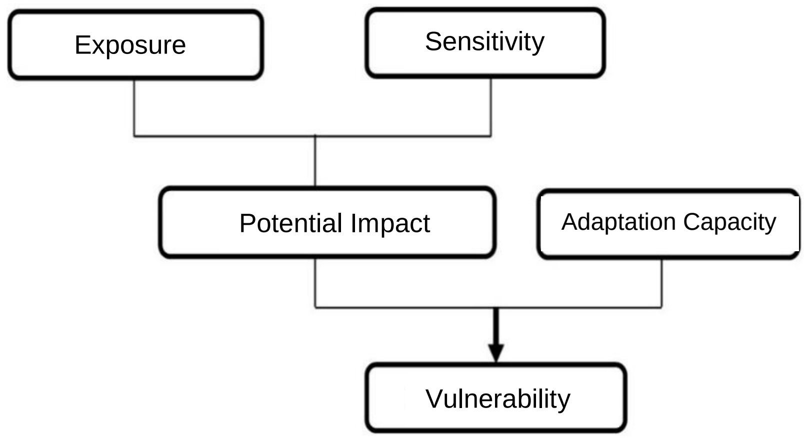
***Sensitivity*** is related with "the degree to which a system is affected, either beneficially or adversely by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise)" (IPCC, 2001).

***Vulnerability***: According to Türkeş and Akgündüz (2011), **"*Climate Change Vulnerability*"** can be defined in the broadest sense as "the relationship between the degree of being affected by or impressionability to climate change stress, level of compensation of or responding to this stress (sensitivity or susceptibility), and level of adaptation to climate changes (adaptability), of a community or system". In this definition, if the word climate is used instead of climate change, then Climatic Vulnerability concept can be reached (Türkeş, 2013, 2014). In general, adaptation to climate change covers and requires the presence of adjustments and arrangements made in advance to be prepared against projected climate change (e.g., changes in average conditions) and climatic variability (e.g., changes in extreme values and variability) in order to mitigate harmful effects of climate change and to seize possible beneficial opportunities (IPCC , 2007). Climatic vulnerability is mostly related to the facts and concepts of poverty and food insecurity. Therefore, all efforts and activities aimed at eliminating poverty and food insecurity and insufficiency provide significant mitigations and improvements in the level of climatic vulnerability (Türkeş, 2017b).

Another important concept hereof is the **"*Adaptation Capacity*"**. Most ecological and social systems develop on an adaptation capacity (Türkeş, 2017b). However, climate variability and rapid climate change rates observed today bring about new and additional pressures that may lead to the exceedance of the existing coping capacity. Therefore, the local knowledge obtained and methods applied, relating to the matter, by farmers, tree farmers (e.g., "Forest Villagers in Turkey), and fishermen (especially those who make traditional small local fishery) over time are vital in terms of the adaptation capacity. (Türkeş, 2017b). Therefore, this means the acknowledgment of the importance and advantages of local knowledge obtained in the fields of fishery and livestock, agricultural systems and farming, management of soil, water and nutrients, agricultural forestry systems and management of forest (bushes, trees, woods) fire. (Türkeş, 2017b).

***Exposure + Sensitivity = Potential impact:*** It is not necessary that systems, on which climate change may have an impact, but which are highly exposed and/or sensitive systems, are vulnerable.

Figure 8: Flowchart of agricultural vulnerability assessment




Source: Fellman, 2012; Füssel and Klein, 2006

The flowchart of agricultural vulnerability assessment is given in Figure 8. In this study, in order to classify the indicators in Table 3, IPCC definitions were used for the draft and vulnerability proposed by Füssel and Klein (2006). The codes M, H, and A given in Table 3 are used in Table 4. In addition, the indicators and indexes used in the vulnerability assessment are explained below.

The indicator is an instrument that plays an important role in transforming data in various characteristics and levels into related information in order to be used and interpreted by public and decision makers. Through a variety of statistics and analyses, the indicators provide a combination, that can be easily and accurately used in decision-making, of existing data, conditions, features and trends related to a subject, event, problem, and process.

An index is a statistical tool or value that summarizes, in a single basic number, a group of data collected in relation to a natural event and process or socioeconomic activity. Therefore, an index can sometimes be also defined as a scaled composite variable. In terms of climatology, main examples concerning the matter are the standardized or normalized precipitation, drought or precipitation activity indexes which quantitatively determine the severity and duration of a drought, and the climatic human comfort indexes which lay down a quantitative measure for the determination, as objectively as possible, of the fact that to what extent people feel the conditions that are hot or cold, humid or dry. Each index has a distinctive calculation methodology developed for a certain scientific, technical and/or application purpose, and indexes are usually explained in terms of changes that form according to a basic value.

Table 3: Indicator list used for impact assessment (adapted from Füssel and Klein (2006)).

| Exposure | | Sensitivity | | Adaptive Capacity | |
|---|---|---|---|---|---|
| E2 | Change in Temperature | H2 | Soil organic substance (%) | A1 | Product diversification |
| E3 | Change in Precipitation | H3 | Soil phosphorus (mg 100 g-1) | A3 | Insurance |
| E4 | Variation in Precipitation in Winter and Spring | H4 | Soil pH (hm3/year) | A2 | Consumed fertilizer (kg/decare) (standardized sum of N, P, and K from the additional fertilizer) |
| | | H5 | Groundwater availability (dimensionless) | | |
| E5 | Variation in number of days with frost | H1 | Farmlands (%) | | |
| E1 | Farming areas (ha) affected from hailstorm | H6 | Irrigated lands (%) | | |

Data listed in Table 3 is obtained from MGM, Turkish Statistical Institute (TURKSTAT), Agricultural Insurance Pool (TARSİM) and Turkish Ministry of Agriculture and Forestry. Categorization of some indicators is more difficult than others. For example, the "product diversification" is considered as an indicator of adaptation capacity, that is to say, the more variety of the product type, the easier the use of another product to adapt to the climatic change. However, Gbetibouo et al. (2010) classifies this as a sensitivity indicator, because they reasoned that the high diversity of products may reduce the vulnerability since different products have different responses to climate change. In this study, product diversification is taken as the adaptation capacity indicator. In the literature, 13 different adaptation capacity indicators given below are used.

- Unemployment rate
- Social welfare payment
- Farmland
- Farm incomes
- Number of farms
- Number of elder employees
- Dependency rate
- Internal migration
- Average yield of all crops
- Access to storm forecast information

Since the adaptation capacity indicators listed above could not be obtained on the district basis, they could not be used in this study.

### 2.3.2. Index Calculations

Index calculations require many important Index configuration decisions such as variable selection, normalization, weight, and summarizing results (Jones and Andrey, 2007).

#### i) Normalization

After selecting the indicators of the reviewed indexes, they are normalized between 0 and 1 by the minimum-maximum transformation as follows. The purpose in normalization is to bring the values of the index to the same scale and ensure that they are gathered.

$$N = \frac{(Real\ Value - Minimum\ Value)}{(Maximum\ Value - Minimum\ Value)} \qquad (1)$$

Where, *N* shows the normalized value.

#### ii) Weighting methods

According to the studies in the literature, weighting methods can be grouped under 4 headings:

- **W1**: Equal weight. This weighting method has been used by some researchers to evaluate general vulnerability and adaptation capacity (Brooks et al., 2015; Ding, 2008)
- **W2**: Absolute value of the first basic factor loadings. This weighting was applied by Gbetibouo et al. (2010) and they showed that it is a suitable method for the determination of the weight. For a detailed explanation, the study of Gbetibouo et al. (2010) may be referred.
- **W3**: All factors with an eigenvalue > 1 are used. In literature, it was used by Nardo et al. (2008).
- **W4**: The weights of the vulnerability indicators are quantitatively determined in line with the opinions of the stakeholders.

In this study, it was decided that the equal weight method is the most appropriate weight determination method considering the data length, size and the small size of the study area.

#### iii) Summarizing methods

Summarizing methods can be grouped under three headings. Since equal weights are used in this study, the summarization method shown with S1 will be used.

S1: $$V_j = \sum_{i=1}^{n} w_i . x_{ij} / \sum_{i=1}^{n} w_i$$ i=1….*n*, j=1….*J* (2)

Where, *V* is Vulnerability Index, *w* is weight, *X* is indicator value, *i* is indicator and *j* is specific study area (Ravindranath et al., 2011). If equal weight is used then arithmetic mean can be used. If equal weight is not used, then the S2 method given in the *Equation* (3) below can be used.

S2: $$V_j = V_{ACj} + V_{ESj}$$ (3)

Where;

$$V_{AC_j} = \sum_{i=1}^{n} w_{iAC} . x_{iACj} / \sum_{i=1}^{n} w_{iAC}$$ (4)

$$V_{ES_j} = \sum_{i=1}^{n} w_{iES} . x_{iESj} / \sum_{i=1}^{n} w_{iES}$$ i=1….*n*, j=1….*J* (5)

$I_{AC}$ are adaptation capacity indicators and $I_{ES}$ are exposure/sensitivity indicators. In addition, Gbetibouo et al. (2010) applied a standardization approach to summarize the results and give weight to the indicators (S3):

S3: $$V_j = \sum_{i=1}^{n} w_i (x_{ij} - \bar{x}_i) / s_i$$ i=1….*n*, j=1….*J* (6)

Where, $\bar{x}$ is average indicator value and *s* is the standard deviation of the indicator.

### 2.3.3. Agricultural Vulnerability Assessment of Kucuk Menderes Basin under Today's Climate Conditions

The vulnerability assessment has been carried out for the Kucuk Menderes Basin in today's climatic conditions by using the indicators given in Table 3 and the methods mentioned in Index calculations, and the index values of each indicator are given in Table 4. The M, H and A codes are given in Table 4 to describe the data.

Table 4: Vulnerability levels calculated for the districts in the Kucuk Menderes Basin

| | EXPOSURE | | | | | SENSITIVITY | | | | | | ADAPTATION CAPACITY | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data code | E1 | E2 | E3 | E4 | E5 | H1 | H2 | H3 | H4 | H5 | H6 | A1 | A2 | A3 |
| Bayındır | 0.07 | 0.56 | 0.75 | 0.55 | 0.39 | 0.43 | 0.81 | 0.85 | 0.00 | 0.68 | 0.56 | 1.00 | 0.60 | 0.54 |
| Beydag | 1.00 | 0.30 | 0.49 | 0.56 | 0.46 | 0.70 | 0.63 | 0.74 | 0.83 | 0.99 | 0.80 | 0.00 | 0.83 | 0.00 |
| Kiraz | 0.61 | 0.38 | 0.85 | 0.79 | 0.23 | 0.68 | 0.63 | 0.48 | 0.83 | 0.91 | 0.50 | 0.00 | 0.83 | 0.28 |
| Menderes | 0.12 | 0.54 | 0.29 | 0.38 | 0.28 | 0.70 | 0.50 | 0.00 | 0.10 | 0.89 | 0.58 | 1.00 | 1.00 | 0.58 |
| Odemis | 0.27 | 0.48 | 0.57 | 0.44 | 0.39 | 0.67 | 0.63 | 0.34 | 0.75 | 0.58 | 0.20 | 1.00 | 0.99 | 0.39 |
| Selcuk | 0.00 | 0.55 | 0.18 | 0.18 | 0.23 | 0.45 | 0.75 | 0.24 | 0.00 | 0.67 | 0.45 | 0.00 | 0.97 | 0.26 |
| Tire | 0.00 | 0.42 | 0.96 | 0.78 | 0.39 | 0.53 | 0.38 | 1.00 | 0.00 | 0.75 | 0.40 | 1.00 | 0.95 | 0.78 |
| Torbalı | 0.00 | 0.60 | 0.48 | 0.51 | 0.31 | 0.46 | 0.69 | 0.93 | 0.00 | 0.37 | 0.23 | 1.00 | 0.98 | 1.00 |

As seen in Table 4, each indicator's index values on district basis are given for the components of vulnerability assessment. For example, the M2 coded column indicating the temperature change indexes shows **the extent of exposure to temperature change**. While Torbalı, with an index value of 0.60, is the most affected district from the temperature change, Beydag, with an index value of 0.30, is the least affected district from the temperature change. Temperature change is calculated as the difference between the average temperature of the long term before 2000 and the average current temperature values (2012-2016). Thus, it was possible to determine the effect of today's conditions on the temperature increase seen after 2000 (signal of climate change). The same approach was applied for the indicators of change in precipitation, change in winter and spring precipitation, number of days with frost event.

For soil pH value (H4), which is one of the sensitivity indicators, 0 index value was calculated in Bayındır, Selcuk, Tire and Torbalı. Sensitivity indexes were calculated as 0 because the value of 7 is neutral for the soil pH classification and the soil pH of the mentioned districts is 7. The soil pH value of Beydag and Kiraz districts, whose sensitivity is calculated as 0,83, is between 5.6 and 6.5 (moderate acid and mild acid).

Variation in soil alkali values, mass movements, and of hail and flood events cannot be directly determined through climate projections. Therefore, future variations in soil alkali values, mass movements, and hail and flood events could not be taken into consideration. However, in terms of agricultural importance, a comprehensive project in which these parameters are taken into account should be carried out in future studies. It should be kept in mind that such calculations will require a wide variety of data supplies/accounts and cannot be calculated in a short time due to its difficulty.

The consumed fertilizer (kg/da) (standardized sum of N, P, and K from the additional fertilizer), which is one of the adaptation capacity indicators, is inversely proportional to the A2 vulnerability (Ravindranath et al., 2011). As the fertilizer consumption is the highest in Bayındır, the highest A2 index with a value of 0.4 is calculated in this district.

Table 5: Vulnerability levels which were calculated for the districts in the Kucuk Menderes Basin

| | EXPOSURE | | SENSITIVITY | | ADAPTATION CAPACITY | | VULNERABILITY | |
|---|---|---|---|---|---|---|---|---|
| | Total Index | Percent | Total Index | Percent | Total Index | Percent | Index Arithmetic Mean | Percent |
| Bayındır | 2.32 | 46.40 | 3.33 | 55.50 | 2.14 | 71.33 | 2.60 | 55.64 |
| Beydag | 2.81 | 56.20 | 4.69 | 78.17 | 0.83 | 27.67 | 2.78 | 59.50 |
| Kiraz | 2.87 | 57.40 | 4.03 | 67.17 | 1.11 | 37.00 | 2.67 | 57.21 |
| Menderes | 1.61 | 32.20 | 2.77 | 46.17 | 2.58 | 86.00 | 2.32 | 49.71 |
| Odemis | 2.14 | 42.80 | 3.17 | 52.83 | 2.38 | 79.33 | 2.56 | 54.93 |
| Selcuk | 1.13 | 22.60 | 2.56 | 42.67 | 1.23 | 41.00 | 1.64 | 35.14 |
| Tire | 2.55 | 51.00 | 3.06 | 51.00 | 2.73 | 91.00 | 2.78 | 59.57 |
| Torbalı | 1.90 | 38.00 | 2.68 | 44.67 | 2.98 | 99.33 | 2.52 | 54.00 |

The total and percentage values of the vulnerability assessment components are given in Table 5. Percentage values and Index mean were calculated by finding the arithmetic mean of the "exposure", "sensitivity", and "adaptation capacity" indexes. The vulnerability percentages were grouped according to the following class intervals (Ravindranath et al., 2011).

- Very low: 0 ≤ Percentage < 20
- Low: 20 ≤ Percentage < 40
- Medium: 40 ≤ Percentage < 60
- High : 60 ≤ Percentage < 80
- Very high: 80 ≤ Percentage < 100

It was observed that, except for Selcuk and Torbalı, the districts in the Kucuk Menderes Basin are at medium category/level in terms of exposure to the impacts of climate change under today's conditions. When the indicators were examined, the index values in Selcuk and Torbalı were found low since these districts were less exposed to the impacts of the production areas affected by the change in precipitation, change in winter and spring precipitation, and hailstorm.

When the adaptation capacity index values were examined, it was determined that the districts in Kucuk Menderes Basin, in general, are listed between low and very high level in terms of adaptation to the agricultural effects of climate change. Due to the excessive fertilizer consumption in Beydag and the lack of product diversification and insurance size, the adaptation capacity was found to be low. At this point, it is important to keep in mind that only three indicators were used in this evaluation. When studies in the literature were reviewed, it was seen that 14 different adaptation capacity indicators were used. Unfortunately, no data on the district basis were found for the remaining indicators.

Vulnerability levels of the districts in the Kucuk Menderes Basin, except for Selcuk, were evaluated as "medium" level. To give an example of the reasons of the fact that the agricultural vulnerability of Selcuk district due to today's climate change is low, it should be expected that Selcuk would be least affected by the temperature increase since the air temperature in this district is higher as compared to other districts, especially Beydag and Kiraz which are located in the east. It is obvious that the relatively cold regions would be more affected by the temperature increase. As a result of the evaluation of 14 indicators through a similar logic, such a result was obtained.

### 2.3.4. Climate Models and Scenarios

Climate change projections require to run a model on a global scale. Greenhouse gas emissions depend on factors such as population growth, economic growth, increased demand for energy and food (agriculture), and technological change. Future emission scenarios are created with different stories based on these factors. These scenarios include the information that how much emissions will be released into the atmosphere in the forthcoming years, and that how these emissions will change the amount of greenhouse gases in the atmosphere. The fact that to what extent will greenhouse gases, which will accumulate in the atmosphere, cause the greenhouse effect and that how this situation will change the climate can only be revealed by integrating the scenario information into a "Global Climate Model" and prospectively running the model. Before the IPCC assessment studies, model run experiments are conducted for different scenarios and projection data is prepared for these reports. The experiment performed for the Fifth Assessment Report (AR5) which was announced to the world's public opinion in 2013 was called CMIP5 (Fifth Coupled Model Intercomparison Project). In these experiments, around 40 different Global Climate Models were run. These models are mostly similar but differ from each other in terms of resolution, physics parameterization, grid structure, etc. Due to these differences, discrepancies occur in model projections. Table 24 provides information on the global climate models involved in the CMIP5 experiment. As explained below, the mean of projections obtained by the CMIP5 experiment is used in this study as it reduced the uncertainty.

High-resolution climate change projections created using the regional model usually have a high degree of uncertainty as they are derived from a small number of global models (<3). For the same parameter, there may be great differences between the model outputs. For example, while a model predicts an increase in precipitation for İzmir, other(s) may predict a decrease in precipitation. This is the main disadvantage of studying with a small number of models. Projections on a global scale are generated using a large number of models (around 40). IPCC reports assess climate change on the basis of the average or median of these models. This approach is called as "bundle" (*ensemble*) approach. The most important advantage of the bundle approach is the reduction of uncertainties that may arise from the use of a single model. In this study, the global model outputs have been assessed with a bundle approach even if their resolution is low. Thus, it is ensured that more climate parameters (climate indices) were taken into account.

The use of direct global model outputs in the analyses may bring to mind a question of how well this data with a very low resolution can represent the Kucuk Menderes Basin. In climate change studies, changes are considered rather than direct model outputs. The systematic deviation (error) resulting from the model itself is also substantially eliminated by this way. On the other hand, since the change patterns are mainly related to the changes occurring in the general circulation of the atmosphere, they spatially show similarities in large areas. To give an example for Turkey, it is expected that temperatures to increase in everywhere in the future, and precipitation to decrease in the southern half of the country. There will be no big difference between the temperature increase in İzmir and, for example, the temperature increase in Manisa. Or, a big difference is not be expected between the change in precipitation in İzmir and the change in precipitation in Manisa. However, there can be a big difference between the change in precipitation in İzmir and the change in precipitation in Trabzon. Therefore, even if the resolutions of the global models are low, it is possible to say that the representability of data is acceptable in the Kucuk Menderes Basin scale when the study is based on the changes.

In general, adding on the observations the changes obtained from models, future data is generated and then used in impact assessment studies. The direct difference in temperature is calculated and added to the observations of the reference period (1961-1990 or 1986-2005). For the precipitation, the change percentage is calculated from the model outputs and this change percentage is reflected in the observations of the reference period in percentage. Global model simulations within the scope of the CMIP5 experiment were performed for two periods. The first period is between 1861-2005 and the second period is between 2006-2100 during which RCP scenarios are applied. In the Fifth Assessment Report of IPCC, a period of 20 years between 1986 and 2005 was used as the reference period. Climate change projections were examined either continuously so as to cover the period of 2006-2100 or the average of three periods which are 2016-2035, 2046-2065, and 2081-2100. In the climate change section of this study, the time intervals used in the IPCC report have been adopted.

Table 6: Information on models used in the CMIP5 experiment. Different numbers of models were used for scenario simulations in the CMIP5 experiment. For the RCP4.5 and RCP8.5 scenarios, 42 and 39 models were run respectively.

| Global Modelling Center (or Group) | Global Model | Geodetic Resolution (in degrees in lat x lon direction) |
|---|---|---|
| Beijing Climate Center, China Meteorological Administration | BCC CSM1 | 2.8x2.8 |
| | BCC CSM 1M | 1.1x1.1 |
| College of Global Change and Earth System Science, Beijing Normal University | BNU ESM | 2.8x2.8 |
| Canadian Centre for Climate Modelling and Analysis | CCCMA CM4 | 2.8x2.8 |
| | CCCMA ESM2 | 2.8x2.8 |
| Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology | CCSR ESM | 2.8x2.8 |
| | CCSR ESM CHEM | 2.8x2.8 |
| | CCSR MIROC4H | 0.56x0.56 |
| | CCSR MIROC5 | 1.4x1.4 |
| Centro Euro-Mediterraneo per I Cambiamenti Climatici | CMCC CM | 0.75x0.75 |
| | CMCC CMS | 1.8x1.8 |
| Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancée en Calcul Scientifique | CNRM CM5 | 1.4x1.4 |
| Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence | CSIRO AC10 | 1.25x1.8 |
| | CSIRO AC13 | 1.25x1.8 |
| | CSIRO MK6 | 1.8x1.8 |
| EC-EARTH consortium | ECMWF EC EARTH | 1.1x1.1 |
| The First Institute of Oceanography, SOA, China | FIO ESM | 2.8x2.8 |
| NOAA Geophysical Fluid Dynamics Laboratory | GFDL CM3 | 2x2.5 |
| | GFDL ESM2G | 2x2.5 |
| | GFDL ESM2M | 2x2.5 |
| NASA Goddard Institute for Space Studies | GISS E2H | 2x2.5 |
| | GISS E2H-CC | 2x2.5 |

| Global Modelling Center (or Group) | Global Model | Geodetic Resolution (in degrees in lat x lon direction) |
|---|---|---|
| | GISS E2R | 2x2.5 |
| | GISS E2R-CC | 2x2.5 |
| Institute for Numerical Mathematics | INM CM4 | 1.5x2 |
| Institut Pierre-Simon Laplace | IPSL CM5ALR | 1.9x3.75 |
| | IPSL CM5AMR | 1.25x2.5 |
| | IPSL CM5BLR | 1.9x3.75 |
| LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences and CESS, Tsinghua | LASG FGOALSG2 | 2.8x2.8 |
| LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences | LASG FGOALSS2 | 1.6x2.8 |
| Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology) | MPI ESMLR | 1.9x1.9 |
| | MPI ESMMR | 1.9x1.9 |
| | MPI ESMP | 1.9x1.9 |
| Meteorological Research Institute | MRI CGCM3 | 1.1x1.1 |
| National Center for Atmospheric Research | NCAR CCSM4 | 0.9x1.25 |
| Community Earth System Model Contributors | NCAR CESM1-BGC | 0.9x1.25 |
| | NCAR CESM1-CAM5 | 0.9x1.25 |
| | NCAR CESM1-FCHEM | 0.9x1.25 |
| | NCAR CESM1-WACCM | 1.9x2.5 |
| Norwegian Climate Centre | NOR ESM1M | 1.9x2.5 |
| | NOR ESM1ME | 1.9x2.5 |
| Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais) | UKMO HADCM3 | 2.5x3.75 |
| | UKMO HADGEM2AO | 1.25x1.875 |
| | UKMO HADGEM2CC | 1.25x1.875 |
| | UKMO HADGEM2ES | 1.25x1.875 |
| Multi Model Ensemble | MME GCM | 0.5x0.5 |

The primary indicator of climate change is the increase in temperature. The increase in temperature causes, by affecting the whole climate system, changes in other parameters. Glacier melting, snow cover shrinkage, sea level rise and changes in precipitation pattern can be counted among the main indicators. The parameters primarily considered in climate change projections are the average annual temperature and total precipitation. Although these parameters give information about the general change, they do not provide much information about how daily life will be affected. Daily life is affected by extreme weather events such as heat wave, heavy precipitation, and drought. Hence, a comprehensive climate change study should provide information on possible changes in extreme events. Within the scope of this study, 25 extreme parameters (indices) are also laid down in addition to the main climate indicators such as temperature and precipitation. Table 7 gives information about all climate indices included in this study.

Table 7: Climate indices, definitions and units (RR: daily precipitation amount; Tmin: daily minimum temperature; Tmax: daily maximum temperature; T: daily average temperature).

| İndex | Name | Definition | Unit |
|---|---|---|---|
| CDD | Maximum length of dry spell | Number of consecutive dry days when "RR < 1 mm" | days |

| | | | |
|---|---|---|---|
| CWD | Maximum length of wet spell | Number of consecutive wet days when "RR ≥ 1 mm" | days |
| CSDI | Cold spell duration index | Annual count of days with at least 6 consecutive days when Tmin < 10th percentile | days |
| DTR | Daily temperature range | "Tmax – Tmin" | °C |
| FD | Number of frost days | Number of days when "Tmin < 0 °C" | days |
| GSL | Growing season length | Annual count between first span of at least 6 days with T > 5 °C and first span after July 1st of 6 days with T < 5 °C | days |
| ID | Number of icing days | Number of days with "Tmax < 0 °C" | days |
| PRCPTOT | Annual total precipitation in wet days | Total precipitation in wet days (annual total precipitation) | mm/day |
| R1mm | Annual count of days when precipitation greater than equal to 1 mm | Number of days when "RR ≥ 1 mm" | days |
| R10mm | Annual count of days when precipitation greater than equal to 10 mm | Number of days when "RR ≥ 10 mm" | days |
| R20mm | Annual count of days when precipitation greater than equal to 20 mm | Number of days when "RR ≥ 20 mm" | days |
| R95pTOT | Annual total precipitation in days with heavy precipitation | Annual total precipitation when RR > RR(95th percentile) (Calculated for the reference period of RR(95th percentile)) | mm/year |
| R99pTOT | Annual total precipitation in days with extreme precipitation | Annual total precipitation when RR > RR(99th percentile) (Calculated for the reference period of RR(99th percentile)) | mm/year |
| Rx1day | Maximum one-day precipitation | Maximum one-day precipitation amount | mm/day |
| Rx5day | Maximum five-days precipitation | Maximum five-days precipitation amount | mm/5days |
| SDII | Simple precipitation intensity index | Annual total precipitation / number of wet days | mm/day |
| TN10p | Percentage of cold nights | Percentage of days when "Tmin < 10th percentile" | % |
| TN90p | Percentage of warm nights | Percentage of days when "Tmin > 90th percentile" | % |
| TNn | Minimum of daily minimum temperatures | Minimum value of daily minimum temperatures | °C |
| TNx | Maximum of daily minimum temperatures | Maximum value of daily minimum temperatures | °C |
| TX10p | Percentage of cold days | Percentage of days when "Tmax < 10th percentile" | % |
| TX90p | Percentage of hot days | Percentage of days when "Tmax > 90th percentile" | % |
| TXn | Minimum of daily maximum temperatures | Minimum value of daily maximum temperatures | °C |
| TXx | Maximum of daily maximum temperatures | Maximum value of daily maximum temperatures | °C |

Climate change projections are made on the basis of greenhouse gas scenarios. The scenarios are based on stories involving future situations of factors affecting emission releases, such as population growth, economic development, technological change, energy, and agricultural production. In the IPCC's Fourth Assessment Report, which was released in 2007, scenarios called SRES (Special Reports on Emissions Scenarios) were used. These scenarios comprise A1 and A2 scenarios which predict high emission releases, and B1 and B2 scenarios which predict relatively low emission releases, and sub-scenarios thereof. Among these scenarios, A2 scenario, which is based on a world story in which the regionality of economic development continues as is today, and A1B scenario, which is based on a world story that has rapid economic growth, that is more integrated, and in which energy diversity is achieved (predicting a medium level emission release), are the ones most studied. The scenarios for the IPCC's Fifth Evaluation Report published in 2013 were amended and four scenarios called RCP (Representative Concentration Pathways) were created.

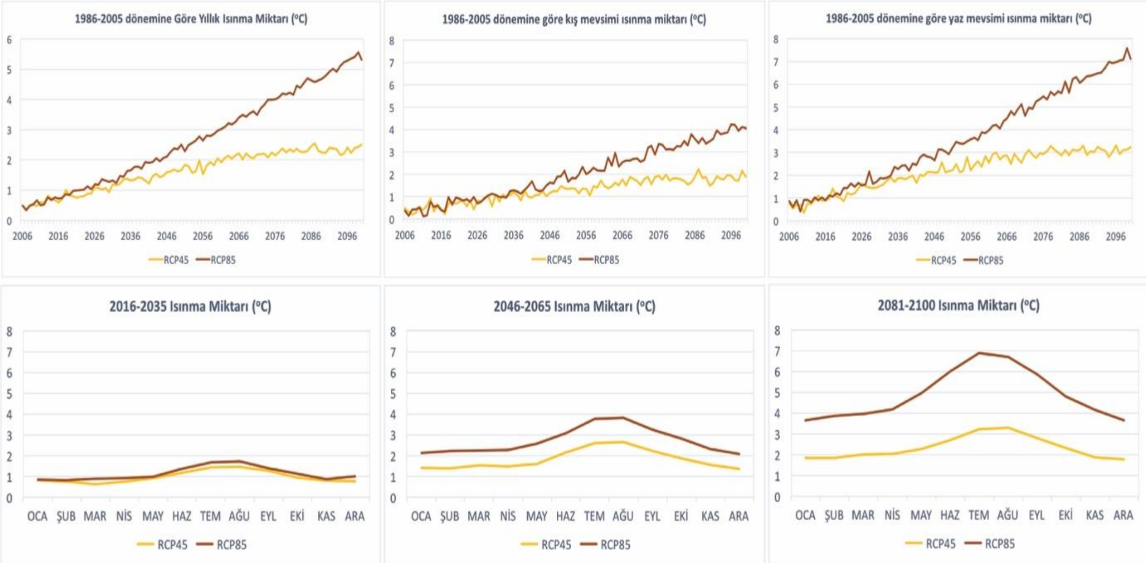
Population growth, technological development, and social reaction were taken into consideration in the creation of these scenarios. The scenarios are named RCP2.6, RCP4.5, RCP6.0, and RCP8.5; general information about these scenarios is given in Table 26. The numbers in the names indicate the radiative forcing in 2100 in W/m$^2$. For example, the RCP8.5 scenario implies that due to the greenhouse effect which will strengthen, 8.5 W/m$^2$ more energy will be trapped at the near-ground level in the year 2100 relative to the pre-industrial period. RCP8.5 and RCP4.5 scenarios are equivalent, among SRES scenarios, to A2 and B1 respectively. Table 8 provides information about these RCP scenarios. RCP2.6 reaches its peak point in the first quarter of the century and then follows a decreasing emission pathway. RCP4.5 emissions increase until the mid-century and then decrease, while RCP6.0 emissions increase until the last quarter of the century and then decrease. RCP8.5 emissions follow a continuously rising pathway until 2100. In this study, among RCP scenarios, RCP4.5 and RCP8.5 were used when evaluating global model projections.

Table 8: General information about RCP scenarios

| RCP | Radiative Forcing | Concentration (ppm) | Emissions (Greenhouse gases identified in the Kyoto Protocol) |
|---|---|---|---|
| 8.5 | > 8.5 W/m$^2$ | In the year 2100 >~1370 $CO_2$-equivalent | Increase until the year 2100. |
| 6.0 | ~6.0 W/m$^2$ | ~850 $CO_2$-equivalent (when stabile after the year 2100) | Decrease in the last quarter of the century. |
| 4.5 | ~4.5 W/m$^2$ | ~650 $CO_2$-equivalent (when stabile after the year 2100) | Decrease as of the mid-century. |
| 2.6 | ~2.6 W/m$^2$ | Reaches to peak point with the value of ~490 $CO_2$-equivalent before the year 2100 and then decreases. | Decreases as of the first quarter of the century. |

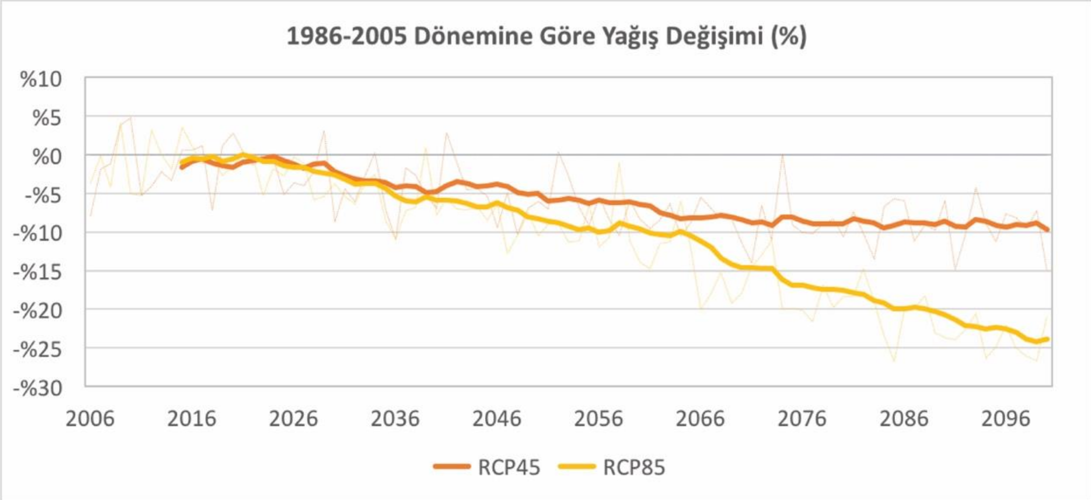
Projections made on the basis of RCP4.5 and RCP8.5 scenarios indicate that, toward the end of the century, annual average temperatures in the basin will increase between 2 and 6 °C as compared to today (i.e. average of 1986-2005) (Figure 9). Until the 2030s, the increases are similar in both scenarios. From this date onwards, the scenarios differentiate from each other. According to the pessimistic scenario (RCP8.5), the increase will be almost linear and it will reach 5.5 °C at the end of the century. According to RCP4.5, the rate of increase in temperature will slow down as of the 2060s, and the increase in temperature at the end of the century will be slightly above 2.0 °C. Seasonal differences occur in increases in temperature (Figure 9). Increases in temperature in summer are higher than those in winter.

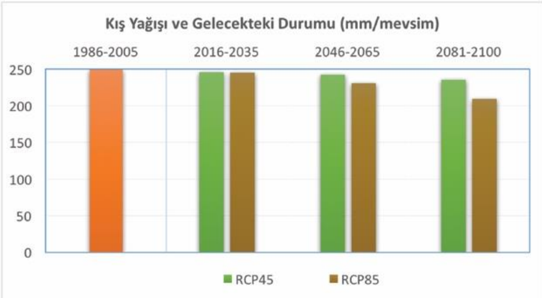
Figure 9: Annual and winter and summer warming levels, according to two scenarios, in the Kucuk Menderes Basin in the 21st century (relative to the period of 1986-2005), and increases in temperature in the basin for the three periods in the future (2016-2035, 2046-2065 and 2081-2100) according to these two scenarios

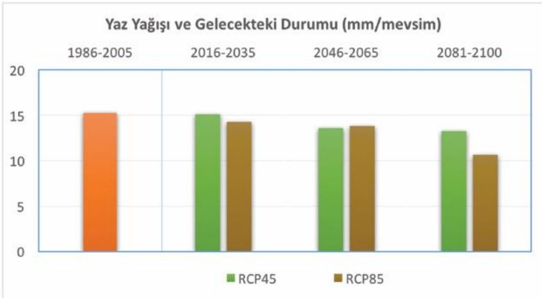


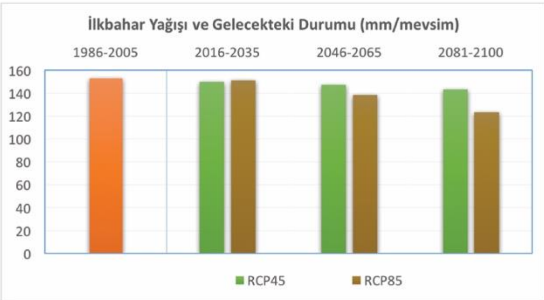

According to the 21st century climate change scenario simulations, the precipitation in Kucuk Menderes Basin will decrease in the future (Figure 9). It is predicted that the precipitation in the basin will tend to decrease as of the 2020s. The decrease rate until the mid-century will be around 5% according to the RCP4.5 scenario and around 10% according to the RCP8.5 scenario. The decrease rate will reach the level of 25% at the end of the century according to the RCP8.5 scenario. Differences may occur between the seasons in terms of precipitation change. The seasons in which the Kucuk Menderes Basin receives most and least precipitation are winter and summer respectively. Although high decreases as a percentage are foreseen for summer, the absolute values are smaller as compared to other seasons.

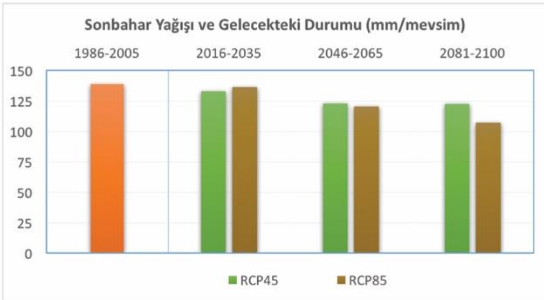
Figure 10: Change in precipitation (%), according to two scenarios, in the Kucuk Menderes Basin in the 21st century, relative to the reference period of 1986-2005; Amounts of precipitation (orange bar) measured in the basin (Odemis station) for winter, summer, spring, and autumn; according to two scenarios 2016-2035


1986-2005 Dönemine Göre Yağış Değişimi (%)
%10
%5
%0
-%5
-%10
-%15
-%20
-%25
-%30
2006
2016
2026
2036
2046
2056
2066
2076
2086
2096
RCP45
RCP85


Kış Yağışı ve Gelecekteki Durumu (mm/mevsim)
1986-2005
2016-2035
2046-2065
2081-2100
250
200
150
100
50
0
RCP45
RCP85


Yaz Yağışı ve Gelecekteki Durumu (mm/mevsim)
1986-2005
2016-2035
2046-2065
2081-2100
20
15
10
5
0
RCP45
RCP85


İlkbahar Yağışı ve Gelecekteki Durumu (mm/mevsim)
1986-2005
2016-2035
2046-2065
2081-2100
160
140
120
100
80
60
40
20
0
RCP45
RCP85


Sonbahar Yağışı ve Gelecekteki Durumu (mm/mevsim)
1986-2005
2016-2035
2046-2065
2081-2100
150
125
100
75
50
25
0
RCP45
RCP85

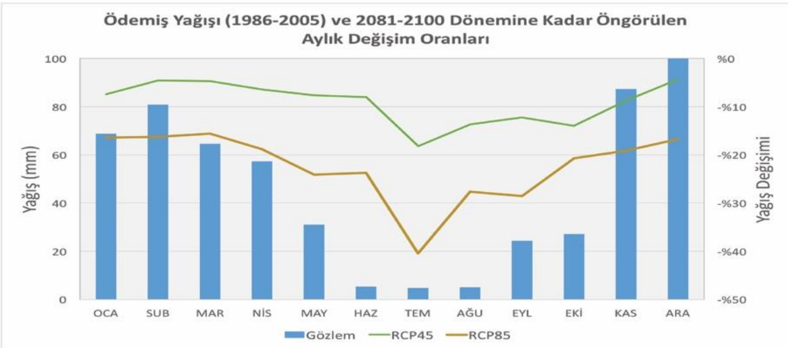

Ödemiş Yağışı (1986-2005) ve 2081-2100 Dönemine Kadar Öngörülen
Aylık Değişim Oranları
Yağış (mm)
Yağış Değişimi
100
80
60
40
20
0
%0
-%10
-%20
-%30
-%40
-%50
OCA
SUB
MAR
NİS
MAY
HAZ
TEM
AĞU
EYL
EKİ
KAS
ARA
Gözlem
RCP45
RCP85

Figure 11: Current value and future change of climate indices calculated by models

Figure 12: Current value and future change of climate indices calculated by models

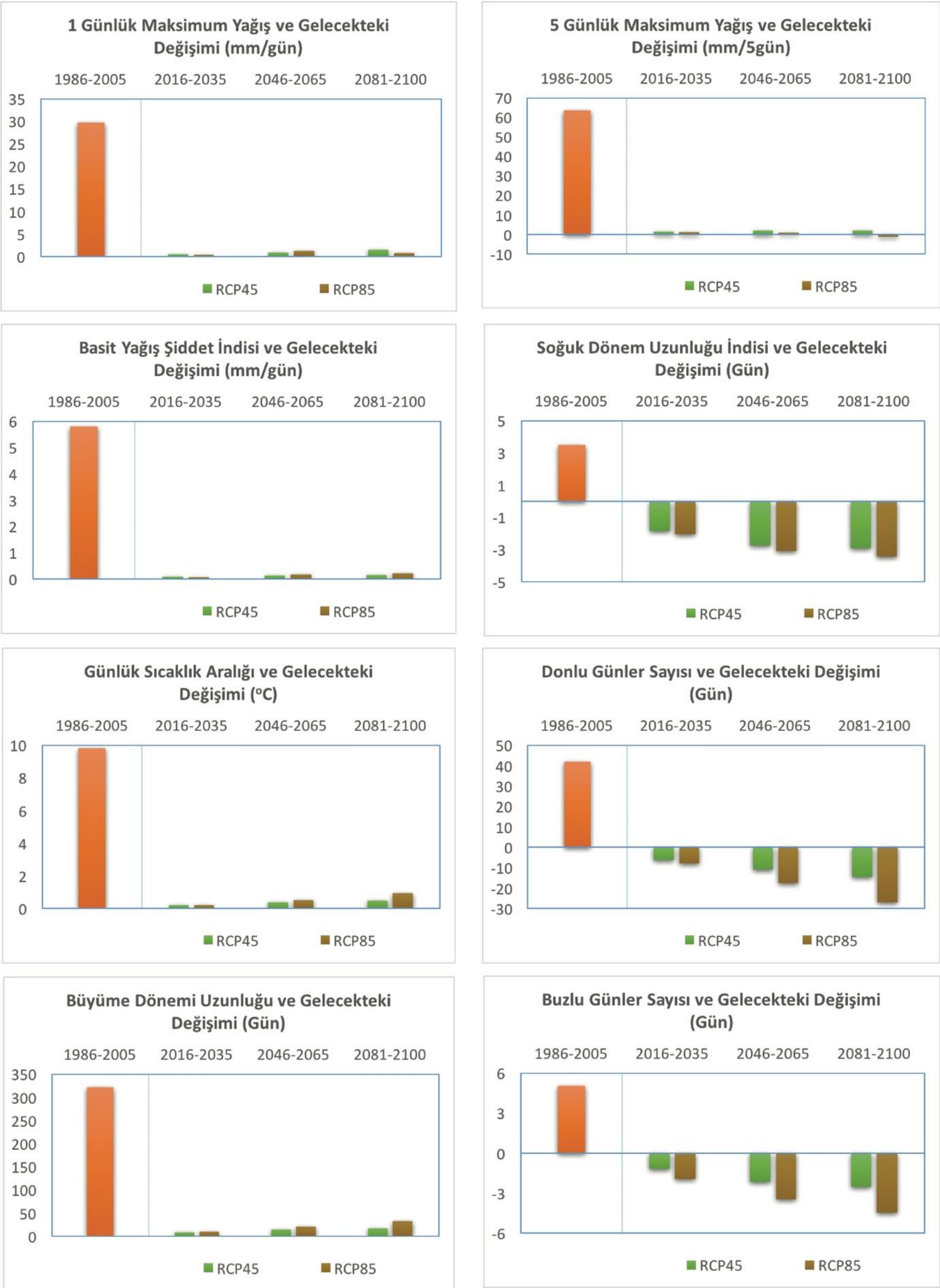
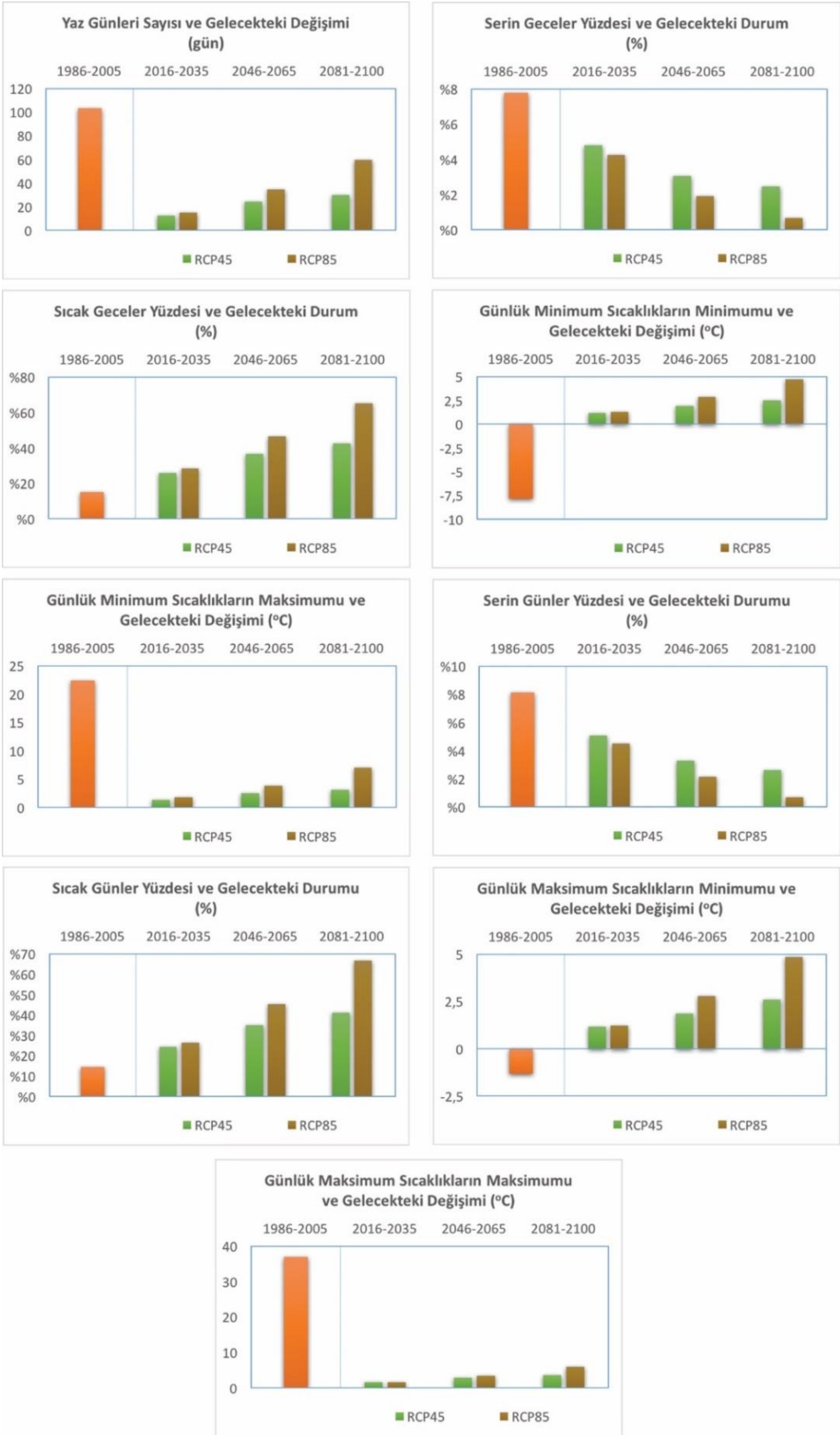


Figure 13: Current value and future change or situation of climate indices calculated by models




When the seasonal distribution of the precipitation in Figure 9 is reviewed, no significant decrease, especially for the precipitation in winter, is observed until 2050. However, a decrease in the number of wet days occurs. As seen in Figure 12, an increase in the simple precipitation intensity index is predicted to occur. Hence, although a significant decrease in total precipitation is not seen, the fact that more intense but fewer wet days will be seen supports the prediction. As seen in Figure 11, the increase in the number of days when precipitation is 20 mm and more, and the decrease in the total number of days when precipitation is 10 mm and more, support the increase predicted in the precipitation intensity in the future.

Daily life is affected by extreme weather events such as heat wave, extreme precipitation, and drought. The changes in the 25 extreme climate parameters defined for these extreme events are shown in Figure 11-13. Precipitation projections indicate in general that, in the basin, the longest drought period will prolong, the longest wet period will shorten, and the amount of precipitation in days with excessive precipitation will increase. The temperature-related indices indicate that those at the hot side will increase and those at the cold side will decrease. For example, numbers of cold, iced, and frost days and numbers of cool nights and days will decrease. On the other hand, numbers of summer days, hot days and hot nights will increase. The growth season will prolong to some extent, and the daily temperature range will slightly increase.

### 2.3.5. Climate Change's Effects on the Kucuk Menderes Basin between the Present and 2050

Global Circulation Model (GCM) estimation data was used to evaluate the effect on agriculture of future climatic conditions in the Kucuk Menderes Basin. Present conditions were compared with possible future conditions using the projection data calculated up to 2050. For the evaluation of the future situation, present and future climatic working conditions and future drought conditions were examined through the ***Heat Index*** and ***Standardized Precipitation Index*** (SPI) respectively.

#### Heat Index

The Heat Index is a measure of the feels like temperature when the current temperature and relative humidity are evaluated together. The chart in Figure 14 can be used to measure and evaluate the temperature index value. For example, if the air temperature is 35.5 °C and the relative humidity is 65%, the Heat Index is measured at 49.4 °C. This value is the actually felt value. The non-numbered red areas in Figure 14 indicate an extreme hazard. If the Heat Index value is estimated at 40.5 °C (102 °F) and above for two consecutive days, the emergency procedures specified by the US National Air Services are applied. It should also be noted that strong winds especially during very hot and dry weather are extremely dangerous to human health.

Figure 14: Heat Index warning indicator provided by US National Weather Service (NWC) and the National Oceanic and Atmospheric Administration (NOAA).

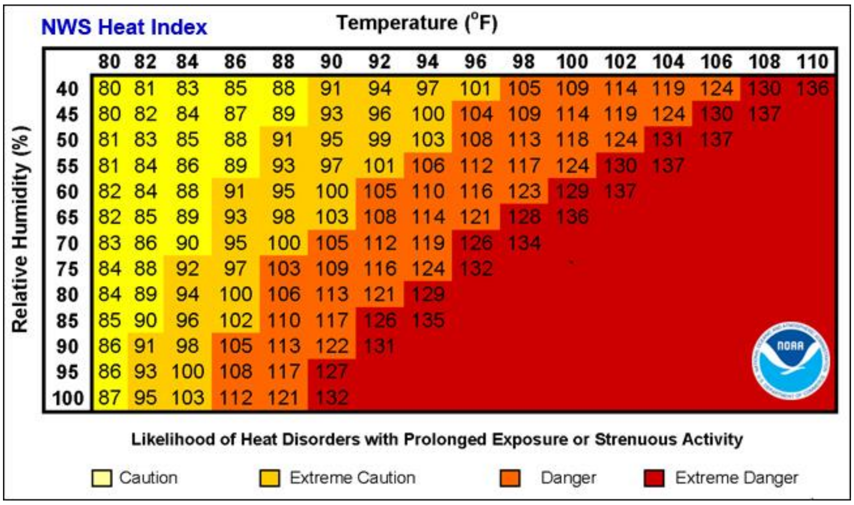
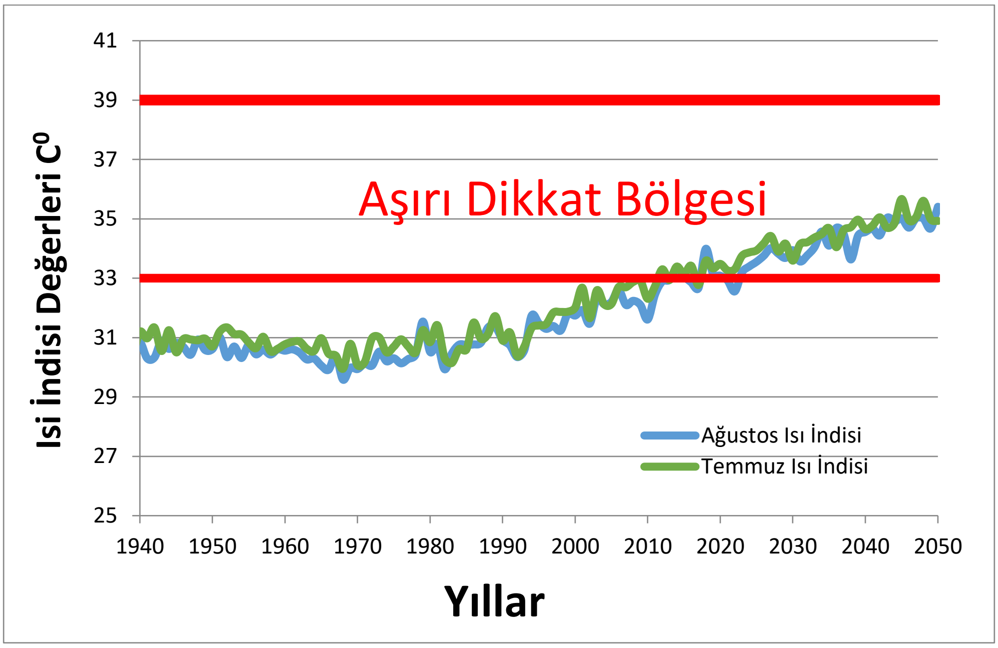



Figure 15 shows the graph of heat indices calculated for 1940-2050 for the Kucuk Menderes Basin. Heat indices were calculated with monthly maximum temperature data (°C) and monthly relative humidity data (%). As seen in Figure 15, August and July heat index values after 2022 are in the "extreme attention/hazard zone".

Figure 15: The long-term change of the Kucuk Menderes Basin's July and August heat indices in the period of 1940-2050.




Since the data used are monthly, the increase in heat index after 2022 is very significant. This is a continuous situation which is prevalent throughout all July and August months and shows that conditions develop which should continuously be controlled and monitored for occupational health. In general, July heat indices calculated were higher as compared to August. Since the hottest months in the region are July and August, it was found unnecessary to account for other months of the year.

### Standardized Precipitation Index

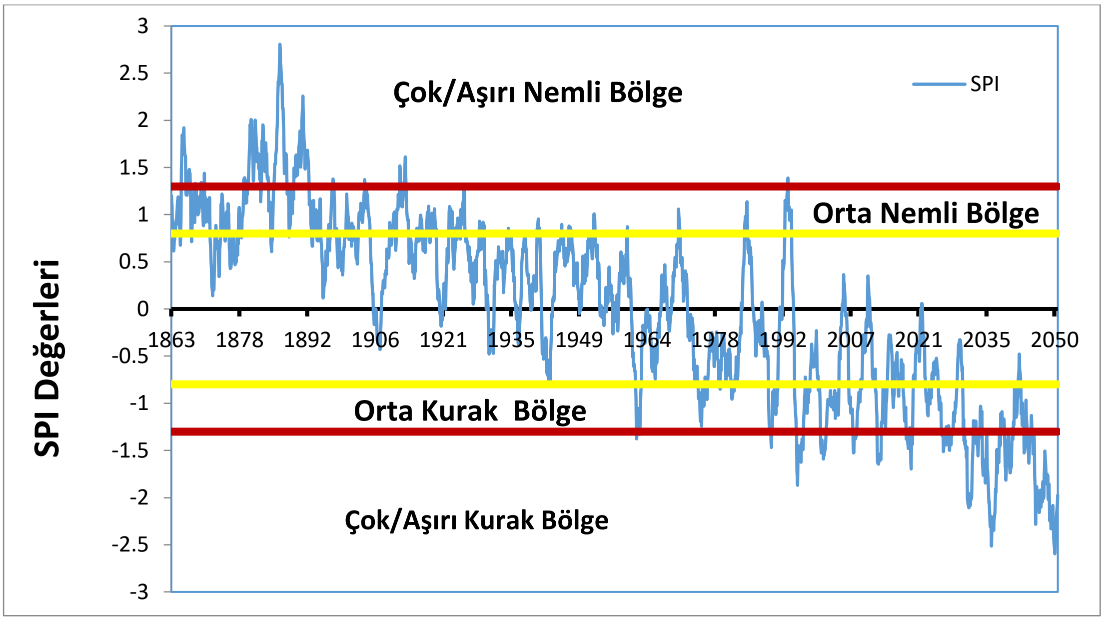
Standardized precipitation index (SPI) can be defined as the deviation from the long-term average value, of the amount of precipitation obtained from climatic records and normalized by the standard deviation. Also, gamma transformation is applied to approximate the SPI distribution to normal (Thom, 1966; Heim, 2002). SPI is advantageous in comparison with other indices in the literature thanks to its simplicity and temporal flexibility, and thus, it is used in water resources applications in all time scales (Türkeş and Tatlı, 2009). SPI can be calculated from 1- to 24-month time scale to determine long-term and short-term drought events. Since SPI behaves normally, it is equally suitable for dry and wet condition analysis. In this project, 24-month SPI values were used so that long-term drought events can be determined.

Table 9: Standardized precipitation index classification

| SPI Values | Drought Classification |
|---|---|
| 2.0 ≥ SPI | Exceptionally wet |
| 1.6 < SPI ≤ 1.99 | Extremely wet |
| 1.3 < SPI ≤ 1.59 | Very wet |
| 0.8 < SPI ≤ 1.29 | Moderately wet |
| 0.5 < SPI ≤ 0.79 | Abnormally wet |
| 0 < SPI ≤ 0.5 | Slightly wet |
| 0 > SPI ≥- 0.5 | Slightly dry |
| -0.5 > SPI ≥ -0.79 | Abnormally dry |
| -0.8 > SPI ≥ -1.29 | Moderately dry |
| -1.3 > SPI ≥ -1.59 | Very dry |
| -1.6 > SPI ≥ -1.99 | Extremely dry |
| -2.0 ≥ SPI | Exceptionally dry |

Table 9 presents the classification based on the SPI values. SPI values < 0 indicates dry conditions whereas SPI values >0 indicates wet conditions. If the SPI values are greater than +2, extreme humid conditions are present, and if less than -2, extreme drought conditions are present. By using various time scales of SPI, meteorological, agricultural and hydrological drought can be determined respectively according to drought durations. As the drought duration prolongs, hydrological drought conditions start to be observed. In this project, 24-month SPI values were used for the determination of long-term drought conditions.

Table 16: Temporal distribution of 24-month SPI values calculated for the Kucuk Menderes Basin.




As seen in Figure 16, slight and moderate drought conditions has prevailed after the 90s. Besides, it is predicted that according to SPI values, severe and extreme drought conditions will be seen as of 2030. When Figure 16 is observed, both humid and drought conditions are seen from time to time between 1930 and 1990. However, after the 90s, the prevalence of drought conditions continues to increase. According to this, it is predicted that after 2022, moderate and severe/extreme drought conditions will be seen **continuously**, in other words, aridification tendency will strengthen. Since 24-month SPI values are considered as a sign of hydrological drought and also may involve, on a time basis, both the meteorological and probable agricultural drought events, water deficit will occur in the Kucuk Menderes Basin and it is predicted that this need will gradually increase by 2050. As a result of this situation, a sharp decrease is expected in the levels of groundwaters, rivers, and lakes. Also, it is obvious that during the growth period, there will be insufficient soil moisture in a certain critical period during which a particular plant needs water. Therefore, it is inevitable to take measures in order for agricultural activities in the region are not affected.

### 2.3.6. The impact of Sea Level Rise on the Kucuk Menderes Basin

In order to determine the rise in sea level, Digital Surface Model, so-called WorldDEM, which was obtained by TanDEM-X satellite group having approximately 12 m (0.4 arc seconds) spatial resolution and absolute vertical accuracy better than 2 m, was used. In the method used, the sea level (0 m) was marked along the coasts, flow directions were calculated on the basis of the surface model such as a flood modelling in the case of 1m, 2m, 5m, and 10m rise, the flood areas to form towards inland areas were determined, and flow accumulations were calculated after basin modelling. In other words, the river floods calculation method was used. If only areas under a certain elevation were marked, areas to which sea water does not reach would also engage, and areas disconnected from each other would develop. This problem was eliminated with the method applied.

In addition, the biggest problem with respect to which areas would be affected by sea level rises is due to DEM resolutions. In this project, the rises between 1m and 10m were calculated by means of sea flooding model, for the Kucuk Menderes Basin. This method gives more accurate results as compared to marking directly the places below a certain level. The maps that are given in Figures 17-20 for the sea level rise of 1m, 2m, 5m, and 10m respectively were prepared by this method.

Figure 17: Status of Kucuk Menderes Basin when sea level rises by 1 meter


In Figure 17, it is seen that when the sea level rises by 1 meter, sea water transgresses towards the inland areas by 1-2 km in a small area in the coastal region of Selcuk. In Figure 17, the inland area towards which the sea water (indicated by the red arrow) transgresses is illustrated with light blue color. The transgression of seawater is shown on Google Earth maps.

Figure 18: Status of Kucuk Menderes Basin when sea level rises by 2 meters

Figure 19: Status of Kucuk Menderes Basin when sea level rises by 5 meters


Figure 20: Status of Kucuk Menderes Basin when sea level rises by 10 meters


Figure 17-20 shows the sea water transgression in the Kucuk Menderes Basin due to the rise in sea level by 2, 5, and 10 meters respectively. It is seen that when the sea level rises by 10 meters, the sea water transgresses towards the inland areas by 16-20 km and covers a significant part of Selcuk. However, as shown in Table 28, a maximum of 32 cm sea water rise is expected until 2050. As for the situation in 2100, the maximum sea level rise is 88 cm. Even in the most unfavorable situation, sea water transgresses by 1-2 km in a small inland area as seen in Figure 30. In this case, it is seen that the sea water rise does not pose a surface risk for the Kucuk Menderes Basin.

Table 10: Change in temperature and sea level rise according to the IPCC special report emission scenarios (SRES)

| Tarih | Global Sıcaklık Değişimi ($C^0$) | Global Deniz Seviyesi Yükselmesi (cm) |
|---|---|---|
| 1990 | 0 | 0 |
| 2000 | 0.2 | 2 |
| 2050 | 0.8-2.6 | 5-32 |
| 2100 | 1.4-5.8 | 9-88 |

As seen in Table 10, the sea level rise predicted on a global scale is between 5 to 32 cm until 2050, and between 9 to 88 cm until 2100.

(*http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=29*)

Conclusions and Recommendations

The recommendations are summarized below for the selection of the main agricultural product according to the climate characteristics of the Kucuk Menderes Basin, the impact of the regional climate on agriculture, the agricultural risks of the climate, and the future climate projection results.

- In the basin, in cluster 1, which is closest to the sea, precipitation is more intense and the altitude of total precipitation is higher. Towards the east, there is a general decrease in precipitation intensity and altitude. The annual average total precipitation difference between cluster 3, which is at the easternmost of the basin, and cluster 1 is 127 mm. Therefore, agricultural products which need more water may be preferred in cluster 1, by utilizing also the groundwater usage opportunities.
- According to the RCP 4.5 scenario, the change in the annual total precipitation is estimated to be less than 5% by 2050. Therefore, no significant change in total precipitation is predicted.
- Since Cluster 3 is in relatively more inland region of the basin, it is cooler than cluster 1, and the average temperature difference is 0.97 °C for winter months. This situation should be considered in the selection of the main agricultural product. Given especially that according to RCP 4.5 scenario, the maximum air temperatures will increase by approximately 2 °C until 2050, agricultural products which are less resistant to change in temperature should be preferred in Cluster 3.
- When the wind climatology of the basin is observed, it is seen that the winds in cluster 1 are more intense. Agricultural activities, in particular, with a high probability of being affected by wind (e.g. greenhouse growing) should be preferred to be carried out in cluster 3. Beydag and Kiraz stand out as the most suitable districts.
- Cluster 2 can be considered, in terms of climate characteristics, as a transition region between cluster 1 and cluster 3. It can be, therefore, expected that the agricultural products to be selected both for cluster 1 and cluster 3 are selected for cluster 2 as well.
- It is predicted that, according to heat index results, working conditions in the Basin during July and August will reach, starting from 2022, a level that requires “extreme caution” in terms of occupational health. Therefore, agricultural products that require more physical power during summer should not be selected. In addition, it may be suggested to select agricultural products that entail the use of machines instead of people in the summer.
- According to the results of Standardized Precipitation Index analysis, it is predicted that a continuous water deficit and severe/extreme drought conditions will be effective as of 2030. Moreover, during the period from 2007 to the present, there has not been a year in which hydrological water surplus is experienced under the current climatic conditions in the Basin. Occasionally “moderate drought” conditions are observed. Therefore, if measures to counter drought are not taken, it is clear that the selected agricultural products will be at great risk.
- Effects on agriculture of climatic conditions of the districts in the Kucuk Menderes Basin, except for Selcuk, were determined at “medium” level. Odemis and Torbalı were classified, in terms of agricultural risk, in “medium” risk level.
- As a result, priority should be given to Odemis and Torbalı, and care should be taken, for the selection of agricultural products in terms of climatic vulnerability and risks. If possible, in the future, products that will suffer the minimum economic loss under the hotter and more drought climatic conditions should be selected in these districts.

Table 11: Comparison of KMRB's 2021-2050 Climate Projection Data with Long Years (1986-2017) Average

| | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AVERAGE TEMPERATURE (°C) (2021-2050) | 5.5 | 6.2 | 8.6 | 12.5 | 17.0 | 21.9 | 25.6 | 25.5 | 20.9 | 15.0 | 9.9 | 6.6 | 14.6 |
| LONG YEARS AVERAGE (°C) (1986-2017) | 4.7 | 5.4 | 7.9 | 11.7 | 16.1 | 20.7 | 24.1 | 24.0 | 19.6 | 14.0 | 9.0 | 5.9 | 13.6 |
| DIFFERENCE | 0.8 | 0.9 | 0.7 | 0.8 | 0.9 | 1.3 | 1.5 | 1.6 | 1.3 | 1.0 | 0.9 | 0.8 | 1.0 |
| EXTREME MAX. TEMPERATURE (°C) (2021-2050) | 9.7 | 11.4 | 14.5 | 19.1 | 23.4 | 28.9 | 33.0 | 33.0 | 28.3 | 21.7 | 15.2 | 10.9 | 20.8 |
| LONG YEARS EXT. MAX (°C) (1986-2017) | 8.9 | 10.6 | 13.7 | 18.2 | 22.6 | 27.4 | 31.3 | 31.7 | 27.0 | 19.6 | 13.3 | 9.4 | 19.5 |
| DIFFERENCE | 0.8 | 0.7 | 0.8 | 0.9 | 0.7 | 1.5 | 1.7 | 1.4 | 1.3 | 2.1 | 1.8 | 1.5 | 1.3 |
| EXT MIN TEMP (2021-2050) | 1.1 | 1.5 | 2.8 | 6.1 | 10.4 | 14.9 | 17.8 | 17.8 | 14.1 | 9.2 | 5.0 | 2.2 | 8.6 |
| LONG YEARS EXT. MIN (°C) (1986-2017) | -0.2 | 0.4 | 2.4 | 5.4 | 9.4 | 13.5 | 16.2 | 16.2 | 12.7 | 8.1 | 4.2 | 1.3 | 7.5 |
| DIFFERENCE | 1.37 | 1.07 | 0.40 | 0.70 | 1.03 | 1.36 | 1.67 | 1.66 | 1.45 | 1.02 | 0.78 | 0.93 | 1.12 |
| AVERAGE MAX TEMP (°C) (2021-2050) | 9.1 | 10.5 | 13.7 | 18.1 | 22.8 | 27.9 | 32.1 | 32.2 | 27.5 | 20.7 | 14.4 | 10.3 | 19.9 |
| LONG YEARS AVERAGE MAX (°C) | 8.2 | 9.5 | 12.8 | 17.2 | 21.8 | 26.6 | 30.4 | 30.5 | 26.1 | 19.6 | 13.3 | 9.4 | 18.8 |
| DIFFERENCE | 0.9 | 1.0 | 0.9 | 0.9 | 1.0 | 1.4 | 1.6 | 1.6 | 1.4 | 1.1 | 1.1 | 0.9 | 1.2 |
| AVERAGE MIN TEMP (2021-2050) | 1.7 | 2.1 | 3.7 | 6.9 | 11.0 | 15.4 | 18.7 | 18.6 | 14.6 | 9.9 | 5.8 | 3.0 | 9.3 |
| LONG YEARS AVERAGE MIN (°C) (1986-2017) | 1.0 | 1.2 | 3.0 | 6.2 | 10.2 | 14.3 | 17.3 | 17.1 | 13.4 | 9.0 | 5.0 | 2.3 | 8.3 |
| DIFFERENCE | 0.8 | 0.9 | 0.7 | 0.7 | 0.8 | 1.1 | 1.4 | 1.5 | 1.2 | 0.8 | 0.8 | 0.8 | 1.0 |
| RELATIVE HUMIDITY (%) (2021-2050) | 84.6 | 80.9 | 75.1 | 68.5 | 64.4 | 58.6 | 49.8 | 47.9 | 55.1 | 69.7 | 80.7 | 85.1 | 68.4 |
| LONG YEARS AVE. REL. HUMIDITY (%) (1986-2017) | 84.9 | 81.5 | 75.9 | 69.3 | 65.3 | 60.6 | 52.1 | 49.8 | 57.0 | 71.3 | 82.0 | 85.7 | 69.6 |
| DIFFERENCE | -0.30 | -0.60 | -0.80 | -0.80 | -0.90 | -2.00 | -2.30 | -1.90 | -1.90 | -1.60 | -1.30 | -0.60 | -1.25 |
| TOTAL PRECIPITATION (mm) (2021-2050) | 97.7 | 77.3 | 69.8 | 57.2 | 58.9 | 47.6 | 28.7 | 20.5 | 26.2 | 55.4 | 78.4 | 98.6 | 716.3 |
| L.Y. AVERAGE TOTAL PREC. (mm) (1986-2017) | 99.1 | 77.6 | 71.7 | 57.2 | 60.2 | 49.7 | 30.0 | 21.0 | 29.2 | 58.9 | 83.2 | 101.5 | 739.3 |
| DIFFERENCE | -1.5 | -0.3 | -2.0 | 0.0 | -1.3 | -2.2 | -1.3 | -0.5 | -3.0 | -3.5 | -4.8 | -2.8 | -23.1 |

# Annex-3: National Strategy and Action Plans for Agricultural and Rural Development

## National Rural Development Strategy Paper

It is prepared in order to constitute a holistic policy framework for rural development activities, to establish a basis for the National Rural Development Plan which is predicted to be prepared and implemented in 2006, and to provide a perspective to relevant stakeholders in the preparation and implementation of rural development programs and projects to be financed by national and international resources. While the Agricultural Strategy aims, as a sectoral target, the agricultural sector to achieve a competitive and sustainable structure in the structural transformation process, the National Rural Development Strategy (NRDS) aims, in a way to cover the sectoral objectives of the agricultural strategy, "accelerating rural development to increase the welfare of rural society", and includes broader social objectives.

NRDS defines the main purpose for rural development as "improving and rendering sustainable the living and working conditions of the rural community in their territory, in harmony with urban areas, based on the utilization of local potential and resources, and on the protection of natural and cultural assets".

## Strategic Plan of the Ministry of Agriculture and Forestry

The strategic plan for the 2018-2022 period identifies seven strategic areas. These areas are:

1- Agricultural production and supply security
2- Food safety
3- Plant health, animal health and welfare
4- Agricultural infrastructure and rural development
5- Management Of Aquaculture And Fishery Resources
6- Research & Development
7- Institutional capacity.

## National Strategy for Regional Development by the Ministry of Development

The Strategy Document which is planned to cover the period of 2014-2023 states that: the High Council of Regional Development (HCRD) and the Regional Development Committee (RDC) at national level were established; the secretariat of HCRD and RDC will be carried out by the Ministry of Development; and in addition, Regional Development Administrations and Development Agencies were established so as to accelerate the development of the regions by on-site coordination of the programming, implementation, monitoring and evaluation activities of the Southeastern Anatolia Project, Eastern Anatolia Project, Eastern Black Sea Project and Konya Plain Project.

As a summary, the following strategies are targeted in the strategy paper:

- Accelerating development in rural areas.
- Improving the rural economy and increasing employment opportunities.
- Encouraging the establishment of agricultural-food industry businesses in rural settlements.
- Unemployed rural labor force, especially women, who resigned from agricultural employment and continue to reside in the rural area will be directed to new and alternative agricultural production activities.
- Implementation of training courses on micro-business and entrepreneurship as well as non-agricultural business development support programs for youth,
- Activation of social security system for agricultural workers.
- Expanding and strengthening the organization by giving priority to the villages which have no producer organization.
- Providing income support to businesses engaged in subsistence farming, on the basis of micro-business.
- Improvement of rural environment and protection of natural resources.
- Implementation of programs encouraging water-saving methods.
- Supporting renewable energy production for environmentally friendly energy use.

- Strengthening local development capacity.

### Agricultural Law

The Agricultural Law No. 5488, which has a framework law nature, stipulates, as the highest legal norms, the basic rules related to many fields regarding agriculture, rural development, support and incentives, and agriculture financing, and defines the basic concepts related to agriculture and rural development.

> *In the Agricultural Law, the following conceptual definitions are made.*
>
> ***Agriculture:*** *All kinds of production, growing, processing, and marketing activities carried out by using natural resources together with appropriate inputs.*
>
> ***Farmer:*** *Natural and legal persons engaged in agricultural production either continuously or for at least one production or growing period as a landlord, tenant, or sharecropper.*
>
> ***Agricultural business:*** *The businesses that are engaged in agricultural activities for the production of plant and/or animal and/or aquaculture products by using the factors of production, or that are engaged in, as well as these agricultural activities, activities aimed at processing, storage, conservation, and marketing.*
>
> ***Agricultural production****: The production of plant, animal, and aquaculture products, as well as microorganism and energy, by using agricultural inputs along with soil, water, and biological resources.*
>
> ***Contracted production:*** *The form of agricultural production that is carried out through written contracts based on the principles of mutual benefits of farmers and growers as well as other natural and legal persons.*

**Objectives of the agricultural policies are defined as:**

a) Developing agricultural production in accordance with domestic and foreign demand;
b) Conservation and development of natural and biological resources;
c) Increasing efficiency;
d) Strengthening food security and safety;
e) Development of producer organizations;
f) Strengthening agricultural markets;
g) Increasing the welfare level in the agricultural sector by ensuring rural development.

The law includes basic regulations on rural development, support for agriculture and financing of subsidies. These regulations are:

**Rural development:** The Ministry shall take measures for, in rural areas, improving the agricultural and non-agricultural employment, increasing and diversifying incomes, and increasing the level of education and entrepreneurship of women and young population. The Ministry shall make arrangements for rural development programs, projects and activities and shall ensure coordination between public institutions. Participation, bottom-up approach, and development and institutionalization of local capacity are the basic principles in rural development programs, projects and activities.

**The purpose of agricultural supports** is to contribute to the solution of the priority problems of the agricultural sector, to increase the effectiveness of the policies implemented, and to facilitate the harmonization of the sector with these policies. Agricultural support policies are implemented through programs that will ensure the conditions of economic and social effectiveness and efficiency (see 4.3. for instruments of agricultural subsidies).

**The financing of agricultural subsidies** is provided by budget resources and external sources. The resource to be allocated in the budget cannot be less than one percent of the gross national product.

### Providing Subsidized Credit Facilities

Within the framework of the Council of Ministers' Decrees published every year, subsidies at various rates are applied to credits which are facilitated, on areas determined within the scope of the decrees, by Ziraat Bank to its farmer customers and Agricultural Development Cooperatives and by Agricultural Credit Cooperatives to their partners. In practice, the credit risk belongs to the credit institution and interest is covered by the Treasury as a subsidy.

With the Decree No. 11188 of the Council of Ministers concerning the implementation in 2018, it has been decided to subsidize the interest expenses varying up to 100% in various subjects related to vegetative and animal production. In practice, the maximum amount of subsidized credit per business and minimum and maximum capacities of the businesses have been regulated.

## Agricultural and Rural Organization in İzmir and Kucuk Menderes Region

The rural development policies applied since the establishment of the Republic are separated into two parts as the pre-planning period and planned period. Pre-planning period includes the span until 1963 in which the first plan was made. Modernization movements that started in this period affected also the development efforts in agriculture and rural areas. Special importance was given to these issues since a significant part of the population was living in rural areas and the economy was mainly based on agriculture. From 1963 onwards, the so-called Planned Period, the models proposed and implemented for the development of agriculture and rural areas have been included in the development plans prepared for five-year periods. Agriculture-Village and Rural Development Models, Development Plans, Strategy Papers, Rural Development Projects (RDP), and Regional Development Projects can be listed as planning and practices performed in this period.

The major problem areas are: the fact that agricultural businesses in Turkey are small and have a scattered structure; inadequacies in market access and organization, and failure to disseminate education-publication services. Livestock businesses in Turkey are generally small scale. On the other hand, the production of fodder crops and the protection and improvement of meadows and pastures are insufficient, the number of artificial inseminations is below the international average, and measures for animal movements and animal health are in a situation far from adequacy. During the planned period, the quantity and variety of subsidies for livestock have been increased, regional projects have been implemented, and these supports have resulted in an increase in meat and milk production in recent years.

In order to transform the agricultural product markets into a more competitive and efficient structure, regulations have been made regarding the marketplaces, licensed warehousing, commodity exchanges, and futures and options transactions. During the planned period, EU harmonization studies related to “Agriculture and Rural Development”, “Food Safety, Veterinary and Phytosanitary” and “Fisheries” chapters were continued but only “Food Safety, Veterinary and Phytosanitary” chapter was opened for negotiation. National Rural Development Strategy and Rural Development Plan papers were put into effect for the first time for a more effective rural development policy management, a multilateral monitoring committee was established for monitoring the plan, and the implementations have been largely transferred to local institutions. The institutional capacity for rural development at the local level was strengthened. Main institutions contributing to the formation of this capacity are the Agriculture and Rural Development Support Agency, development agencies, special provincial administrations, and unions for providing services to villages. Together with the new regulation, the metropolitan municipality of 30 provinces and their district municipalities have also become key actors in rural development. KÖYDES which was launched as a pilot project in 2005 was transformed into an integrated rural infrastructure program with the inclusion of small-scale agricultural irrigation in 2010 and waste water components in 2011.

The İzmir-specific situation of the producer organizations, which are established to meet the needs of the agricultural producers, and whose legal framework is determined by the government, is as follows:

- Chambers of Agriculture: There are 21 agricultural chambers in İzmir and its districts. Farmers, who are located in districts where there is no chamber of agriculture, can receive services by becoming a member of the nearest chamber of agriculture.
- Agricultural Producers Associations: In İzmir, there are a total of 26 agricultural producers’ associations comprised of 12 associations dealing with plant products, 13 associations dealing with animal products and 1 association dealing with marine products. A total of 1355 producers comprised of 583 producers engaged in plant production, 753 producers engaged in animal production and 19 producers engaged in marine products are members of these associations.
- Breeders Associations: There are 3 Breeders Associations in İzmir including the Stud Sheep-Goat Breeders Association, Bee Breeders Association, and Stud Cattle Breeders Association. A total of 15,371 breeders including 5,434 stud sheep-goat breeders, 1,352 bee breeders, and 8,585 stud cattle breeders, are members of these associations.

- Agricultural Cooperatives (Agricultural Development Cooperative, Irrigation Cooperative, Aquatic Products Cooperative): In İzmir, there are 163 agricultural development cooperatives, 100 irrigation cooperatives, and 47 aquaculture cooperatives. A total of 41,227 producers are members of these cooperatives, where agricultural development cooperatives have 23,835 members, irrigation cooperatives have 14,765 members, and aquaculture cooperatives have 2,627 members. In İzmir, there are four associations formed by agricultural cooperatives.
- Agricultural Sales Cooperatives: In İzmir, there are three Fig Sales Cooperatives which came together and organized under "Tariş Fig Union". The Union plays a role in the establishment of market prices. In addition, there are two Grape Sales Cooperatives. Grape Agriculture Sales Cooperatives came together and organized under "Tariş Grape Union". The Union which produces and exports large quantities of seedless raisins is one of the biggest seedless raisins buyer and exporter institutions in Turkey. There are eight Olive and Olive Oil Agricultural Sales Cooperatives. These cooperatives were organized under "Tariş Olive and Olive Oil Agricultural Sales Cooperatives Union".
- Agricultural Credit Cooperatives: There are 57 Agricultural Credit Cooperatives in İzmir.

All of the above-mentioned agricultural producer organizations in KMRB are included among the important actors. They serve at different points in the value chain, such as agricultural production, processing and marketing. Such organizations of producers are an important indicator for both İzmir and Turkey.

## Policies, Legislation and Projects Being in Force in the Framework of Adaptation to Climate Change in Agriculture Sector

| Laws | Explanation |
|---|---|
| Statutory Decree No. 639 dated 03.06.2011; regarding the duties of the Ministry of Food, Agriculture and Livestock: | *To determine, support and disseminate new forms of production by considering human health and ecological balance; to provide coordination with relevant institutions to prevent pollution which may occur; to carry out studies in order for the animal production to be made by means of methods protecting human health and ecological balance; to carry out services related to global climate changes, agricultural environment, drought, desertification, other agricultural disasters, and agricultural insurance; to provide aid, in the framework of the principles stated in its specific legislation, to farmers who suffered from natural disasters; to conduct researches with the purpose of the development and rational use of soil and water resources.* |
| Agricultural Law No. 5488 | *The purpose of the law is the constitute the basis of agricultural policies, and the objectives of the agricultural policy are expressed as follows: development of agricultural production in accordance with domestic and foreign demand; protection and development of natural and biological resources; strengthening food security and safety; development of producer organizations; increasing the welfare of the agricultural sector by strengthening agricultural markets and ensuring rural development.* |
| Law No. 5403 on Soil Protection and Land Use | *This legal arrangement includes provisions for completion of the inventories related to the lands, prevention of the use of agricultural lands for non-agricultural purposes and taking all measures related to the protection and sustainable use of agricultural lands.* |
| Law No. 3083 on Agricultural Reform regarding Rearrangement of Land in Irrigated Areas | *It includes a legal arrangement supporting the Law No. 5403, such as: (1) efficient plant cultivation in lands, and regional employment; (2) land allocation, and providing support and training to farmers who have no or insufficient land; (3) integration of small lands for efficient plant growing; and (4) creation of new settlements or enlargement of existing sites.* |
| Pasture Law No. 4342 | *It has introduced regulations for the identification, allocation, sustainable use, enhancement and improvement of the efficiency, and inspection of the use of pastures, grasslands, and meadows. These regulations are parallel with and supportive of policies to combat and adapt to climate change. The permission of the land allocated must be renewed every 5 years.* |
| Seed Growing Law | *The purpose of the Seed Growing Law is: to increase the yield and quality in the plant production; to provide quality assurance for seeds; to make arrangements regarding the production and trade of seed, and to make arrangements required for the restructuring and development of the seed sector. It is known that roughage* |

| | |
|---|---|
| | *with high nitrogen efficiency decreases $N_2O$ emissions from livestock. The seed improvement of fodder crops having high nitrogen binding strength will provide an advantage in reducing greenhouse gases.* |
| **Regulations** | **Explanation** |
| Regulation on Good Agricultural Practices | *Pursuant to the Regulation on Good Agricultural Practices which was amended in 2005 and 2006, the control and certification activities are carried out by private institutions authorized by TOB. In this context, 12 private institutions have been authorized by the Ministry to perform control-certification activities. In addition, these authorized institutions should be accredited by Turkish or foreign accreditation bodies according to EN 45011 or ISO/IEC Guide 65.* |
| Regulation on Principles and Implementation of Organic Agriculture | *The regulation sets out the principles and procedures regarding: protection of ecological balance; execution of organic agricultural activities; regulation, development and expanding organic agricultural production and marketing.* |
| Regulation on Agricultural Basins | *The Regulation on Agricultural Basins lays down the procedures and principles for carrying out, supporting, organizing, and specializing, in an integrated manner, of agricultural activities in the agricultural basins determined, and for preparing the agricultural inventory. These applications enable the adaptation to the changing climatic conditions in terms of effective use, protection, and planning of soil and water resources.* |
| **Programs** | **Explanation** |
| Environmentally Based Agricultural Land Protection Program (ÇATAK) | *This project aims to increase the quality of soil and water in areas, where intensive agricultural activity is undertaken, which has erosion, soil and water pollution risks, and irrigation water shortage problems, and where natural balance has begun to deteriorate, to take necessary cultural measures for the sustainability of renewable natural resources, prevention of erosion, and reduction of negative effects of agriculture, and to raise awareness of producers about agriculture-environment. By means of including the "Minimum Soil Cultivation Based Agriculture" practices in the scope of the project, improvement of the soil structure, reduction of input costs, and increasing agricultural income of producers have also become priority issues. By popularizing the practices for organic agriculture, good agriculture, and protection of soil and water structure and natural flora in areas where the project is planned to be implemented, it is targeted that producers can evaluate the effect on the environment of the agricultural activity they undertake, and can protect the environment considering the plant and animal habitat.* |
| Incentive for Modern Irrigation Systems | *Significant progress has accomplished in the provision of irrigation systems in order for producers have a modern pressurized irrigation system in the field by facilitating investment and working capital credits with low-interest rate (with a discounted interest rate) to meet the financing needs of the producers with appropriate conditions, to improve agricultural production, and to increase the efficiency and quality.*<br>*A large number of agricultural engineers working in agricultural credit cooperatives received hands-on training, and numerous projects were prepared.* |
| Agriculture Insurance Practices | *The purpose is to indemnify losses from meteorological disasters such as frost, hail, tornado, flood, hurricane, stream overflow, etc. that have been gradually increasing due to climate changes. Through the Agricultural Risk Management strategy, it is aimed to ensure the sustainability of production by guaranteeing the products of the producers exposed to such risks.* |
| Sustainable Land Management and Climate-Friendly Agriculture Practices Project | *The project aims to adapt and popularize low-carbon emission technologies within the framework of land degradation, climate change, conservation of biodiversity, and efficient use of agriculture and forest areas.*<br>*The project, which is carried out in Konya Closed Basin, consists of rehabilitation of degraded areas, climate-friendly agriculture practices and work packages of improvement of environmental structure for multi-faceted benefits obtained from sustainable land management.* |
| Studies and practices on the use of renewable energy sources in agriculture | *Supplying the energy need in rural areas and agricultural businesses through renewable energy technologies is a factor which may provide an advantage for a sustainable environment. Energy is used in agricultural businesses for agricultural activities such as heating, cooling, drying, lighting, running milking units for which electricity is consumed.*<br>*The use of geothermal resources for all sectors became possible thanks to the Regulation for Implementation of the Law on Geothermal Resources and Natural Mineral Waters. Greenhouse growing is one of the agricultural fields where geothermal resources are used. The current situation in greenhouses both using and not using geothermal resources was analyzed in terms of economic, social, and environmental aspects, and* |

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| | *the reasons to engage in the geothermal greenhouse growing and the problems encountered in the production process were determined.*<br>*The investments which are made for the use in agriculture of renewable energy resources that are of great importance in terms of a sustainable environment are in the scope of support.* |

# Annex-4: Linking goals in the selection of key agri-products to local strategy papers and planning efforts

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| **Economic** | | | | |
| To boost the competitiveness of agricultural products grown in the Kucuk Menderes Basin in the domestic and international markets | Objective 1: To ensure the accessible and sustainable supply of agricultural products and to establish an agricultural sector that is highly competitive at national and international levels<br>A1. H1.2: To devise policies and to identify appropriate policy tools for the creation of a competitive and sustainable agricultural sector<br>Objective 6: To conduct Research & Development aimed at enhancing quality and productivity in agricultural production<br>A6. H6.1: To develop new varieties, races, methods, and technologies in line with domestic and foreign agricultural market demands | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Value Added Production and Marketing (Relevant Sub-strategies: (i) Obtaining geographical indication for local agricultural products; (ii) Development of alternative productions and providing marketing support; (iii) Increasing on-site marketing initiatives, (iv) Establishment of product-based agricultural specialization areas; (v) Establishment of agriculture-based industrial/processing facilities; (vi) Development of organization and industrialization for processing milk and milk products)<br>Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Ecological production (i) development of organic product diversity, (ii) providing support for certification process and marketing<br>Innovation and Entrepreneurship Axis 14 – A KMRB which brands in husbandry and ensures marketing and high quality:<br>- Ensuring branding: (i) Supporting the branding and establishment of cooperatives by means of grants and training courses; (ii) supporting institutionalization steps such as trademark, registration, patent, packaging, logo design. | Development Axis: Strong Economy – Sustainable Production and Service Delivery 5.1.4.H5: (i) Contract farming will be expanded in agricultural production. (ii) İzmir-specific local products such as olive, fig, cherry, peach, satsuma mandarin, grape, blessed thistle, artichoke, okra, cowpea, and table herbs (baby's tears, chicory, fat hen, cibez) will be branded. (iii) Awareness-raising activities will be carried out to ensure that agricultural products receive geographical indications both at the national and EU levels, and efforts and initiatives in this aspect will be supported. (iv) Growing of early fruit varieties such as cherry and satsuma mandarin will be developed in order to make use of the export advantage of İzmir, in particular, in such varieties. | |
| To ensure food safety and security at national and regional levels | Objective 1: To ensure the accessible and sustainable supply of agricultural products and to establish an agricultural sector that is highly competitive at national and international levels<br>A1. H1.1: Ensuring supply security for agricultural products<br>Objective 2: To ensure food and feed safety in order to protect natural resources and human health from production to consumption, in accordance with international standards | Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Soil-Water Management and Monitoring (Related sub-strategies: (i) organization of agricultural activities of the people living in the city in the non-cultivated agricultural lands; (ii) adaptation to the basin of high-tech advanced irrigation methods, and minimization of agricultural water use, (iii) planning of basin product pattern suitable for soil and climate to ensure healthier products and foods)<br>- Ecological Production (Related sub-strategies: (i) determination of potential organic/good agricultural areas; (ii) providing support for | Development Axis: Strong Economy – Sustainable Production and Service Delivery 5.1.4.H5: (i) Environmental-friendly and traceable certified production techniques such as good agriculture, organic agriculture, and integrated controlled production will be popularized in line with the approach of safe food from field to table in Dikili, Bergama, Kınık, Kiraz, Beydag, Odemis, Bayındır, Tire, and Karaburun districts which constitute | |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| | Objective 4. H4.2: To consolidate small and fragmented agricultural lands and make land use planning, in order to ensure sustainable agricultural production | certification process and marketing; (iii) improvement of organic product diversity, (iv) planning organic and good agricultural production, and ensuring a joint integrated production with husbandry; (v) establishment of healthy food markets with products from good agriculture and organic agriculture; (vi) protection and development of pastures, and development, and promotion for increasing the market share, of pasture husbandry (for healthy food)) | the secondary agricultural zone. | |
| To reduce price instability and to improve farmers' decision-making processes related to agricultural activities | Objective 1: To ensure the accessible and sustainable supply of agricultural products and to establish an agricultural sector that is highly competitive at national and international levels<br>A1. H1.1: Ensuring supply security for agricultural products<br>A1. H1.4: To develop training strategies and consulting system for producers and consumers | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Multi-Tier Organization and Monitoring of Production (Relevant sub-strategies: (i) Establishment of basin agricultural information system; (ii) Providing agricultural education support in cooperation with public and local authorities, (iii) Delivering training for the development of technological greenhouse growing and soilless farming practices<br>- Value Added Production and Marketing (Related sub-strategies: (i) Enhancing alternative productions and providing marketing support; (ii) Maximizing initiatives for on-site marketing<br>Innovation and Entrepreneurship Axis 14 – A KMRB which brands in husbandry and ensures marketing and high quality:<br>- Ensuring branding (i) Supporting the branding and establishment of cooperatives by means of grants and training courses,<br>- Ensuring the effectiveness of management-organization: (i) Providing all kinds of rent, land and credit supports to cooperatives which have many subscribers who will make an integrated and large-scale production, (ii) Establishment of an exchange for livestock and floriculture, (iii) Supporting permaculture formations in animal husbandry, carrying out awareness, training and implementation studies at the basin and local levels.<br>Innovation and Entrepreneurship Axis 15 - A KMRB which forms the human capital supporting the development in agriculture:<br>- Co-production, learning by sharing: (i) providing training on marketing, sales, and promotion to small-scale | Development Axis: Strong Economy - Sustainable Production and Service Delivery 5.1.4.H5: Licensed warehousing practices will be expanded in order to increase the revenue and value-added obtained by the local producer. | |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| | | producers, (ii) providing free training on how to do e-commerce | | |
| To boost the economic welfare of the regional population by ensuring the sustainability of crops that make a maximum contribution to the basin's agricultural income and that are produced with a higher yield and value-added as compared to the national average | A1. H1.2: To devise policies and to identify appropriate policy tools for the creation of a competitive and sustainable agricultural sector<br>A3. H3.1: To preserve quality and to boost yield in vegetative production through environment-friendly plant health activities<br>A6. H6.1. To develop new varieties, races, methods, and technologies in line with domestic and foreign agricultural market demands | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Multi-Tier Organization and Monitoring of Production (Relevant sub-strategies: (i) Delivering training for the development of technological greenhouse growing and soilless farming practices<br>- Value Added Production and Marketing: (i) Establishment of product-based agricultural specialization areas,<br>- Farming: (i) Development of innovative production methods; (ii) Planning of product diversity; (iii) Development and promotion, on the basin basis, of new plant products that are compatible with changing climatic conditions and that strengthen the competitiveness with other basins; (iv) Improving the investment in basin-specific agricultural plant cover, ensuring the increase in cultivated lands and quality, providing support for processing, promotion, and marketing. | Development Axis: Strong Economy – Sustainable Production and Service Delivery 5.1.4.H5: (i) İzmir-specific local products such as olive, fig, cherry, peach, satsuma mandarin, grape, blessed thistle, artichoke, okra, cowpea, and table herbs (baby's tears, chicory, fat hen, cibez) will be branded. (ii) The generation of value added in the agricultural sector will be enhanced. (iii) Semen and embryo transfer centers will be established to sustain quality stud livestock breeding. The number of decontaminated businesses in cattle and sheep breeding will be increased. | |
| To minimize the vulnerability of the agricultural industry to climate change by ensuring the continuity of the main products providing input into the agricultural industry of the region | A1. H1.1: Ensuring supply security for agricultural products<br>A1. H1.2: To devise policies and to identify appropriate policy tools for the creation of a competitive and sustainable agricultural sector | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Value Added Production and Marketing (Relevant Sub-strategies: (i) Establishment of agriculture-based industrial/processing facilities; (ii) Development of organization and industrialization for processing milk and milk products.<br>Innovation and Entrepreneurship Axis 13 – A KMRB ensuring agriculture-based industry and vertical integration:<br>- Development of sub-industries: (i) development of facilities such as livestock tethering (Beydag), drying, bottling plants, ice houses, cold storage rooms, loading facilities, feed mills,<br>- Supporting large-scale agricultural industries and infrastructures: (i) Providing support for land consolidation and large-scale agricultural industry, (ii) Supporting integrated meat and dairy products facilities. | Development Axis: Strong Economy – Sustainable Production and Service Delivery 5.1.4.H5: (i) The utilization of alternative energy resources in agriculture will be expanded, and the utilization of mainly biomass energy as well as wind and solar energy will be expanded in districts whose economy is based on agriculture. The existing greenhouses will be modernized and geothermally heated greenhouses will be developed in Bergama, Dikili, Bayındır, and Seferihisar. (ii) Semen and embryo transfer centers will be established to sustain quality stud livestock breeding. The number of decontaminated businesses in cattle and sheep breeding will be increased.<br><br>Development Axis: Strong Society – Social Inclusion for Social Harmony | 8.4.5.2. Management of Pollution from Livestock Husbandry Activities:<br>- Supervision of animal wastes discharges to receiving environment: It can be ensured that the large-scale individual enterprises and the small/medium-sized enterprises located in settlement of the Animal Husbandry OIZ obtain significant economic input from the renewable energy incentive and the generation of organic fertilizer by means of stabilizing animal wastes in compost and/or anaerobic digestion (biomethane) plants and directing to organic material and/or bioenergy recycling projects.<br>- It can be ensured that if central/large capacity biomethane |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| | | | 5.3.3.H5: Agriculture-based industry for processing and packaging of agricultural products will be improved. E-commerce opportunities in rural areas will be improved. | plants of Animal Husbandry OIZ and large individual enterprises receive biodegradable wastes from other sectors, such plants earn more income by taking waste disposal fees and also generating extra biomethane from agricultural wastes. |
| To reduce the vulnerability of stable markets to climate change by ensuring the continuity of agricultural productions where well-established market channels exist | Objective 1: To ensure the accessible and sustainable supply of agricultural products and to establish an agricultural sector that is highly competitive at national and international levels<br>A1. H1.2: To devise policies and to identify appropriate policy tools for the creation of a competitive and sustainable agricultural sector | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Value Added Production and Marketing (Relevant Sub-strategies: (i) Obtaining geographical indication for local agricultural products; (ii) Development of alternative productions and providing marketing support; (iii) Increasing on-site marketing initiatives, (iv) Establishment of product-based agricultural specialization areas; (v) Establishment of agriculture-based industrial/processing facilities; (vi) Development of organization and industrialization for processing milk and milk products)<br>- Farming: (i) Development and promotion, on the basin basis, of new plant products that are compatible with changing climatic conditions and that strengthen the competitiveness with other basins; (ii) Improving the investment in basin-specific agricultural plant cover, ensuring the increase in cultivated lands and quality, providing support for processing, promotion, and marketing.<br>Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Ecological production (i) development of organic product diversity, (ii) providing support for certification process and marketing<br>Innovation and Entrepreneurship Axis 14 – A KMRB which brands in husbandry and ensures marketing and high quality:<br>- Ensuring branding: (i) Supporting the branding and establishment of cooperatives by means of grants and training courses; (ii) supporting institutionalization steps such as trademark, registration, patent, packaging, logo design. | Development Axis: Strong Economy - Sustainable Production and Service Delivery 5.1.4.H1: (i) In order to set an example for eco-efficiency applications and to ensure the development of the relevant market it will be ensured that regional actors sign cooperation protocols on "green procurement", "environmentally sensitive products and technologies" and "generation of energy and product from wastes", etc.; (ii) In order for agricultural products obtain geographically indications at both national and EU levels, activities will be carried out to raise awareness and actions and initiatives in this manner will be supported. | |
| To preserve agricultural sectors with relatively well- | A1. H1.2: To devise policies and to identify appropriate policy tools for the creation | Agricultural Axis 1 – Integrated Planned Agricultural Production: | Development Axis: Strong Economy - Sustainable Production and Service | |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| developed innovation and technical capacity and to support the production of value-added crops in the region | of a competitive and sustainable agricultural sector<br>Objective 6: To conduct Research & Development aimed at enhancing quality and productivity in agricultural production<br>A6. H6.1: To develop new varieties, races, methods, and technologies in line with domestic and foreign agricultural market demands<br>A6. H6.3: To develop R&D cooperation with national and international organizations<br>A6. H6.4: To ensure transferring R&D results into practice | - Value Added Production and Marketing (Relevant Sub-strategies: (i) Development of alternative productions and providing marketing support; (ii) Establishment of product-based agricultural specialization areas; (iii) Establishment of agriculture-based industrial/processing facilities; (iv) Development of organization and industrialization for processing milk and milk products)<br>- Multi-Tier Organization and Monitoring of Production: (i) Delivering training for the development of technological greenhouse growing and soilless farming practices<br>- Farming: (i) Development of innovative production methods (e.g. use of intelligent greenhouse with advanced technology); (ii) Improving the investment in basin-specific agricultural plant cover, ensuring the increase in cultivated lands and quality, providing support for processing, promotion, and marketing; (iii) Determination of locations, and giving priority to the establishment, of specialization zones and integrated facilities for animal husbandry.<br>- Agricultural infrastructure: (i) constructing modern animal slaughterhouses and accredited laboratories; (ii) cold storage rooms for agricultural products; (iii) Constructing integrated production facility(ies) for animal products in the basin; (iv) Establishment of shelter, port, and facilities in sea and freshwater fishery and encouraging investments.<br>Agricultural Axis 2 – Clean Basin, Safe Food<br>- Soil-Water Management and Monitoring (i) Adaptation to the basin of high-tech advanced irrigation methods, and minimization of agricultural water use; (ii) Precision agriculture practices based on remote sensing technology.<br>- Ecological production: (i) Supporting cooperatives for integrated organic meat plants and the production therein.<br>Innovation and Entrepreneurship Axis 13 – A KMRB ensuring agriculture-based industry and vertical integration: | Delivery 5.1.4.H2: (i) Regional actors shall be enabled to encourage industrial applications through their cooperation on issues such as green procurement, environment management practices aimed at ensuring efficiency in enterprises, use and production of environmentally sensitive products and technologies, and generation of energy and products from wastes.<br>(ii) İzmir will be enabled to become a region where pilot schemes are carried out for expanding industrial symbiosis practices considering the capacity already built up related to eco-efficiency/clean production through projects undertaken in previous periods.<br><br>Development Axis: Strong Economy – Sustainable Production and Service Delivery 5.1.4.H5: (i) The utilization of alternative energy resources in agriculture will be expanded, and the utilization of mainly biomass energy as well as wind and solar energy will be expanded in districts whose economy is based on agriculture. The existing greenhouses will be modernized and geothermally heated greenhouses will be developed in Bergama, Dikili, Bayındır, and Seferihisar. (ii) Modern irrigation systems will be expanded, and utilization of pressurized irrigation systems will be increased. | |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| | | - Development of sub-industries: (i) Establishment of industrial zones for agricultural equipment and machinery; (ii) development of facilities such as livestock tethering (Beydag), drying, bottling plants, ice houses, cold storage rooms, loading facilities, feed mills,<br>- Supporting large-scale agricultural industries and infrastructures: (i) Providing support for land consolidation and large-scale agricultural industry, (ii) Supporting integrated meat and dairy products facilities. | | |
| To reduce the vulnerability of products exported from the region to climate change and to preserve their competitiveness in foreign markets | A1. H1.2: To devise policies and to identify appropriate policy tools for the creation of a competitive and sustainable agricultural sector<br>A1. H1.3: To play a more active role in the international arena, and to get involved in decision making processes of international organizations | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Value Added Production and Marketing (Relevant Sub-strategies: (i) Obtaining geographic indication for local agricultural products; (ii) Development of alternative productions and providing marketing support; (iii) Establishment of product-based agricultural specialization areas; (iv) Establishment of agriculture-based industrial/processing facilities<br>Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Ecological production (i) development of organic product diversity, (ii) providing support for certification process and marketing<br>Innovation and Entrepreneurship Axis 14 – A KMRB which brands in husbandry and ensures marketing and high quality:<br>- Ensuring branding: (i) Supporting the branding and establishment of cooperatives by means of grants and training courses; (ii) supporting institutionalization steps such as trademark, registration, patent, packaging, logo design | | |
| **Social** | | | | |
| To reduce unemployment by ensuring the sustainability of products that create maximum agricultural employment in the region, to support socioeconomic prosperity in the region, and to reduce migration from rural to urban areas by activating | Objective 4: To develop the rural economy; to improve the agricultural, social and physical infrastructure of rural areas.<br>A4. H4.1: To enhance income and employment opportunities in rural areas and to diversify the rural economy | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Multi-Tier Organization and Monitoring of Production: (i) Supporting the women entrepreneurship in rural area<br>Tourism Axis XX – A KMRB developing its tourism infrastructure:<br>- Development of Financial & Institutional Infrastructures: (i) Supporting active participation of women and young people in income-generating tourism activities. | Development Axis: Strong Society – Social Inclusion for Social Harmony 5.3.3.H5: Trainings will be given and financial supports will be provided to farmers in general along with producer unions and cooperatives towards transitioning into high value-added agricultural activities at rural areas. | |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| the unemployed labor force | | - Transformation of local values into distinctive/value-creating tourism products: (i) Preservation and promotion of local cultural differences by supporting family businesses<br>Innovation and Entrepreneurship Axis 15 - A KMRB which forms the human capital supporting the development in agriculture:<br>- Co-production, learning by sharing: (i) opening courses on making paste, tarhana, etc. through public education centers (ii) providing training on marketing, sales, and promotion to small-scale producers, (iii) delivering training on viticulture, citriculture, etc. | | |
| To maintain agricultural sectors in which disadvantaged social groups such as women and young people are active, and to preserve their socioeconomic prosperity while increasing their participation in the workforce | Objective 4: To develop the rural economy; to improve the agricultural, social and physical infrastructure of rural areas.<br>A4. H4.1: To enhance income and employment opportunities in rural areas and to diversify the rural economy | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Multi-Tier Organization and Monitoring of Production: (i) Supporting the women entrepreneurship in rural area<br>Tourism Axis XX – A KMRB developing its tourism infrastructure:<br>- Development of Financial & Institutional Infrastructures: (i) Supporting active participation of women and young people in income-generating tourism activities.<br>- Transformation of local values into distinctive/value-creating tourism products: (i) Preservation and promotion of local cultural differences by supporting family businesses<br>Innovation and Entrepreneurship Axis 15 - A KMRB which forms the human capital supporting the development in agriculture:<br>- Co-production, learning by sharing: (i) opening courses on making paste, tarhana, etc. through public education centers (ii) providing training on marketing, sales, and promotion to small-scale producers, (iii) delivering training on viticulture, citriculture, etc. | | |
| To ensure the continuity of the production of traditional and geographically-indicated products in the region and to prevent that the potential consequences of climate change adversely affect the | A1. H1.2: To devise policies and to identify appropriate policy tools for the creation of a competitive and sustainable agricultural sector<br>A4. H4.1: To enhance income and employment opportunities in rural areas and to diversify the rural economy | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Value Added Production and Marketing (Relevant Sub-strategies: (i) Obtaining geographic indication for local agricultural products; (ii) Development of alternative productions and providing marketing support; (iii) Establishment of product-based agricultural specialization areas; (iv) Establishment of agriculture- | | |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
|---|---|---|---|---|
| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| social and cultural structure of the region | | based industrial/processing facilities<br>Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Ecological production (i) development of organic product diversity, (ii) providing support for certification process and marketing<br>Innovation and Entrepreneurship Axis 14 – A KMRB which brands in husbandry and ensures marketing and high quality:<br>- Ensuring branding: (i) Supporting the branding and establishment of cooperatives by means of grants and training courses; (ii) supporting institutionalization steps such as trademark, registration, patent, packaging, logo design | | |
| To ensure that women, young people and small family businesses contribute to agricultural production in the basin in an active and sustainable manner | Objective 4: To develop the rural economy; to improve the agricultural, social and physical infrastructure of rural areas.<br>A4. H4.1: To enhance income and employment opportunities in rural areas and to diversify the rural economy | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Multi-Tier Organization and Monitoring of Production: (i) Supporting the women entrepreneurship in rural area<br>Tourism Axis 11 – A KMRB developing its tourism infrastructure:<br>- Development of Financial & Institutional Infrastructures: (i) Supporting active participation of women and young people in income-generating tourism activities.<br>- Transformation of local values into distinctive/value-creating tourism products: (i) Preservation and promotion of local cultural differences by supporting family businesses<br>Innovation and Entrepreneurship Axis 15 - A KMRB which forms the human capital supporting the development in agriculture:<br>- Co-production, learning by sharing: (i) opening courses on making paste, tarhana, etc. through public education centers (ii) providing training on marketing, sales, and promotion to small-scale producers, (iii) delivering training on viticulture, citriculture, etc. | Development Axis: Strong Society – Social Inclusion for Social Harmony 5.3.3.H5: In order to integrate the rural population with urban population and to strengthen the dialogue between them activities and projects to which people of all age groups can get involved will be implemented. | |
| To raise awareness about, and to enhance adaptation efforts for, climate change of farmers and agricultural actors in the sectors accorded priority by public policies, and to ensure public supports highly | A6. H6.3: To develop R&D cooperation with national and international organizations | Settlement Structure and Culture Axis xx - Healthy, Qualified, Safe and Habitable Environments:<br>- Local Representation and Cooperation: (i) Strengthening the cooperation between Municipalities in KMRB and the Governorate on physical planning and management of the basin; (ii) Strengthening cooperation between districts by reinvigorating | | |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| meet the expectations of civil society | | the Union of Municipalities of KMRB and developing joint workshops, seminars, and projects; (iii) Strengthening cooperation among civil society organizations that are sensitive to natural and cultural assets, and Metropolitan Municipality and district municipalities. | | |
| To support agricultural sectors in which farmer organizations are active and influential, and to enhance farmers' opportunities to access the market, funding, and knowledge | A1. H1.4: To develop training strategies and consulting system for producers and consumers<br>A6. H6.3: To develop R&D cooperation with national and international organizations | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Multi-Tier Organization and Monitoring of Production (Relevant sub-strategies: (i) Establishment of basin agricultural information system; (ii) Establishment of multi-tier organization; (iii) Providing agricultural education support in cooperation with public and local authorities, (iv) Delivering training for the development of technological greenhouse growing and soilless farming practices; (v) Establishment of local leadership program on the basin basis,<br>- Value Added Production and Marketing (Related sub-strategies: (i) Enhancing alternative productions and providing marketing support; (ii) Establishment of product-based agricultural specialization zones,<br>Innovation and Entrepreneurship Axis 14 – A KMRB which brands in husbandry and ensures marketing and high quality:<br>- Ensuring branding: (i) Supporting the branding and establishment of cooperatives by means of grants and training courses; (ii) supporting institutionalization steps such as trademark, registration, patent, packaging, logo design<br>- Ensuring the effectiveness of management–organization: (i) Providing all kinds of land, rent, and credit supports to cooperatives which have many subscribers who can make an integrated and large-scale production, (ii) Establishment of an effective executive board which can carry out strategies (iii) Establishment of an exchange for livestock and floriculture, (iv) Supporting permaculture formations in animal husbandry, carrying out awareness, training and implementation studies at the basin and local levels<br>Innovation and Entrepreneurship Axis 15 - A KMRB which forms the human capital supporting the development in agriculture: | Development Axis: Strong Society – Social Inclusion for Social Harmony 5.3.3.H5: Rural organization capacity, in particular, producer cooperatives in rural areas will be developed, and producer organizations will be strengthened. | |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| | | - Co-production, learning by sharing: (i) opening courses on making paste, tarhana, etc. through public education centers (ii) providing training on marketing, sales, and promotion to small-scale producers, (iii) delivering training on viticulture, citriculture, etc. (iv) delivering training on how to do e-commerce; (v) delivering free training on how to obtain an organic certificate. | | |
| To support the production of products with high social reputation, and to prevent people engaged in agriculture to abandon the sector and rural area, as well as to prevent social structure to deteriorate | Objective 4: To develop the rural economy; to improve the agricultural, social and physical infrastructure of rural areas.<br>A4. H4.1: To enhance income and employment opportunities in rural areas and to diversify the rural economy | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Multi-Tier Organization and Monitoring of Production: (i) Supporting the women entrepreneurship in rural area<br>Tourism Axis 11 – A KMRB developing its tourism infrastructure:<br>- Development of Financial & Institutional Infrastructures: (i) Supporting active participation of women and young people in income-generating tourism activities.<br>- Transformation of local values into distinctive/value-creating tourism products: (i) Preservation and promotion of local cultural differences by supporting family businesses<br>Innovation and Entrepreneurship Axis 15 - A KMRB which forms the human capital supporting the development in agriculture:<br>- Co-production, learning by sharing: (i) opening courses on making paste, tarhana, etc. through public education centers (ii) providing training on marketing, sales, and promotion to small-scale producers, (iii) delivering training on viticulture, citriculture, etc. | | |
| **Environmental** | | | | |
| To identify the green, blue and grey water footprints of agricultural production, and to protect groundwater and surface water sources | A3. H3.1: To preserve quality and to boost yield in vegetative production through environment-friendly plant health activities<br>A4. H4.3: To ensure the protection and efficient use of soil and water resources | Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Soil – Water Management and Monitoring: (i) Monitoring of basin's water balance sheet; (ii) Determination of priorities and quantities of water use; (iii) Adaptation to the basin of high-tech advanced irrigation methods, and minimization of agricultural water use<br>Environment, Energy and Water Resources Axis 6 – A KMRB Effectively Utilizing Water Resources<br>- Exploring, planning, and management of water resources: | Development Axis: Strong Economy – Sustainable Production and Service Delivery 5.1.4.H5: (i) Soil and water resources will be protected and improved. (ii) Modern irrigation systems will be expanded, and utilization of pressurized irrigation systems will be increased.<br>Development Axis: High Quality of Life – Sustainable Environment 5.2.2.H1: (i) Regarding | Management of Pollution from Agricultural Activities: (i) Inspecting dealers who sell agricultural inputs to prevent pollution caused by such materials; (ii) Introducing a consultancy system to determine the kind and quantity of inputs to be used; (iii) The pollution level of groundwaters in the basin and water in the basin's general catchment area should be checked, at |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | | (i) conducting researches for the integrated use of water resources in KMH; (ii) Planning for the protection and development of groundwater resources; (iii) Delivering training and carrying out studies on the relationship between, and effective use of, underground and surface water resources; (iv) Planning industrial water use, and carrying out studies for monitoring/controlling the industrial investments having excessive water consumption; (v) Expanding the use of drip irrigation systems; (vi) Establishment of a continuous monitoring network focused on quantity and quality throughout the KM river; (vii) Construction of underground dams in order to feed groundwater. | water usages other than drinking water usage, techniques and technologies for water saving and water recycling will be encouraged to be used and developed for the water use for industrial, domestic, and in particular agricultural purposes. Excessive water draw for agricultural and industrial activities by which more than 50% of groundwater is used will be prevented. | appropriate intervals, according to the samples taken and results of analyses to be conducted whether there is a pollution problem arising from agricultural activities, and the use of the pesticides should be controlled.<br><br>The pollution arising from wastewater of geothermal plants and from underground sources poses a risk among the elements boosting the borate concentration of the dam. In order to reduce this risk, relevant legislation should be amended, and the discharge of untreated geothermal waters should be prevented.<br><br>Plans recommended to be implemented in the Kucuk Menderes River Basin:<br><br>(i) To establish an integrated and efficient water quality management system in the basin; (ii) To prevent pollution occurring in the Kucuk Menderes River and its branches; (iii) To plan the quality and quantity of, and to prepare and implement management programs for, water resources utilization areas so that protection-rehabilitation projects can be developed; (iv) To design and implement wastewater, sewage, solid waste and similar infrastructure services, and projects on environment and ecological balance, and to take necessary measures to achieve the planned targets; (v) WWTPs should be commissioned in Kiraz and Tire, the settlements that most pollute Kucuk Menderes River, in the basin; (vi) Wastewater to Kucuk Menderes River and Beydag Dam should be prevented; (vii) Industrial |

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| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | | | | facilities especially dairy farms should build treatment plants; (viii) Controls on well drilling should be tighter; (ix) Domestic wastewater should be utilized for irrigation purposes; (x) Discharge of untreated domestic and industrial wastewater to the river should be prohibited; (xi) Studies should be carried out for the management of urban wastewater, industrial wastewater, and agricultural pollution; (xii) The rainwater discharges in the city should be completely separated from the wastewater sewerage network, the construction of new rainwater channels should continue, and possibilities should be sought to discharge rainwater to dams; (xiii) Any kind of settlement, industrialization and mining activities that will disrupt the natural balance and cause pollution should be precluded; (xiv) This zone should be considered and protected as a drinking and service water basin; (xv) Actions should be taken throughout the riverbed to prevent pollution caused by intense agricultural activities; (xvi) Treated and disinfected domestic wastewater should be preferred rather than groundwater, for irrigation purposed water consumption in agricultural lands; (xvii) It is important to reduce the use of groundwater as well as tighten the inspection of the wells; (xviii) The monthly variation in the quantity of groundwater should be monitored.<br><br>- Urgent prevention of all uncontrolled discharges made from plants to the sewerage system and receiving environment |

İZKA İzmir Kalkınma Ajansı Development Agency · THE WORLD BANK IBRD • IDA \| WORLD BANK GROUP · GFDRR Global Facility for Disaster Reduction and Recovery

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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| | | | | - Establishment of domestic and industrial wastewater infrastructure management within Tahtalı Dam protection strip<br>- To encourage the use of appropriate irrigation techniques where irrigation is required, and to determine and monitor the amount, and duration and time of implementation<br>- Taking measures to encourage saving in water usage<br>- Encouraging and promoting cooperative irrigation instead of public irrigation will ensure the rational use of groundwater resources<br>- The product pattern should be selected to be suitable for the water potential of the basin. |
| To ensure resource efficiency in agricultural production | A3. H3.1: To preserve quality and to boost yield in vegetative production through environment-friendly plant health activities<br>A4. H4.3: To ensure the protection and efficient use of soil and water resources | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Farming: (i) Developing outdoor soilless farming materials and preventing soil loss through seedling tubes<br>Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Soil – Water Management and Monitoring: (i) Monitoring of basin's water balance sheet; (ii) Determination of priorities and quantities of water use; (iii) Adaptation to the basin of high-tech advanced irrigation methods, and minimization of agricultural water use; (iv) Planning of basin product pattern compatible with the soil and climate.<br>- Ecological production: (i) Protection and development of pastures, and development, and promotion for increasing the market share, of pasture husbandry<br>Environment, Energy and Water Resources Axis 6 – A KMRB Effectively Utilizing Water Resources | Development Axis: Strong Economy - Sustainable Production and Service Delivery 5.1.4.H5: In order to expand the use of modern agricultural techniques and increase producers' knowledge and skills on input usage, activities for farmers such as training courses and practical demonstrations will be increased in areas where the agricultural workforce is intense, in particular, the Bayındır-Tire-Odemis triangle. | - It should be ensured that the industry in the basin moves out of the basin in a planned way.<br>- Good production and treatment technologies should undergo a detailed examination, in terms of their capacity and treatment performance, and possible improvements should be carried out in a certain period of time. |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| | | - Exploring, planning, and management of water resources: (i) conducting researches for the integrated use of water resources in KMH; (ii) Planning for the protection and development of groundwater resources; (iii) Delivering training and carrying out studies on the relationship between, and effective use of, underground and surface water resources; (iv) Planning industrial water use, and carrying out studies for monitoring/controlling the industrial investments having excessive water consumption; (v) Expanding the use of drip irrigation systems; (vi) Establishment of a continuous monitoring network focused on quantity and quality throughout the KM river; (vii) Construction of underground dams in order to feed groundwater; (viii) Carrying out studies regarding multi-purpose use of lakes.<br>- Environmental problems and their solutions: (i) Overall characterization of KM river pollution; (ii) Taking actions to eliminate pollutants arising from agriculture; (iii) Making a plan for the removal of domestic and industrial solid wastes, (iv) Taking actions to minimize excessive water draw from wells.<br>Environment, Energy and Water Resources Axis 7 – A KMRB Effectively Utilizing Renewable Resources<br>- Development of Renewable Energy Resources (all sub-strategies)<br>Environment, Energy and Water Resources Axis 8 – A KMRB Institutionalizing the Management of Environmental Problems<br>- Monitoring, control and prevention of pollution sources: (i) Devising projects for transforming agricultural waste to value-added products | | |
| To support decisions on the effective use and protection of soil | A3. H3.1: To preserve quality and to boost yield in vegetative production through environment-friendly plant health activities<br>A4. H4.2: To consolidate small and fragmented agricultural lands and make land use planning, in order to ensure sustainable agricultural production | Agricultural Axis 1 – Integrated Planned Agricultural Production:<br>- Farming: (i) Developing outdoor soilless farming materials and preventing soil loss through seedling tubes<br>Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Soil – Water Management and Monitoring: (i) Planning of basin product pattern compatible with the soil and climate. | Development Axis: Strong Economy – Sustainable Production and Service Delivery 5.1.4.H5: (i) In order to ensure the sustainability of agricultural activities in Menemen, Kemalpaşa, Menderes, Torbalı, and Seferihisar which forms the primary agricultural zone, fertile lands will be protected and their allocation to other sectors | - Agricultural Pollution Management activities should be carried out.<br>- Training should be delivered on the conscious use of water and fertilizer in agriculture, starting from villages.<br>- Taking measures regarding pollution from livestock |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| | A4. H4.3: To ensure the protection and efficient use of soil and water resources<br>A6. H6.2: To preserve, and to ensure the sustainable utilization of, genetic resources and biodiversity | - Ecological production: (i) Protection and development of pastures, and development, and promotion for increasing the market share, of pasture husbandry | will be prevented. (ii) Land consolidation activities will be expedited. Protective measures will be taken for the protection and rehabilitation of the land. | husbandry and agricultural activities<br>- To prepare the updated inventory of all agricultural lands; to determine, store in a database, and consistently update the data on landowners and processed products<br>- To determine, systematically store in a database, and update the data on the amount of pesticides and fertilizers used per each product<br>- To inform farmers about fertilizers and pesticides which are appropriate for their products, and to prepare annual usage plans<br>- To provide farmers with more frequent training and guidance services at regular intervals about unfavorable environmental situations which would be caused, during practicing, by unconscious usages in the wrong time and wrong frequency<br>- To check whether or not the pesticides used are expired or prohibited; to ensure proper removal of the packaging of pesticide used<br>- To encourage the use of environmentally least harmful pesticides and fertilizers<br>- To introduce suitable agricultural technologies in agricultural activities such as cultivation, plowing, harvesting, which farmers may use in their lands, and to expedite related training activities |

| KAPRA Key agricultural product Selection Goals | Related Goals / Strategies / Principles | | | |
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| | TOB 2018–2022 Strategy Plan | IBB Kucuk Menderes Sustainable Development and Life Strategy | IZKA - Izmir Regional Plan | TÜBİTAK – KMRB Conservation Action Plan |
| To suggest agricultural production methods resistant to climate change | A4. H4.3: To ensure the protection and efficient use of soil and water resources<br>A6. H6.4: To measure the potential effects of climate change on agricultural systems and to devise proposals for taking actions | Environment, Energy and Water Resources Axis 10 – A KMRB resistant to effects of climate change<br>- Short- Medium- Long-Term Estimations on the Basin Scale of Global Climate Change Impacts: (i) Measures against climate change: enhancing mitigation, adaptation, resilience. | Development Axis: High Quality of Life – Sustainable Environment 5.2.2.H6: Biodiversity will be maintained in sensitive ecosystems (Kucuk Menderes Delta, Gediz Delta, Foça...) in İzmir. | |
| To ensure promoting agricultural products relatively more suited to climate-smart practices in the region | A3. H3.1: To preserve quality and to boost yield in vegetative production through environment-friendly plant health activities<br>A4. H4.3: To ensure the protection and efficient use of soil and water resources<br>A6. H6.2: To preserve, and to ensure the sustainable utilization of, genetic resources and biodiversity<br>A6. H6.4: To measure the potential effects of climate change on agricultural systems and to devise proposals for taking actions | | | |
| To promote production methods having limited adverse effects on environment, such as organic farming and good farming | A3. H3.1: To preserve quality and to boost yield in vegetative production through environment-friendly plant health activities<br>A4. H4.3: To ensure the protection and efficient use of soil and water resources<br>A6. H6.2: To preserve, and to ensure the sustainable utilization of, genetic resources and biodiversity<br>A6. H6.4: To measure the potential effects of climate change on agricultural systems and to devise proposals for taking actions | Innovation and Entrepreneurship Axis 15 - A KMRB which forms the human capital supporting the development in agriculture<br>- Co-production, learning by sharing: (i) providing free training on how to obtain an organic certificate<br><br>Agricultural Axis 2 – Clean Basin, Safe Food:<br>- Ecological Production: (i) Enhancing organic product diversity; (ii) Supporting cooperatives for integrated organic meat facilities and production therein; (iii) Planning organic and good agricultural production, and ensuring a joint integrated production with husbandry; (iv) Establishment of healthy food markets with products from good agriculture and organic agriculture | Development Axis: Strong Economy - Sustainable Production and Service Delivery 5.1.4.H5: Environmental-friendly and traceable certified production techniques such as good agriculture, organic agriculture, and integrated controlled production will be popularized in line with the approach of safe food from field to table in Dikili, Bergama, Kınık, Kiraz, Beydag, Odemis, Bayındır, Tire, and Karaburun districts which constitute the secondary agricultural zone. | - Ecologic agricultural activities in the region should be supported and encouraged.<br>- The local community should be made aware, and encouraged on the use, of good agriculture such as organic farming, drip irrigation, etc. |

# Annex-5: International good practices and projects underlying the KAPRA Methodology

## 1. *"Identification of Lands of Agricultural Importance" – Western Australia*

The study, namely "Identifying areas of agricultural significance", conducted by the Western Australian Government in 2000 aimed to identify, and pave the way for, the agricultural lands in the region for the best agricultural use and management (Kininmonth, 2000). The purpose of the project was the sustainability, with maximum value added and yield, of agricultural activity in regions within the framework of the principles of rural development and ecological sustainability. In this context, the suitability of land for the optimum agricultural use and agricultural production (cultivation) was evaluated.

A multi-criteria model called CAASAM (Comparative Agricultural Area Suitability Assessment Methodology) was carried out in economic, social, and environmental perspectives in the study built on indicators similar to those in KAPRA. CAASAM considered 15 physical and non-physical criteria that are important for key agricultural activities, and the use and improvement of each area. These criteria were divided into three groups for evaluation:

- ✓ The productivity factors (*climatic conditions, water quantity, water quality, access to water*) that are considered as physical factors required for the production;
- ✓ The protection factors (*land degradation, offsite environmental effects*) that are considered as environmental factors effective on management;
- ✓ Development factors which are necessary for economic production (*product diversity, export opportunity, presence of processing facilities, transportation infrastructure (internal/external market), presence of services and facilities, land expansion possibility, need for worker*)

Evaluation criteria are categorized as *Essential* (1), *Important* (2) and *Desirable* (3) to understand that a criterion is more important than others. For each of the criteria evaluated, a weighted value was assigned to each area. <u>This approach was a reference, in the key agricultural product selection methodology used in KAPRA, to rank among each other, and to weight, sub-categories according to their importance.</u> Indicators, which are considered as serving to a more important purpose within the scope of the project, were higher weighted.

## 2. *"Guidelines for Value Chain Selection: Integrating Economic, Environmental, Social and Institutional Criteria" – GIZ*

The study, namely "*Guidelines for Value Chain Selection: Integrating economic, environmental, social and institutional criteria*", which was completed in 2015 provides a holistic approach to the selection of value chains that should be encouraged or protected for any development purpose. (GIZ & ILO, 2015).

<u>The guide suggests drawing up a shortlist of potential value chains using a narrow set of indicators, and then defining a final list by employing a wider set of indicators as an option; this approach was used also in KAPRA.</u> It suggests performing the product/value chain selection by using a matrix in which the economic, environmental, social and institutional indicators are organized in a certain framework and weighted according to the level of importance. Although it was preferred to take constant data and statistics as the basis when researching indicators, the study does not consider the selection of the value chain as a mathematical practice. Values can be assigned to indicators, and these values may be weighted, but background questions & tools guiding the valuation of indicators are generally qualitative, and comparisons are often applied through an approach based on qualitative information. In addition to the available information and statistics, it is possible to measure, compare and prioritize value chains on the basis of expert opinion (expectations and assumptions).

GIZ's study suggests 8 steps for value chain prioritization: 1. Start point; 2. Shortlisting; 3. Election criteria and modeling; 4. Literature study; 5. Education; 6. Field study; 7. Workshop with stakeholders; 8. Final selection. These steps were respectively implemented in KAPRA or adapted to the project (GIZ, BMZ & ILO, 2015).

## 3. *"Development of Competition in African Agriculture" – World Bank*

Stakeholder engagement is considered as key in this type of prioritization studies. Within the scope of the project, so-called "*Building Competitiveness in Africa's Agriculture*", of which the World Bank carried out in Sub-Saharan Africa in 2010; approaches for the development of agricultural value chains aiming to improve productivity, efficiency, and quality were researched due to the increased demand for African goods, and a tool was developed which enables prioritization of investments that will be supported. This tool was used also for the value chain selection in the Value Chain Development Program conducted by GIZ in Morocco. In the mentioned program, it was emphasized that stakeholders should be made a part of the process as early as possible, and that it is important to test, through workshops, these stakeholders' commitment to and willingness for the process (Webber, 2010).

<u>This approach was adopted also in KAPRA, and regular interviews were hold and a workshop was organized to hear the expectations and priorities of the stakeholders and to obtain their feedback on the results of the study in the first and subsequent phases of the project.</u>

### *4. "Environmental Indicators for Agriculture: Methods and Results" – OECD*

The study, namely "*Environmental Indicators for Agriculture: Methods and Results*", which was conducted by OECD in 2001 serves as an inventory of the environmental impacts of agriculture in OECD countries. The report aims to develop agricultural-environmental indicators in OECD countries, using various indicator determination and calculation methods and definitions previously practiced in OECD countries. The study revealed preliminary findings on the latest trends in the current environmental conditions in the agricultural sectors in OECD countries and exposed existing constraints and problems for the development of such indicators (OECD, 2001).

Within the scope of the report, OECD used a general framework that forms the indicator determination process. The Driving Force-State-Response (DSR) framework identifies the determinative indicators by focusing on the agriculture-related causes (such as changes in farm management applications or input use) in the background of the change of climate conditions, and also emphasizes the effects of agriculture on the environment. Most indicators used in the study may be useful in describing the environmental dimension that should be considered for a sustainable agricultural sector. Besides, as it was foreseen also in KAPRA, attention was drawn to the economic and social aspects of sustainable agriculture and socio-economic indicators were included in the model in addition to environmental indicators.

<u>Some of the indicators included in KAPRA and recommended in the OECD study are as follows:</u>

***Broad economic, social and environmental context:*** Agricultural GDP, agricultural production, agricultural employment, age/sex distribution of farmers, number of enterprises, agricultural subsidies, Land use: Utilization of agricultural land, revenue of enterprise

***Enterprise management and environment:*** General operating method: Existence of general environmental farm management plans, organic farming, Plant nutrition method: Fertilizer use, soil and land management: Practices for the protection of topsoil and land management, Pest control: Utilization of non-chemical pest eradication methods, Irrigation and water management: Efficiency and intensity of water use, water stress

***Effect of the environment on agriculture:*** Soil quality and protection, water quality, greenhouse gases (gross agricultural greenhouse emissions)

### *5. Olive Oil Value Chain Study - Greece*

A thesis study (Lunde, 2007) examining the contribution of olive oil production to rural development in Greece researches an alternative business model that will ensure the environmental, social, and economic sustainability of olive oil production in a local rural community. This research project was designed so as to include various factors affecting farms in the region, including climate, government policy and the effects of the market. Selecting olive oil as the product to be researched in the study was the result of addressing the indicators such as the cultural importance, traditional character, economy, and eligibility for government subsidies with regard to products, in addition to the topography and the applied plant nursing practices. Other similarities of both project's regions and target groups are the factors such as difficulties faced by small farmers, utilization of conventional farming methods, farmer experience, subjective approach of local stakeholders, density of elder farmers, consideration of topography, and inadequacy of cooperatives. In addition to statistical data, the interviews held and the researcher's own observations were also determinative in this study. The effect of the cultural importance of olive oil, both in today and in the past, on farmer behavior and production decisions were examined, by frequently using, in addition to quantitative methods, the qualitative methods such as structured and semi-structured interviews and participant observations.

The project area is similar to the Kucuk Menderes Basin in terms of climate and agricultural production pattern. Due to this cultural infrastructure, which is considered to be the case for the Kucuk Menderes Basin, factors such as the product's traditional character and the farmer behavior was taken into consideration in the selection of the product, by means of the KAPRA methodology.

### 6. *Slow Food Presidia Project*

Another example of monitoring and assessing sustainable agriculture and food systems through an indicator-based method is the *Slow Food Presidia* initiative. Peano et al. (2014) evaluate the process from farm to market for high quality local products. In addition to the product quality, the economic, ecological and socio-cultural indicators are used in monitoring and assessment. Weighting of indicators and criteria are determined with the involvement of local stakeholders. Along with equal weighting, weights can be changed according to the desire of the local stakeholders. Stakeholders' participation in the monitoring and evaluation process is thus encouraged. This approach was used also in KAPRA; while the indicators were weighted in the model, observations of the stakeholders and the outputs of the workshop were taken into consideration.

### 7. *Case Study – Italy: Sustainable Agriculture and Soil Conservation (SoCo Project)*

The *Case Study – Italy: Sustainable Agriculture and Soil Conservation (SoCo Project)* conducted by Rusco et al. (2009) on behalf of the European Commission lays down, as similar to KAPRA, the concerns about environmental sustainability and protective agriculture. In the project, a case study approach was applied, and case studies were conducted in ten European countries where mostly the Mediterranean climate is dominant. In the instruments used for land planning, the related plots were divided into five levels as High Mountains, Moderate Mountains, Low Mountains, Inland Alluvial Plain, Coastal Alluvial Plain, and evaluated separately. Models were used to assess land degradation risk when measuring the area's vulnerability to erosion, compaction and reduction of organic substance content. This study also emphasized the need to ensure a balance between sustainable agriculture and socioeconomic and environmental factors. It was seen that topography was taken into consideration in prioritization instruments.

## Annex-6: Report of the Workshop on Risk Assessments for Key Agricultural Products

The Workshop on Risk Assessment for Key agricultural product was held on 29 March 2018 at the Izmir Chamber of Commerce with the organization of the World Bank, İzmir Development Agency (IZKA) and the program's technical advisor Frankfurt School of Finance & Management. **"Regulators and promoters", "Manufacturers", "Input, financing and technical information providers", "Processors" and "Marketing and Sales"** groups, which are the most important players of the value chain, were invited to the workshop. Participation was largely from public institutions and organizations.[25]

At the beginning of the first session of the workshop, which was held in three sessions, IZKA and World Bank (WB) presentations took place giving information about the purpose and content of the study, and other studies in the region.

This report summarizes the messages, information and ideas from the workshop that will guide the next phases of KAPRA.

<u>Practice 1</u>

<u>Objective:</u> This purpose of this practice was to hear the opinions of the regional stakeholders about the key agricultural product definition and obtain the predictions of the stakeholders about the key agricultural products in the basin in order to create a study-specific key agricultural product definition.

The participants were asked the following questions to collect their general opinions: ***"What definition comes to your mind when you say key (agricultural) product?", "In your opinion, which criteria are considered when selecting key agricultural products in a region?", and "Which agricultural products come to your mind when you consider the regional dynamics?"***. Stakeholders expresses many opinions such as ***"products that are directly associated with social welfare and that ensure people stay where they live", "products that are a complementary factor in the country/region/basin", "products with high economic return", "technology-inclined, innovative products", "products ensuring food security", "products requiring know-how"***. Although some researchers, who conduct studies in the academic field, state that key agricultural products cannot be selected in such a short time without depending on numerical data, it is explained that this practice is only a preliminary research. After a general exchange of ideas, a list on which major agricultural products in the region are included was shared with the participants, and they were asked to select 5 key agricultural products that are most important according to themselves. The products which are not included in the list but can be considered as important were added by the participants.

According to the results of the practice 1, **olives for oil** was considered, with 27 votes, in the first rank among the key agricultural products of Kucuk Menderes Basin. Olive was followed by **silage corn** with 25 votes, **milk** with 22 votes, **cotton** with 17 votes, and **nursery and (outdoor) ornamental plants** with 15 votes[26].

<u>General comments and suggestions shared in Practice 1:</u>

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[25] A total of 44 people from the region participated in the workshop.

[26] Notes regarding Practice 1:
- A total of 42 participants responded to the key agricultural product determination study.
- Some of the participants indicated 6 products in the lists, but the first 5 products they wrote were included in the assessment.
-Since the types of the products, in particular for olive (oil-table), corn (grain-silage), and tomato (table-industry) were not specified, it was surmised, taking into consideration the trends in the region, that types were considered as olives for oil, silage corn, and table tomato.
- The items called with different names such as nursery, ornamental plants, cut flowers, floriculture, outdoor ornamental plants, were collected in a group, and rose (cut) was excluded from this group as it is specifically expressed.

The following criteria have been suggested for key agricultural product selection:

- **Complementarity** within Turkey/region/basin (relations such as livestock husbandry and fodder crops, etc.)
- Infrastructure should be suitable for the product / the product should be **adapted to the region**
- The producer's **welfare** is directly dependent on the production of the product
- Products which farmers in the region have the **know-how**
- **Products with no alternative** (products such as chestnut and cherry, of which there are no alternatives in the mountains)
- Creation of high **value-added when the product is processed**
- High **economic value** of the product and its prevalent production
- Availability for further use of technology in the future
- **Tendency to decrease our dependence on imports**
- **Capacity to adapt to climate change**
- Having a **comparative superiority** in the production of the product as compared to other regions.

In addition, the following comments were shared by the participants:

- Producers in the region are inclined to shift to **innovative products**. The Basin has a high flexibility to switch to new products with high economic values.
- It is of great importance that the Metropolitan Municipality and government develop **support policies**.
- The methodology should absolutely include **horticulture, floriculture and fruit arboriculture,** in which the Basin ranks in first place in Turkey in terms of production.
- **The support and subsidized loans provided in the region** have a critical effect on product pattern.
- A **priority ranking should be made regarding the distribution of water** when identifying the key agricultural products.

After the practice 1, the key agricultural product evaluation method developed by the Technical Advisor of the project was explained in general terms and the question marks in the minds of the participants were tried to be eliminated. Then, Practice 2 was carried out to see how the criteria used in the method developed were prioritized from the perspective of the local stakeholders.

Practice 2

Objective: The purpose of this practice was to understand and discuss the agricultural production priorities of different groups so that the perspectives and priorities of stakeholders can be reflected in the key agricultural product selection model.

Six Tables/groups were formed in Practice 2 in order to determine the priorities of different links of the production chain. Although the representatives of public institutions had multiple Tables due to the high number of participant public institutions and organizations, the **perspectives of four groups** were reflected in this practice. These were, **public authority, producer** (role), **sales and marketing** groups, and the SHW group which was formed with an aim to reflect environmental concerns apart from the production chain.

**Tables 1, 2, and 6 represented the public institutions** (TOB Provincial and District Directorates, Metropolitan Municipality, TARSIM, General Directorate of Meteorology, and others) and **universities** (Ege University, Dokuz Eylül University), **Table 3** represented the **State Hydraulic Works** since it has relatively different priorities from the above mentioned public institutions, **Table 4**[27] represented participants in the role of **producers**, and the **Table 5** represented the **organizations supporting marketing and sales** (Commodity Exchanges, Chamber of Commerce, Chambers of Agriculture, and others).

The list of parameters created by taking into account many economic, social, and environmental factors (see Annex 4) was shared with the participants and they were asked to evaluate with the perspective of the institutions/groups they represent. In this context, economic, social, and environmental indicators were collected in three envelopes, namely **"very important", "moderately important"**, and **"insignificant"**, according to the order of importance.

According to the results of Practice 2, in general, there was a balance in the weight of economic, social, and environmental indicators although there were minor differences in public institutions. The DSI group, which was separated from other public institutions, attached a higher priority to environmental issues (50.5%) in respect of their corporate strategies. Although the social parameters were considered, on the producers' side, a little more important relative to the others, they were more balanced as compared the DSI group. As for the sales and marketing function, the social and environmental factors were more prominent than economic criteria.

General ideas and suggestions shared by Tables during Practice 2

**Table 1 & 2** (Public institution & university)

- Precipitation may take place in an irregular and uncontrollable nature.
- A decrease is observed in the **water level** in the basin.
- More **flood, hail and frost events** are experienced as compared to the past.
- **Methane gas emissions** due to livestock husbandry have been increasing and have an adverse effect on climate.
- **Groundwater levels** have considerably declined due to the fact that usage increases whereas catchment decreases.
- **Animal feces** significantly pollute underground waters.
- Livestock facilities are established in wrong locations. Livestock husbandry should be prohibited in first class agricultural lands.
- The contribution of the institutions on adaptation to, and raising awareness for, climate change is at the Ministry level. For example, according to the Drought Action Plan, product patterns are determined by the Ministry.
- **Drip irrigation and intelligent irrigation** systems should be used; farmers should be made aware of and should implement proper irrigation. Surface irrigation leads to soil erosion.
- In particular, greenhouse growers use **excessive fertilizers and pesticides**, and these chemicals leave residues on plants and especially on greenery that cannot be removed even after washing.

**Table 3** (DSI)

- **Food security** is regarded as self-sufficiency, especially in staple food products. Hence, there should be an indicator directly referencing to food security.
- Groundwater used in agriculture is supplied from deeper over time.
- In all sectors, it is considered beneficial **to plan based on the presence of water**. There is a challenge in meeting the increasing demand, in particular, as a result of industrial facilities' capacity increase. In addition, water pollution increases due to **lack/failure of treatment facilities**.

**Table 4** (Manufacturer – *role play*)

[27] Since there was no representative of producers, processers, and cooperatives among the participants invited to the workshop, Table 4 was chosen to assume this role in order to reflect the opinions of the production groups.

- Economic income and efficiency are very important in the criticality of the product.
- **The existence and activeness of farmers organizations** should increase.
- Due to lower labor costs, **productions with intensive mechanization** are preferred hence women's employment may not be at the desired level.

Table 5 (Sales and marketing)

- More economic criteria can be used.
- Criteria related to changes in cost and market prices can be included.
- Effect of future product pattern on prices, and products with high economic return can be determined (In the future, prices of certain products will increase due to low production and high demand).
- The **dependence on employment/workforce** of the production of the product should be examined from two different perspectives. For example, **it is negative in the economic aspect as it will increase the cost, and it is positive in the social aspect, as it will increase the employment.** However, the cost is a more important decision criterion and labor-intensive productions (such as okra) are carried out as a small-scale family business.
- **The income elasticity coefficient, and back and forth connections (the change over time) should not be ignored.**
- **Demand flexibility** of the products should be studied and **consumption habits/trends** should be taken into consideration. For example, how much will the production of milk or ornamental plants be affected in case relations between municipalities and cooperatives would not continue as today? Or, a solution can be developed considering these situations when developing strategies.
- Regional characteristics such as **competing regions, early-late products**, etc. also create differences in terms of economic returns. In Turkey (even as compared to Europe), earliness highly affects the price. Perhaps the seed improvement activities should be considered and supported in this way. At this point, quality stands out as compared to other regions.
- Today, when deciding the production, farmers tend to products that require less labor and less attention, that have no unsolvable issues such as pigs etc. At this point, **a criterion for products for which technology/computer usage may be higher** can also be developed.
- When using the "employment" term in the methodology, we should specify whether it is unregistered or not.
- When studying on the criterion of **contract farming**, we should take into consideration that this issue does not have a legal basis in our country. **It is mostly against the farmer and does not bind the processor.**
- **The input dependency of the product can also be studied;** there is a cost disadvantage especially if the inputs are mostly from other regions.

Table 6 (Public institution & university)

- Young farmers do not want, independently of the economy, to engage in farming, and they tend to easy and mechanized businesses. A Worker problem has arisen in the region. The community, which has slightly improved their economic condition, now wants to leave farming.

- Both the labor force in KMRB and dairy farming and olive growing are largely undertaken by women. Taking women out of the agricultural sector will have a completely negative impact on the sector.
- Labor wages are very low and women earn less.
- The producers suffer from contract farming and the system is not implemented properly. Processors do not care for the contract and can offer prices far below the contract price, and the producers surrender in order not to lose their customer.
- Policies should be established to remedy the unjust suffering of producers.
- Producers in the region appreciate the value of water, but they remain passive in taking action for water resources.

In the afternoon session, in general, topics such as ongoing climate conditions in the region, possible future climate scenarios, how the agricultural production in the region will be affected under these projections, and climate-resistant agricultural practices were discussed.

Practice 3

Objective: The purpose of this practice was to understand the awareness of stakeholders about climate change, the effects of climate change they observe and the measures they have taken to counter these effects, and the main factors (knowledge, financing, awareness) behind these measures, and to discuss efforts carried out by public and civil society organizations in the region for the adaptation to and mitigation of climate change, and what can be done in addition.

25 people participated in the survey conducted to measure the awareness of the effects of climate change on agriculture.

Given the questions about climatic observations and experiences related to the region, it is seen that 92% of the participants have observed seasonal change in the climate of the region within the last 10 years. In addition, 88% of the participants stated that within the last 10 years, extreme events such as flood, hail, storm, frost, drought have occurred in the region. Three of four survey respondents said that these extreme events have increased within the last 10 years, whereas about 21% of them are indecisive.

While almost all of the participants (96%) thought that climatic changes they have observed have negative effects on agricultural production, there were more of various opinions on the impact of agriculture on climate change. Approximately 74% of the respondents agreed that the agricultural sector has adverse effects on climate change, while 17.5% did not agree with this opinion. While 11 participants (44%) strongly agreed to the opinion that the agricultural sector has had negative effects on natural resources such as water, soil, and air in the Basin, 5 people (20%) were indecisive. Participants, who think that the products currently produced in the Basin cannot be produced 10 years later due to climate change, constituted 3/4 of the total participants.

*1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, 5 = Strongly agree* — *Practice 3 - Awareness survey*

| | Criteria | 1 | 2 | 3 | 4 | 5 | TOTAL |
|---|---|---|---|---|---|---|---|
| 1 | In the last 10 years, I have observed seasonal changes in the regional climate. | 1 | 0 | 1 | 11 | 12 | 25 |
| 2 | When I look at the last 10 years, extreme climate events (flood, hail, frost, drought, etc.) occurred in the region. | 1 | 0 | 2 | 14 | 8 | 25 |
| 3 | Looking at the last 10 years, extreme climate events in the region increased compared to the past. | 1 | 0 | 5 | 10 | 8 | 24 |
| 4 | The climatic changes I observed have negative effects on agricultural production. | 1 | 0 | 0 | 15 | 9 | 25 |
| 5 | I know enough about the effects of climate change and its effects. | 0 | 1 | 2 | 13 | 9 | 25 |
| 6 | Producer and other institutions / organizations in the Basin have enough knowledge about what climate change is and its effects. | 1 | 13 | 8 | 3 | 0 | 25 |
| 7 | The agricultural sector has negative effects on climate change. | 1 | 3 | 2 | 10 | 7 | 23 |
| 8 | The agricultural sector has negative effects on the natural resources of the Basin (underground and surface water resources, soil, air, etc.). | 1 | 1 | 5 | 7 | 11 | 25 |
| 9 | At present, there are products that are produced in the Basin and that I think cannot be produced after 10 years due to climate change. | 1 | 0 | 5 | 13 | 6 | 25 |
| 10 | In order to ensure continuity of agriculture in the Basin, climate change adaptation measures need to be taken. | 1 | 0 | 0 | 7 | 16 | 24 |
| 11 | I have knowledge about what can be done to adapt to climate change in agricultural production. | 0 | 1 | 10 | 12 | 2 | 25 |
| 12 | In the agricultural sector in the Basin, necessary and adequate measures are taken to adapt to the effects of climate change. | 8 | 8 | 7 | 0 | 1 | 24 |
| 13 | The people of the Basin have access to the financing they need to take measures to adapt to climate change impacts. | 11 | 11 | 3 | 0 | 0 | 25 |
| 14 | The people of the Basin have access to the information, training and consulting resources they need to take measures to adapt to climate change impacts. | 9 | 11 | 5 | 0 | 0 | 25 |
| 15 | I think it is critical to take into account the effects of climate change for the continuity of the agricultural sector in the Basin. | 0 | 1 | 0 | 6 | 18 | 25 |

While 88% of the participants considered their own knowledge about the definition and effects of climate change as sufficient, 52% of them did not agree that the knowledge of the producers and other institutions and organizations in the basin is sufficient. On the other hand, 40% of the respondents indicated that they are not sure whether or not they have enough knowledge about what can be done to adapt to climate change in agricultural production and that local stakeholders should be informed about the adaptation of agricultural production to climate change as soon as possible. Almost all of the participants (96%) agreed that climate change adaptation measures should be taken for the sustainability of agriculture in the Basin. On the other side, two out of three participants agreed with that the necessary and sufficient measures have not been taken. 30% of them were indecisive or had insufficient information on this issue.

The fact that no participant responded positively to the accessibility of sources on funding, information, training, and consultancy to take adaptation measures against the effects of climate change, indicates that this issue should be taken into consideration. While 88% of the participants did not agree with the article about the accessibility to financing to mitigate the effects of climate change, 80% of the participants did not agree with the article about the accessibility to non-financial resources.

As a conclusion, the general opinion of participants from various regions and institutions of the Basin is that extreme events have increased in the region within the last 10 years. The mutual effect of agriculture and climate change on each other is an issue that the majority agrees with. Although people have enough knowledge about climate change and its effects, they are more uncertain about climate change adaptation methods. In addition, the fact that the competent authorities are not knowledgeable enough and they do not take necessary and sufficient measures is the dominant opinion in the region. Apart from this, the participants indicated the difficulty of accessing financial and non-financial resources also as a serious problem observed in the region.

General comments and suggestions in the session

- In climatic assessments, it may be more logical to divide the year into six periods, even to examine monthly, considering the phenological characteristics of the plant, rather than dividing into four as spring, summer, autumn, and winter.
- The fact that whether or not the product has a critical value should be determined by taking its phenological period into consideration.
- **Precipitation irregularity** may be more effective than heat.
- Details on the basis of key agricultural products throughout the phenological phase should be examined by means of meteorological data and expert opinions. If their sensitivity is low, the production can continue.
- **Pollination stress** is significant. Factors affecting the pollination should be taken as a specific criterion.
- Development of relevant technologies should also be supported and included in the strategies. (For example; **sensor productions, intelligent agricultural software,** relevant **environmental technologies**, etc.)
- On the climate change side, 5-10-year data may not yield very healthy results.
- Changes in the distribution of precipitation are important stress factors.
- **The effects of livestock husbandry on emission** are very high and should be considered when determining climate change adaptation strategies.
- The drinking/service water consumption (per capita) and population-based drinking/service water consumption are increasing, and these should also be considered. Flood traps are not very applicable in the region. Nowadays, **underground water dam** pilot studies are carried out.

  Droughts, floods, and overflows are increasing. The damage, death, and financial loss can be mitigated by means of the technological change and early warning systems.
- Some stations were closed to climate data, and data from them is also very important.
- **DSI Basin Master Plan** has been published and it can be included in the main documents included in the study.
- The decrease in precipitation may be small, however:
  - **The change in the precipitation periods** affects the product very much. Therefore, the detailed distribution of precipitation should be evaluated.
  - Furthermore, future water allocations will affect the allocation of water to the agricultural sector. Accordingly, planning should be made as if we have less water than the reduction rate.
  - When determining the key agricultural products, the effect of heavy precipitation on the soil should also be taken into consideration. **Adaptability to saline soil** etc. The seed improvement adaptable to this may be recommended.
  - **Warming rate** is of great importance.
  - Effects of storm, flood, drought are experienced differently.
- **Effects on quality** should be involved in the study of the effects of climate change on products.
- **Variety regeneration/improvements** may also be recommended.

- **Greenhouse growing** (climate-smart greenhouses, soilless greenhouses, etc.) can be expanded and improved with simple measures.
- Practices such as **shading** on fruit nursery can be suggested. This will improve the quality.
- It should be taken into consideration that the struggle with diseases will be more difficult and the pests control will be easier.
- **Any other product that is linked to or dependent on the product** should also be considered in strategies.
- Such a study will be further strengthened by the **spatial production pattern planning**. (This can be achieved through incentive.)
- As the climate changes, the soil structure will deteriorate and its salinity will increase, and climate change will be a stress factor.
- Measures should be taken regarding the **soil water retention** capacity.

As a conclusion, the workshop during which the local stakeholders exchanged information about the dynamics, problems, potentials, barriers, and solutions of agricultural production in the region for the development and prosperity of the Basin, revealed the ideas and priorities of different institutions.

The next step will examine the production chains of key agricultural products determined and that how does climate affect these chains, and then will present the climate-smart recommendations for these climate vulnerabilities.

## Annex-7: Indicator-based scores received by products and weighted scores

For Annex-7, please see the separately prepared Excel sheet with the same name.

# Annex-8: Climate change risk assessments specific to products

## 8.1. Climate Change Risk Assessment in Olive Oil Production

The essentials of the cultivation of olive, a Mediterranean plant, are generally determined by climate factors. Factors such as snow, relative humidity, fog, hail, wind, and in particular, temperature, and precipitation are the main ecosystem services to which olive is dependent.

The purpose of this section is to reveal possible effects on olive cultivation of risks that are likely to occur on the basis of the results of basic climate change projections carried out within KAPRA.

### Change in temperature

Given the annual average temperature in the olive growing areas in Turkey, it is seen that 14.5 °C is the lower limit for olive cultivation. In other words, the 14.5 °C isotherm roughly draws the boundaries of the areas where economic olive cultivation can be carried out in Turkey. Accordingly, South Marmara coasts, Aegean coasts and grabens, the coastal section of Mediterranean Region, and the western part of Southeast Anatolia emerge as suitable areas to grow olive trees in terms of temperature (Efe et al., 2011).

When the climate data of the Kucuk Menderes Basin for the period of 1986-2007 is reviewed, it is seen that the average annual temperature is 13.6 °C. Based on the mentioned scenario, it is estimated that the average annual temperature will increase to 14.6 °C between 2021 and 2050 (Table 1). This situation does not seem to have a negative effect on the olive production in the basin considering the average temperature values.

For a good production and sufficient quality, olive requires mild winter conditions and non-extreme hot and normal humid summer conditions. Annual and monthly temperature averages play a significant role in the vegetative and generative development of the olive plant. In particular, the cooling period stands out as a key factor. Temperature is of great importance also in flowering and blooming activities that take place in the further process (Ulaş, M., 2012).

Changes in temperature in the phenological periods of olive were examined. It is seen that in the months of June and September between 2021 and 2050, the temperature will increase by 1.3 °C, average temperatures will reach 21.9 °C and 20.9 °C in June and in September respectively.

Table 1: Change in temperature in active growing period

| Change in temperature in active growing period | | | | | | |
|---|---|---|---|---|---|---|
| Months | April | May | June | September | October | November |
| Long Years (1986-2017) Average Temperature | 11.7 | 16.1 | 20.7 | 19.6 | 14 | 9 |
| Average Temperature between 2021 and 2050 | 12.5 | 17 | 21.9 | 20.9 | 15 | 9.9 |
| Expected temperature difference | 0.8 | 0.9 | 1.3 | 1.3 | 1 | 0.9 |

Table 2: Number of days with a temperature range of 15-25 °C between April and July in KMRB

| Parameters | Long Years Average in KMRB (1986-2005) | Expectation in KMRB between 2021 and 2030 | Expectation in KMRB between 2031 and 2040 | Expectation in KMRB between 2041 and 2050 | Change % |
|---|---|---|---|---|---|
| Number of days with desired temperature range (15- 25 C°) during growing and fruit development | 55 | 56 | 55 | 53 | -3.64 |

It is understood that the change in temperature predicted during the active growth period will not have a negative effect on olive production. The important thing here is that in which period and in what rate will the temperature change. The resulting scenarios foresee that the temperature increase in the early spring rise by 0.8-0.9 °C. This indicates a 3,6% decrease in the number of days with a temperature range of 15-25 °C during the growth and fruit formation period which correspond between April and June. Since this decrease will reflect, as a temperature increase, in the production, it can be said that the number of days with temperatures above 25 °C will increase at the same rate. In addition to this, it is possible to see some imbalances during flowering and growth periods since temperature frequency ranges are expected to increase. Correspondingly, it is estimated that in some years there will be a small amount of yield losses in production, and, to the contrary, in some years it may be a positive reflection on yield. Changes in temperature that may occur during these periods are not considered to have a critical impact on the production of the product until 2050.

When the changes in temperature in the physiological period are reviewed, it is seen that as compared to the long years average, the maximum temperature increase will be in August by 1.6 °C, and extreme temperatures will increase by 1.7 °C. It can be said that this situation will increase the stress coefficient of the plant in July-August which is the period of physiological separation, will have, even though partial, a negative effect on production, and will increase the periodicity coefficient. There is no research or study that will allow numerical analysis of these changes.

Table 3: Change in temperature in physiological period

| Change in temperature in physiological period | | | | | | |
|---|---|---|---|---|---|---|
| Months | July | August | December | February | March | April |
| Long Years (1986-2017) Average Temperature | 24.1 | 24 | 5.9 | 5.4 | 7.9 | 11.7 |
| Long Years (1986-2017) Extreme Temperature | 31.3 | 31.7 | 9.4 | 10.6 | 13.7 | 18.2 |
| Average Temperature between 2021 and 2050 | 25.6 | 25.5 | 6.6 | 6.2 | 8.6 | 12.5 |
| Extreme Temperature between 2021 and 2050 | 33 | 33 | 10.9 | 11.4 | 14.5 | 19.1 |

The excessive humidity occurring during the anthesis and pollination periods of olive trees sticks the pollen dusts to each other and prevents the anthesis and accordingly the pollination. The hot and drier winds in this period dry out the stigma, and reduce the anthesis and fruit formation (Ayaz and Varol 2015).

When the changes in temperature in May-June which is the flowering period, it is seen that the extreme temperatures can reach 28.9 °C especially in June. Given that the ideal temperature for fertilization is in the range of 15-20 °C, fertilization at these extreme temperatures is not possible to be healthy and regularly. It is seen that this situation may lead to fertilization problems in late-blooming genera and can cause serious yield losses in certain years. It is very difficult to determine the possible harvest loss since there is no data about how much of the olive genera present in the basin are late-blooming.

Table 4: Change in temperature in flowering period

| Change in temperature in flowering period | | |
|---|---|---|
| Months | May | June |
| Long Years (1986-2017) Average Temperature | 16.1 | 20.7 |
| Long Years (1986-2017) Extreme Temperature | 22.6 | 27.4 |
| Average Temperature between 2021 and 2050 | 17 | 21.9 |
| Extreme Temperature between 2021 and 2050 | 23.4 | 28.9 |

When the climate scenarios are reviewed, it is seen that there will be temperature increases by 0.8-0.9 °C in February and March. In this case, it is estimated that changing based on the genera, the vegetation times will increase slightly and the flowering starting dates will be earlier in the Kucuk Menderes Basin as compared to the previous years.

When the changes in average and extreme temperature between August and November (fruit ripening period), are reviewed, a critical change that will affect the ripening of olives is not observed. On the contrary, the crops may mature slightly earlier and the harvest dates may also be earlier by 1-2 weeks, based on the variety.

Table 5: change in temperature in fruit ripening period

| change in temperature in fruit ripening period | | | | |
|---|---|---|---|---|
| Months | August | September | October | November |
| Long Years (1986-2017) Average Temperature | 24 | 19.6 | 14 | 9 |
| Long Years (1986-2017) Extreme Temperature | 31.7 | 27 | 19.6 | 13.3 |
| Average Temperature between 2021 and 2050 | 25.5 | 20.6 | 15 | 9.9 |
| Extreme Temperature between 2021 and 2050 | 33 | 28.3 | 21.7 | 15.2 |

### Excessive cold weather conditions

Olive cultures with sub-tropical characteristics begin to suffer serious damage at temperatures of -5 °C and below, as they are sensitive to extreme cold conditions; frost occurs first in leaves, then in shoots and branches, and finally in the body. The olive tree can only tolerate low temperatures down to -7 °C. This situation depends on the variables such as the variety of the tree, the intensity and frequency of frost, as well as wind speed, humidity, exposure, soil moisture, soil temperature. These damages occur as defoliation, changing of annual shoots into brown, cracking and drying on the fruit skin. In more severe cold weather such as -10 °C and below (varying according to olive varieties), serious hazards ranging up to the death of the whole tree may occur. (Ayaz & Varol, 2015).

Table 6: Cold weather's effect on the olive physiology

| Cold Weather (°C) | Physiological Effect |
|---|---|
| -5 | Causes the death of fragile tissue of the tree |
| -7 | It is the ultimate cold-resistance limit of some olive varieties |
| -10 | Causes the death of all olive trees |

Table 7: Change in number of days colder than -7 °C

| Parameters | Long Years Average in KMRB (1986-2005) | Expectation in KMRB between 2021 and 2030 | Expectation in KMRB between 2031 and 2040 | Expectation in KMRB between 2041 and 2050 | Change % |
|---|---|---|---|---|---|
| Number of days colder than -7 °C per year | 14 | 4 | 4 | 4 | -71,43 |

The previous years' average of number of days with a temperature of lower than -7 °C and projections until 2050 considering climate change are shown in Table 7. Given the table, a decrease of 71.4% is expected, compared to the previous year's averages, for the number of days with a temperature of less than -7 °C. This will have a positive effect on the olive production by decreasing extreme low temperatures that restrict the production.

## Excessive hot weather conditions

During the vegetation period, high temperatures also affect negatively the olive tree and fruit yield as low temperatures do. As the temperature increases, the photosynthesis intensity also increases and usually reaches the highest value at 30 °C. The structure of several enzymes that play a role in photosynthesis begins to deteriorate at temperatures above this, therefore the activity starts to decrease. As a result, photosynthesis intensity decreases from 30 °C upwards and stops completely in environments between 40 °C and 45 °C. In order for olive trees to be able to resist temperatures above 40 °C, additional irrigation is required (Ayaz & Varol 2015).

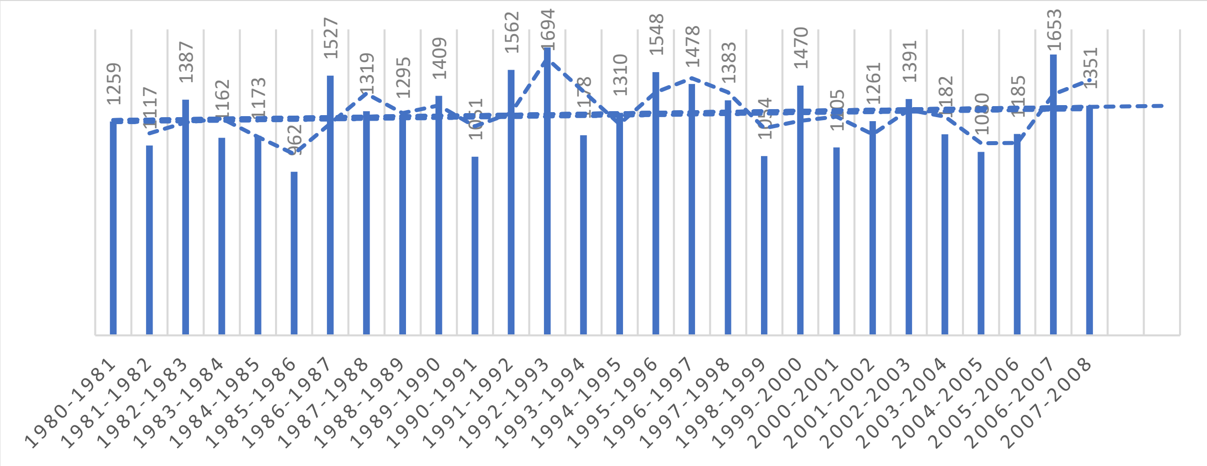
It is known that the maximum temperatures in the basin were up to 48 °C in the past years. Along with climate change, it can be predicted that the number of extremely hot days restricting olive production will increase and affect the production negatively. It can be expected that this situation will cause problems in terms of yield and quality, and also will be reflected in the production of the next year as periodicity. The irrigation requirement will increase even more, especially in July and August, it can cause substantial losses of trees and branches in mountainous or inclined areas where the cultivation is carried out under dry conditions and where the supply of water is difficult.

## Fulfillment of cooling need

Monthly average temperatures are important in terms of their relation to the phenological stages of olives. The average values of the month of January, which is the coldest month in the areas where olive cultivation is intense, range between 4.4 °C and 10 °C. Although olive is a tree that needs cooling, it can achieve this at temperatures of 7 °C and slightly below. The lowest temperature limit, which the olive tree can tolerate, is not further than -7 °C. At locations where the average monthly temperature is 4.4 °C and lower, low temperatures are most likely to recur. Olive cultivation has a risk in areas where these conditions prevail. Olive can meet the cooling need only between 7 °C and -7 °C.

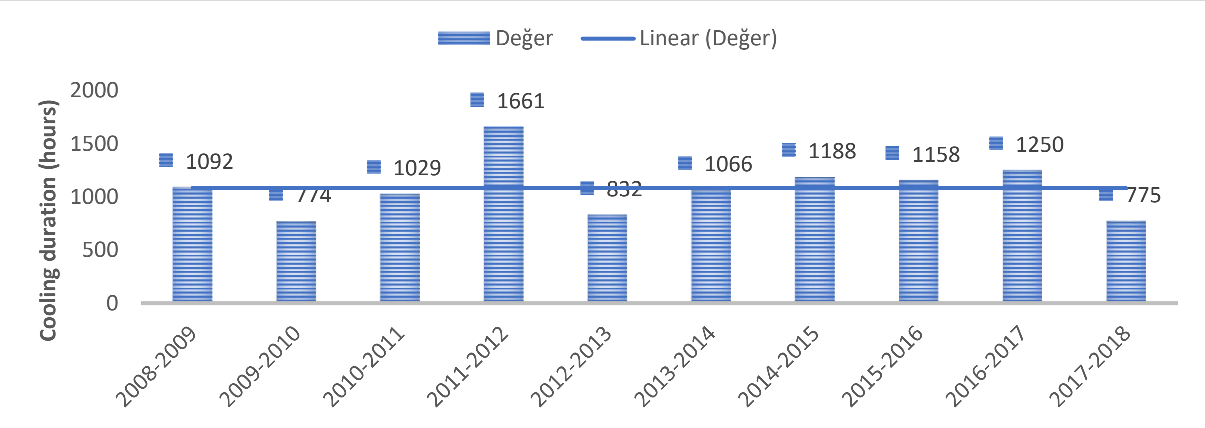
In order for buds can form on the olive trees, the trees must meet the winter cooling requirements. Since olive trees must meet the cooling need necessary for flowering, it requires cooling (from at least 50-60 hours up to more than 1200 hours at 7.2°C and below) in the period from January to April. The number of hours which the olive trees need to spend below 7 °C in winter refers the cooling requirement (Ayaz & Varol, 2015). Cooling requirement varies based on the variety and determined as 600 hours for the Gemlik variety and more than 1.000 hours for the varieties of Domat, Ayvalık, Çakır. In addition, it is known that the trees need a longer cooling period to form buds after a heavy crop year, and that mostly shoot and branches will develop on trees which spend a mild winter after a heavy crop year will (vegetative parts). Additionally, late frosts in spring cause damage to developing buds and cause the trees tend to alternate crop yield from year to year (periodicity) (Ertin, E., 2000).

Figure 1: Cooling duration recorded between 1980 and 2007 in Odemis



*Source: MGM (General Directorate of Meteorology)*

Figure 2: Cooling duration recorded within the last 10 years in Odemis




*Source: MGM (General Directorate of Meteorology)*

It is quite difficult to prepare a scenario on how climate change will affect the fulfilment of cooling need in the basin. The most important reason for this is that the measurement of the cooling need is on the basis of hours, not months or days. In order to prepare these scenarios, daily and hourly historical data must be available. However, when the cooling data between 1980 and 2017 is reviewed, it is seen that the cooling durations of olives have decreased significantly over the years. Considering the total cooling values in Odemis within the past years, it is seen that the highest value was recorded as 1694 hours between 1992 and 1993, and the lowest value was recorded as 774 hours in 2010-2011 period. Again for the said district, while the average for the period of 1980-2007 was 1305 hours, this value dropped down to 1082 hours between 2007 and 2017. The loss within the past decade seems to be 17%. With a simple calculation considering a 17% loss every ten years, it can be assumed that the hourly average cooling durations will drop to the following values within the next 30 years: 902 hours between 2021 and 2030; 748 hours between 2031 and 2040, and 620 hours between 2041 and 2050. As climate change continues, it is possible to say that vulnerability will occur especially in varieties with a high cooling requirement (over 600 hours).

Table 8: Change in cooling need of Odemis based on climate risks

| | Cooling duration (hours) |
|---|---|
| Recorded between 1980 and 2017 | 1242 |
| Recorded between 1980 and 2007 | 1305 |
| Recorded between 2007 and 2017 | 1082 |
| Expected between 2021 and 2030 | 902 |
| Expected between 2031 and 2040 | 748 |
| Expected between 2041 and 2050 | 620 |

## Change in Precipitation

Although the olive tree is known to be drought-tolerant, researches have revealed that high amount of water is needed to obtain a higher yield and quality. Olive trees establish a mechanism to tolerance arid conditions by stopping the crown growth, and continuing the photosynthesis and transpiration activities during water scarcity. However, excessive drought stress during growth period has negative effects on crop and development on olive trees.

The annual precipitation requirement for olives is 700-800 mm. Winter and spring rains stored in the soil provide perfect flowering, increase the grain setting ratio of flowers and reduce the June drop.

The water to be given and the rain to fall in the summer will meet the water need when the grain forms the seed, as well as will make olives larger, increase the value of table olives and ensure oil formation. This also accelerates the development of shoots which will give fruit next year and the creation of meristems (Ayaz M. and Varol N., 2015).

The climate change scenario indicates that there will be less drought than expected in the Kucuk Menderes Basin. However, when the phenological periods are reviewed, it is seen that the effect of drought will occur in July and August which are mostly fruit hardening period.

In addition, the relatively expanding frequency of precipitation and temperature values can have an impact on the harvest and oil quality more than expected over years, and this might cause market losses and further fluctuations in product prices.

Table 9: Effect on productivity of climate change risks on the phenological period basis

| Phenological Event | Period | Effects of water stress | Precipitation decrease Min-Max (%) | Possible effect |
|---|---|---|---|---|
| Shoot Growth | March-June | Shoot growth decreases | 1.3- 2.2 | Shoot growth slightly decrease. Yield slightly decreases |
| Bud | February-March | Bud decreases | 0.3-2.0 | Buds slightly decrease. Yield slightly decreases |
| Flowering | April-June | Abortive flower formation | 0-2.2 | Fruit shedding rate slightly increases. Yield slightly decreases |
| Fruit Set | May-June | Fruit set decreases, Periodicity increases | 1.3-2.2 | Fruit set slightly decreases. Periodicity increases. Yield slightly decreases |
| Fruit Development 1. stage | June-July | Fruits remain small | 1.3-2.2 | Fruit diameter slightly decreases |
| Fruit Development 2. stage | July-August | Fruits remain small | 0.5-1.3 | Fruit diameter slightly decreases |
| Fruit Development 3. stage | August-Harvest | Fruits remain small | 0.5-4.8 | Fruit diameter slightly decreases |
| Oil formation | September-Harvest | Oil ratio and quality decrease | 3-4.8 | Oil ratio and quality decrease |

Water stress in olive trees leads to significant changes in terms of fruit setting and ripening, and of oil content of the fruit. The most critical periods to avoid water stress in the production of olives for oil are the stages of fruit set and oil accumulation. As for the production of table olives, the fruit set, fruit development stage 1 (cell division) and fruit development stage 3 (cell expansion) were found to be critical. 85% of the olive cultivated areas in the world are not irrigated. In non-irrigated areas, a product loss of 100-200 kg/decare occurs every year and the cultivation generally depends on precipitation (Ayaz and Varol, 2015).

It is expected that the amount of precipitation in the Kucuk Menderes Basin will decrease down to 4.8% during the oil formation period of olives. This may lead to considerable losses in oil quality and rates when considered together with temperature increase.

Although the total decrease in the amount of precipitation is 3.1%, water stress will increase even more along with a temperature increase of 1 °C throughout the year. This may lead to a reduction in harvest and oil ratios, as it will create a multiplier effect on yield.

The multiplier effect of temperature increase and precipitation decrease was calculated by using CropWat system. Therefore the followings were determined: the amount of irrigation water required for olive in current climatic conditions; the amount of irrigation water based on the possible climate change scenario; the approximate yield loss according to current climate data, if the olive is not irrigated, and possible yield losses also based on the climate change scenario, if the olive is not irrigated.

When processing data by means of the CropWat system, temperature and precipitation parameters were variable, and other parameters were kept constant. The following assumptions were made in each four scenarios: the effective root depth is 170 cm, the soil type is red loam, and the plant length is 2.500 cm. For olive, the Kc1, Kc3, Kc4 parameters determined by DSI were valued as 0.36, 0.72, and 0.76 respectively. Results were obtained by entering the values of maximum, minimum, and average temperature data on monthly basis, and of monthly precipitation and relative humidity in the CropWat system, for the previous years' averages and climate forecasts.

Accordingly, the results under irrigated cultivation conditions are given in Table 10. As is seen, the results are quite striking. Based on the aforementioned climate change scenario in the Kucuk Menderes Basin, while the amount of precipitation decreased by 3.07%, the plant water request of the olive oil tree increased by 5.83%. It is seen that the precipitation loss increase by 25.8% whereas effective precipitation increase by 8.3%. As a conclusion of all these values, net irrigation water requirement increases by 0.3% according to the CropWat system. In fact, a higher increase was expected in net irrigation water requirement. The plant root structure and the provision of minimum precipitation demand in all vegetation periods are the main reasons for the fact that the net irrigation water requirement does not exceed the critical levels.

Table 10: Irrigation requirement based on climate change

| Change in irrigation requirement | Plant water demand (mm) | Total Precipitation | Effective precipitation (mm) | Precipitation Loss (mm) | Net Irrigation Water requirement (mm) | Number of irrigations |
|---|---|---|---|---|---|---|
| Based on Long Years Average (1986-2017) | 710 | 738.9 | 493 | 245.9 | 217 | 1 |
| Based on climate change scenario (2021-2050) | 751.4 | 716.2 | 533.7 | 182.5 | 217.7 | 1 |
| Difference | 41.4 | -22,7 | 40.7 | -63.4 | 0.7 | 0 |
| Increase (%) | 5.83 | -3.07 | 8.26 | -25.78 | 0.32 | 0 |

Although the calculated net irrigation water requirement is insignificant due to the aforementioned reasons, it is thought that the loss of yield will not be insignificant at all. While the thirst stress-related yield loss in the non-irrigated olive gardens in the basin as compared to those irrigated according to the past years' average climate data is 9.2%, it is thought that this rate will reach 12.6% in the climate change scenario. Considering that most of the production of olives for oil in the Kucuk Menderes Basin is under dry conditions, it is calculated that the average yield loss caused by water stress between 2021 and 2050 will be around 3.4%. It should be noted that the CropWat system did not take the slope of the terrain into account and that the inclined lands in the basin are not terraced. Considering this aspect, it is not wrong to determine that the loss of harvest caused by water stress in the Basin between 2021 and 2050 would be at least 5%.

Table 11: Effect on olive yield of precipitation decrease based on climate change

| Yield loss from water stress | |
|---|---|
| Yield | Yield loss (%) |
| Yield loss in dry olive cultivation in the current situation | 9.2 |
| Yield loss in dry olive cultivation in case of climate change | 12.6 |
| Harvest change (%) | -3.40 |

The capacity of the olive production in the region to adapt to changes in precipitation was examined. It is known that in general, uncontrolled irrigation is used for olive trees in the basin. The most important reason of this is the fact that irrigation water comes from open canals and that the insufficiency of water given by the classical dripping irrigation method. The adaptation capacity seems to be quite low, especially in the inclined and non-irrigated olive gardens. Also, terraces in the region, which will hold the water, are not sufficient.

### Change in relative humidity

Moist air from the sea and large water bodies is beneficial for olive. In moist air, sweating in the leaves of the tree is reduced, and no thirst problem occurs. Olive tree leaves benefit from the moisture in the air when they cannot get enough moisture from the soil. The relative humidity of air is one of the factors that increase the product quality in cultivation of table olives. In areas where relative humidity is sufficient, the water consumption of olive decreases. On the other hand, very high humidity is unfavorable for olive. When the humidity is high, the effect of hot temperature decreases, but an ambient appropriate for some diseases may occur. Excessive relative humidity (over 85%) during flowering period restricts fertilization and reduces grain setting. Also, inadequate relative humidity and dry conditions adversely affect the transformation of flowers to fruit. If the relative humidity is low, the water demand of olives from soil increase.

In general, it is recommended to plant olives at least 1-2 km from the sea. On the contrary, some varieties can grow at the seaside without any damage. Although there are olive trees on the coast in the Aegean and Mediterranean Regions, no damage by relative humidity is observed. However, the effect of relative humidity varies according to the wind direction. Because, while fruit set increases during the long-lasting humid spring, dry winds cause fruit shedding. Irrigation should be given importance in such locations (Buldan and Çukur, 2003; Yıldırım et al., 2008)

As seen in Table 12, the change in relative humidity until 2050 is not considered critical for olive. The decrease of average relative humidity by 1.3% will slightly change the effectiveness of fungal diseases.

Table 12: Percentage and change of relative humidity in KMRB based on climate change

| Aylar | Oc. | Şub. | Mart | Nis. | May. | Haz. | Tem. | Ağ. | Ey. | Ek. | Kas | Ar. | Ort |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nispi Nem (1986- 2017) | 84,9 | 81,5 | 75,9 | 69,3 | 65,3 | 60,6 | 52,1 | 49,8 | 57 | 71,3 | 82 | 85,7 | 69,7 |
| Uz. Yıl Top. Nisbi Nem | 84,6 | 80,9 | 75,1 | 68,5 | 64,4 | 58,6 | 49,8 | 47,9 | 55,1 | 69,7 | 80,7 | 85,1 | 68,4 |
| Fark | -0,3 | -0,6 | -0,8 | -0,8 | -0,9 | -2 | -2,3 | -1,9 | -1,9 | -1,6 | -1,3 | -0,6 | -1,3 |

When changes in relative humidity in the Kucuk Menderes Basin until 2050 are examined, it is not expected that these changes will cause a serious alteration in, and pose a risk for, flowering period in particular.

### Hail and Storm

Hail and storm are other vulnerability factors in the olive production chain. Since these weather events can cause mechanical damages, and increase the penetration of diseases, they may lead to losses of harvest and quality (Ayaz and Varol, 2015). In addition, due to mechanical damages as a result of hail and storm, there may be complete tree losses and accordingly, harvest losses and additional investment/rehabilitation cost may occur. And this situation may lead to an increase in the demand for seedlings and pesticides.

Lack of reliable data prevented to conduct a detailed analysis on hail and storm risks. However, the rate of hail events in the Kucuk Menderes Basin within the past years is low. Nevertheless, when the climate characteristics that cause hail are examined, it can be predicted that the possibility will increase with climate change. This prediction may be reflected in producer's costs as an increase in agriculture insurance premiums.

Hail and storm can also have a negative effect on other links of the chain. Storms and hails in particular may damage the physical infrastructure of enterprises and also lead to problems due to aforementioned losses of harvest and quality.

### Change in wind speed and direction

Wind is an important ecosystem service during the production stage of olive. Breezes in April and May help pollination of olives and increase the fertilization and fruit set, and thus increase yield and harvest (Mete, 2011; Ayaz and Varol, 2015). In addition, the humid winds blowing during the summer period reduce the water requirement of the plant by reducing evapotranspiration and may lead to slight harvest increases (Ayaz and Varol, 2015).

However, besides positive effects, the wind has also negative effects on the chain. High winds cause mechanical damages on trees and thus can lead to loss of crops, and facilitate penetration of diseases. This may lead to an increase in pesticide demand. In addition, in case of loss of trees, seedlings demands may also increase. Since the dry winds blowing in May - June cause the stigma of olive flower to dry, these winds have a negative impact on pollination and fruit set, and ultimately may cause harvest losses. In addition, southwest winds blowing in the winter months may cause trees to come up early and thus lead to trees to become vulnerable to a possible frost situation. Besides, dry winds blowing from the south in the summer months reduce soil moisture and increase the water demand of the plant and cause loss of yield/harvest and additional irrigation (Ayaz and Varol, 2015).

Since there is no wind data for the Kucuk Menderes Basin, a climate projection could not be made for the wind regime.

### Conclusion

Considering climate change projections for the Basin, even though positive effects are also mentioned, the following facts create a critical situation for olive harvest: increases in the number of very hot days and average temperatures; a 3.1 percent decrease in the average amount of precipitation, and less cooling periods to the extent that fail to meet the needs of some olive varieties. As a result of all analyses conducted, it is predicted that unless any action is taken, olive harvest will fall by between 10 and 20 percent by 2050 in the best-case scenario. Concordantly, higher quality and yield losses in olive oil may occur as compared to the aforementioned rates.

As a result of a possible decline in harvest and a loss of quality in the olive production phase, there may be a risk of idle capacity in olive oil processing stage which is the next link in the production chain, and also additional operating expenditures may occur for the supply of products from different places to maintain capacity. Furthermore, a decline in olive oil quality would also lead to a loss of income. In the meantime, a quantitative fall in olive oil production would push prices upward and further reduce international competitiveness, which is already low, creating negative effects in the sector.

In addition, natural disasters such as hail, floods, and storms that may occur in the Basin may have adverse effects on the other links of the production chain. Storms and hails in particular may damage the physical infrastructure of enterprises and also lead to logistical problems.

Table 13: Olive Production and Periodicity

| Üretim (1000 Mt) | İspanya | İtalya | Yunanistan | Türkiye | Tunus | Suriye | Dünya |
|---|---|---|---|---|---|---|---|
| 2002 | 4.303 | 2.732 | 2.000 | 1.500 | 150 | 999 | 13.976 |
| 2001 | 6.780 | 2.894 | 2.249 | 600 | 550 | 497 | 15.670 |
| 2000 | 4.943 | 2.821 | 2.273 | 1.800 | 1.125 | 866 | 16.043 |
| 1999 | 3.460 | 3.765 | 2.196 | 581 | 1.125 | 401 | 13.853 |
| 1998 | 4.279 | 2.548 | 2.068 | 1.650 | 950 | 785 | 14.544 |
| 1997 | 5.879 | 3.591 | 2.087 | 510 | 500 | 403 | 15.138 |
| 1996 | 4.517 | 2.147 | 2.131 | 1.800 | 1.550 | 648 | 15.459 |
| 1995 | 1.694 | 3.288 | 2.199 | 515 | 300 | 423 | 10.340 |
| 1994 | 2.799 | 2.640 | 2.001 | 1.400 | 350 | 518 | 11.527 |
| 1993 | 2.809 | 2.992 | 1.681 | 550 | 1.050 | 325 | 10.938 |
| 1992 | 3.177 | 2.366 | 1.847 | 750 | 675 | 519 | 11.104 |
| Periyodisite Katsayılar | 0,63 | 0,79 | 0,89 | 0,34 | 0,41 | 0,59 | 0,80 |
| FAOSTAT | | | | | | | |

## 8.2. Climate Change Risk Assessment in Industrial Tomato Production

The tomato is a warm/hot climate vegetable, and requires a relatively long vegetation period to produce plenty of crops. Tomato does not grow well in cold weather and does not form fruit at temperatures below 14 °C. Tomato is completely damaged when the temperature falls below -2 °C in the cultivation phase and needs an optimum temperature of 15-20 °C for the normal development. Temperatures below 14 °C delay development and considerably decrease yield.

### Change in temperature

Temperature increases in tomato production have different effects. Increasing temperatures can cause water loss in plants by increasing evapotranspiration, loss of yield/quality, and additional irrigation need (Baptista et al. 2005, Saadi, 2015). In addition, fertilization problem occurs in plants under high-temperature conditions, which may cause the production period to shift forwards. Also, excessively high temperatures can lead to declines in lycopene content in tomatoes, reducing the product quality (Abak et al. 1995; Tüzün, 2015). The fact that producers must use shadings to mitigate the effects of high temperatures can result in additional investment and operating costs. Moreover, producers may need to make additional irrigation to compensate for the water loss due to high temperatures, which, as a result, may lead to increases in irrigation costs.

When the changes in temperatures in the active growth, flowering and fruit formation periods (Table 1) are examined, no negative result is seen in paste tomatoes production. On the contrary, the temperature increases of 0.8-0.9 °C in April and May might be positive for growth and flowering, however no significant change should be expected. The average temperature increase causes the seedling planting periods to be scheduled to an earlier time by 1-2 weeks.

Tomato cannot survive below 10 °C. Sudden temperature drops can cause tomato plant deaths as well as can cause problems in product formation. However, the diurnal temperature variation during tomato cultivation is desired to be more than 6°C. In cases where diurnal temperature variation increases, problems with regard to the formation of lycopene may occur and fruit quality may significantly decrease. Besides, low air temperatures can cause problems for fruit set, and also physical damages in existing fruits (Anonymous, 2008; Tüzün, 2015).

Due to the lack of data, it was not possible to assess in this study whether the diurnal temperature variation required for tomato fertilization will change or not.

It is predicted that climate change will cause extreme low temperatures to decrease. Since this will reduce the possibility of frostbite seedling and flower, it is predicted to have a little positive effect on yield.

It is possible that the extreme temperatures that may occur in July will cause the plants to burn, resulting in losses of yield and harvest. In such case, the harvest will also have to be scheduled to earlier.

Table 1: Change in temperature in active growing and fruit development periods

| Months | April | May | June | July |
|---|---|---|---|---|
| Long Years (1986-2017) Average Temperature | 11.7 | 16.1 | 20.7 | 24.1 |
| Average Temperature between 2021 and 2050 | 12.5 | 17 | 21.9 | 25.6 |
| Expected temperature difference | 0.8 | 0.9 | 1.3 | 1.5 |

## Change in precipitation

Precipitation increase has various effects on different conditions in tomato production. In the case of floods due to heavy precipitation, plant losses may occur. Besides, precipitation can increase the effects of diseases and pests, increasing the air humidity in the region. In addition, heavy precipitation can cause, increasing the salinity of soil, the region to become unfavorable for tomato production, as well as it can cause decreases in the amount of nitrogen as a result of washing the nitrogen in the soil (Boland et al., 2004; Anonymous, 2008; Saadi, 2015). Industrial tomato growers stop irrigation at a certain stage of the production period and try to increase the dry matter accumulation in the product. Precipitation in this stage may lead to decreases in quality, decreasing the rate of dry matter in the product.

According to the climate change scenario, although the total decrease in the amount of precipitation is 3.07%, water stress of the product will increase even more along with a temperature increase of 1 °C throughout the year. To analyze the results of climate change and to research the multiplier effect of precipitation decrease as well as temperature increase, data of paste tomato, which is a plant that is relatively more drought-resistant as compared to other tomato varieties and that does not like water during fruit ripening period, was used in the calculations performed by means of CropWat system.

The purpose was to determine both the rate of decrease in yield and the total water need in the basin required for paste tomato according to the results from four different calculations performed with the CropWat calculation method. Therefore the followings were calculated: the amount of irrigation water required for paste tomato in current climatic conditions; the amount of irrigation water required for this product based on the possible climate change scenario; the approximate yield loss to be observed according to current climate data, if the paste tomato is not irrigated, and possible yield losses to occur based on the possible climate change scenario, if the paste tomato is not irrigated.

When processing data by means of the CropWat system, temperature and precipitation parameters were variable, and others were kept constant. The following assumptions were made in each four scenarios: the effective root depth is 25-100 cm, the soil type is red loam, and the plant length is 60 cm. For paste tomato, the Kc1, Kc3, Kc4 values determined by DSI were taken as 0.25, 1.17, and 0.82 respectively. Results were obtained by entering the values of maximum, minimum, and average temperature data on monthly basis, and of monthly precipitation and relative humidity in the CropWat system, separately for both the previous years' averages and climate forecasts.

Accordingly, the results under irrigated cultivation conditions are presented in Table 2. According to the results based on the aforementioned climate change scenario in the Basin, while the amount of precipitation decreases by 2.74%, the water request of the paste tomato plant increases by 5.5%. On the other side, it is seen that the precipitation loss decrease by 36.1% whereas effective precipitation decrease by 9.72%. In the light of all these values, net irrigation water requirement decreases by 1% according to CropWat system. The fact that the net irrigation water requirement decreased by 1% while the precipitation loss decreased by 36.1% is due to drought-resistance of paste tomato. This shows that based on the current climate change scenario, paste tomato farming can be carried out without additional irrigation taking into account the yield loss of 3.3% in 2021-2050.

Table 2: Irrigation requirement of paste tomatoes based on climate change

| Change in irrigation requirement | Plant demand (mm) | Total precipitation | Effective precipitation (mm) | Precipitation loss (mm) | Net irrigation water requirement (mm) | Number of irrigations |
|---|---|---|---|---|---|---|
| Based on long years average (1986-2017) | 559.2 | 175.3 | 150.2 | 54.8 | 388.8 | 5 |
| Based on climate change scenario (2021-2050) | 590.2 | 170.5 | 135.6 | 34.9 | 384.9 | 5 |
| Difference | 31 | -4.8 | -14.6 | -19.9 | -3.9 | 0 |
| Increase (%) | 5.54 | -2.74 | -9.72 | -36.31 | -1.00 | 0 |

The fact that the result from the CropWat system presented a negligible value in terms of net irrigation water need does not mean that there will be no yield loss. Based on the average climate data of the past year and assuming that paste tomato in the Basin is not irrigated, it is observed that there may be yield loss of 3.3% when the climate change scenario data is compared with the same scenario logic. In this case, it is assumed that paste tomato production without additional irrigation water requirement can be possible with a yield loss of 3.3%.

The climatic values that are entered in the system are the average change values between 2021 and 2050, and it is predicted that there will be further increases in temperature and further decreases in precipitation between 2041 and 2050. It can be argued that this situation will make the irrigation water need more critical and will increase the harvest loss even more. After these years, additional irrigation water need is expected to occur.

Table 3: Effect on yield of precipitation decrease based on climate change

| Yield loss due to water stress | |
|---|---|
| Yield | Yield loss (%) |
| Yield loss in paste tomatoes farming if not irrigated in the current situation | 47.2 |
| Yield loss in paste tomatoes farming if not irrigated in the case of climate change | 50.5 |
| Harvest difference (%) | 3.30 |

According to the climate change scenario, it is predicted that the relative extension of the frequency in precipitation and temperature values will also vary on an annual basis and that there may be additional irrigation water need in certain years.

Considering the capacity of adaptation to potential climate change in terms of precipitation, it is seen that the fact that tomato fields are already irrigated increases the adaptability. On the other hand, the prevalence of surface irrigation in the Basin and the open water channels reduce the adaptability of the paste tomato. Moreover, it should be emphasized that since open system ponds and canals will increase evaporation, they will also increase problems to occur in the supply of water. Migration to (housing and urbanization), and the development of industry in, the basin will also lead to an increase in the demand for water used by the agricultural community, and thus to a gradual increase in the stress on the water used by the agricultural community. It is estimated that this will result in decreases in terms of harvest much more than predicted in yield losses.

### Change in relative humidity

Tomato is a plant species for which extreme humid weather conditions are unfavorable. Excessive increase in moisture along with the increase in temperature leads to disease and pest epidemics which can result in significant yield and quality losses. In addition, increases in air humidity cause flower shedding which can lead to yield losses (Boland et al., 2004).

The change in relative humidity until 2050 is not considered critical for tomato crop. The decrease of average relative humidity by 1.3% will positively change, albeit slightly, the effectiveness of fungal diseases. Nevertheless, the decrease in relative humidity will decrease flower shedding which results in a slight increase in fruit set.

### Fog

No study has been conducted on this weather event according to the climate change scenario.

### Hail

Hail and storms are events that can cause physical damages and that can increase the spread of diseases and pests. Possible damages of these events can cause plant loss and also can reduce the product quality due to deformations on the product.

There are two types of effect. The first one is called "mechanical damage" which is the flower and fruit shedding and leaf and stem injuries. The other one is called "disease formation" which is the damage caused by bacteria and fungus penetrating through injuries caused by hail.

The rate of hail events in the Kucuk Menderes Basin within the past years is very low. Considering the characteristics of the hail occurrence, it is estimated that the frequency intervals brought by climate change will increase the rate of hail events in the region. Along with risks of drought, flood, etc., this will reflect in the agricultural insurance policies as a cost increase.

### Change in wind speed and direction

Since the tomato plant is fertilized with the help of wind, breezy conditions in the field will have a positive effect. On the other hand, strong winds can cause fresh shoots to tilt or break. Frequency increases expected due to climate change suggest that mechanical damages may increase slightly.

### Conclusion

It is predicted that potential climate change will have a negative effect on the production of paste tomatoes in the Basin between 2021 and 2050. These negative effects would be associated not only with the result from climate change's effect on the plant stress but also with the result from the basin's agricultural infrastructure. It can be cited as an example that problems in the supply of water will be triggered since open system ponds and canals will increase evaporation. On the other side, migration to (housing and urbanization), and the development of industry in, the basin will lead to an increase in the demand for water used by the agricultural community, and to a gradual increase in the stress on the water used by the agricultural community. This will result in a decrease in harvest much more than predicted in yield losses.

Along with all these, temperature increases are expected to have also some positive effects. Extreme temperatures, however, will cause negative reflections on yield and quality. In addition to all these, it can be said that climate change increases the vegetation period but the temperatures in July and August have a restrictive effect. Besides, it is also predicted that possible climate change will cause seedling plantation periods to be scheduled to an earlier time. On the other hand, a very low decrease in the amount of precipitation will not have much effect on irrigation water need. Eventually, climate change will cause the total yield loss to most probably be in the range of 3-7%. It would be no surprise if the harvest loss in the basin reaches very high rates of 20-40% due to decreases in planting and other reasons.

## 8.3. Climate Change Risk Assessment in Cow's Milk Production

When assessing total possible risks in milk production, it will be advantageous to examine in two main topics. When examining the effects of climate change on milk production, it would be advantageous, in terms of holism, to gather the effects under two groups: (i) possible effects on the production of fodder crops that are the animal feeding source; and (ii) effects on reproduction, nutrition, digestion, and health of dairy cattle.

### Risk assessment for fodder crops

Troubles which may occur in the feed supply process, especially in the production and provision of roughage and concentrate feed, will lead to problems in the feeding of animals as well as to the increase in costs of milk production. It is observed that financing opportunities of enterprises, which are predominantly small-scaled, in Kucuk Menderes Basin cannot be sufficient against the rapid increases that may occur in input prices. In the first quarter of 2018, price increases of approximately 20% in concentrate feed prices significantly influence production costs. In particular, the increase in global soybean prices reflected also in Turkey. Only 7% of 2.175 million tons of soybean used annually in Turkey is produced domestically while the rest is imported, and the vast majority of this amount is used as the feed raw material for animal husbandry.

When the fodder crops grown in the basin are examined, it is seen that the silage corn is the most sown crop. Besides that, fodder crops such as trefoil, vetch, Italian ryegrass, barley, triticale from legume and poaceae are also produced. The common feature of all these fodder crops is that they need irrigation water for higher yield. Especially the silage corn is the crop that consumes the most water, among them.

According to the possible climate change scenario, a temperature change of 1 °C and the extreme temperatures in July-August are likely to result in loss of yield and quality in fodder crop production. Apart from that, since the tendency towards the drought-resistant varieties and species will increase, and since the vegetation period will somewhat prolong along with changes, the planting trends and preferences of farmers will also change. In addition to all these, a fair amount of cost increases are also predicted.

The total precipitation loss of 3.07% will cause, through the effect of temperature and drought-resistance, the variety- and crop-based alterations in each crop and planting period. It is highly likely that it will have a bigger effect especially on silage corn which is less drought-resistant to and needs more water. These critical risks which may be experienced for fodder crops are expected to pose critical risks for dairy cow husbandry which have expanded in the Basin. This situation is predicted to cause loss of yield and a slight decrease in milk quality.

The production system for the roughage production in the basin depends especially on precipitation and irrigation, and therefore, plans should be prepared for the roughage to be procured from alternative production regions against the lack of irrigation water due to both precipitation decrease and temperature increase.

Considering the adaptability of fodder crops, it was determined that in the Basin, within the framework of machinery, equipment, and financing facilities, surface irrigation is dominant, unconsciousness about irrigation time and quality is common, and production of different varieties (Italian ryegrass etc.) became widespread with an aim to increase milk yield. As a result, negative variations, in terms of product diversity, production schedule, production quantity/quality, costs, are expected in the production of fodder crops which are the sources of animal feeding.

## Risk assessment for cow dairying

The most significant part of the vulnerabilities to occur in the production chain due to climate change is expected to be in the raw milk production phase.

Expectations according to the scenarios for 2021-2050 are the following: a temperature increase of 1°C; a precipitation decrease of 3.07%, and decreases in relative humidity. It is considered that it will be inevitable to control/take measures against ambient conditions to prevent stress of which dairy animals experience due to their physiological structure affected by external factors such as temperature and humidity.

Environmental factors may include many climatic characteristics such as air temperature, humidity or dryness, wind, storm, calm weather, clear or cloudy weather. Air temperature interacts with factors such as humidity, wind, and precipitation, and affects many performance parameters such as meat yield, milk yield, fattening performance, and reproduction.

It is known that the optimum ambient for dairy cattle is where the absolute temperature is 5-25 °C, relative humidity is 60-70% and wind speed is 5-8 km per hour. The higher the humidity in the air, the lower the decrease in body temperature by breathing or sweating. In particular, in the case of high temperature and high relative humidity, the negative impact of the environment on dairy cattle increases even more.

It is expected that climate change will affect milk production due to the sensitivity of dairy cattle to high temperature and humidity. The study of Mauger et al. (2014), in which they used high-resolution dairy industry data, indicates that the national milk production at the end of 21th century would be 7% lower than the base projection, and that this decline would significantly deviate on the state basis. The milk production declines by 0.4% per year in the state of Washington where it is cooler, while the decline in Florida reaches up to 25%. Considering the fact that these production losses occur predominantly in the summer months, it is considered inevitable that the production processes in hot climates to be affected.

In another study for the USA (Key and Sneeringer, 2014), the effects, in milk production, of temperature stress on technical efficiency were evaluated. In this study, which was developed using four different climate scenarios, and which includes the estimations for 2030, the short-term effects of heat stress on milk production remained lower than expected as compared to the other study. The common result of both studies is that the southern states which have warmer climatic conditions suffer more production losses relatively to others.

Table 1: Temperature – Humidity Index (THI), Relative Humidity (%)

| Temperature Humidity Index (THI) Relative Humidity % | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 22 | 66 | 66 | 67 | 68 | 69 | 69 | 70 | 71 | 72 |
| 24 | 68 | 69 | 70 | 70 | 71 | 72 | 73 | 74 | 75 |
| 26 | 70 | 71 | 72 | 73 | 74 | 75 | 77 | 78 | 79 |
| 28 | 72 | 73 | 74 | 76 | 77 | 78 | 80 | 81 | 82 |
| 30 | 74 | 75 | 77 | 78 | 80 | 81 | 83 | 84 | 86 |
| 32 | 76 | 77 | 79 | 81 | 83 | 84 | 86 | 88 | 90 |
| 34 | 78 | 80 | 82 | 84 | 85 | 87 | 89 | 91 | 93 |
| 36 | 80 | 82 | 84 | 86 | 88 | 90 | 93 | 95 | 97 |
| 38 | 82 | 84 | 86 | 89 | 91 | 93 | 96 | 98 | 100 |
| 40 | 84 | 86 | 89 | 91 | 94 | 96 | 99 | 101 | 104 |

No heat stress
Moderate heat stress
Severe heat stress
Dead cows

At air temperatures above 27 °C, cows need energy to reduce their body temperature by means of sweating and breathing. As the absolute air temperature increases, it gets difficult for cows to reduce their body temperature. Animals under heat stress consume 2-12% less dry matter and their milk yield declines which results in a loss of 20-30%. This loss may reach up to 5-12 liters per day when the air temperature exceeds 32 °C. In the dry period, that is, when there is no milking, the calves born from cows that are exposed to heat stress have lower birth weight. In addition, these cows are more sensitive to metabolic diseases after the birth as compared to other cows.

It is also known that the dairy cows under heat stress sweat more. Besides, considering that the large part of the milk produced by the dairy cows consists of water, the vital function of the water for the animals under heat stress should be assessed better. Therefore, animals should be continuously provided with clean fresh water in hot summer months, and waterers should be located where animals can easily access. Also, it would be useful to place the waterers under the shade sails to prevent the water from getting heated. The ideal temperature of drinking water is recommended as 13-19 °C.

On the other hand, the careful regulation of feed rations in the summer months during which the heat stress is observed will ensure animals in the enterprise to suffer less from the heat as well as will prevent the possible losses in the production, and thus, will support the profitability of the enterprise in a positive manner.

As a result of all these studies, it is predicted that the possible climate change will have three main effects on dairy cow husbandry.

a. Effect on husbandry services and barns
b. Effects of changes in animal metabolism on milk yield
c. Effect on animal health

### Effect of climate change on husbandry services and barns

Along with climate change, especially the temperature increase of 1 °C and the high temperatures in July-August will affect not only the animals but also the performance and behavior of the personnel serving these animals. The disordered behavior or lack of performance of personnel is also a factor that can have a direct effect on milk yield.

In such a case, it is thought that the adaptability of personnel can be rapidly enhanced by means of training, improvement of working conditions and rescheduling working hours. On the other hand, since the possible temperature increases will have different effects on the animals that are in different development and yield periods, the shelter systems will need to be redesigned and/or restructured to eliminate these effects. This situation is expected to increase the financing problems, especially in small enterprises.

### Effects of changes in animal metabolism on milk yield

As observed in literature reviews, the effect of climate on animal metabolism will be influential on feeding and relatedly on reproduction.

It is considered that the effect of 1 °C increase in average temperature on feeding will have no negative influence on well-equipped enterprises. The well-equipped enterprises herein mean open or semi-open large enterprises with air conditioning facilities. Since troubles in feeding and thus in sweating in small enterprises which have no air conditioning facility (this is the most common structure) will cause loss of appetite in animals, it is predicted that their yield will decrease, and that increases in live weight will slow down. In addition to this, extreme temperatures in July-August will affect the animals in all enterprises in the Basin and will cause yield losses, and decreases in live weight. On the other hand, such climatic changes will have relatively too little effect on milk fat rates. There is a need for modelings to be able to measure the amount of all these yield losses.

When the temperature-related adaptability were examined, it was seen that large enterprises made mitigating chemical applications and have air-conditioning facilities. On the other hand, enterprises with low capacity have more limited facilities.

When the effects of temperature increases on the reproductive biology are examined, it is predicted that a temperature change of 1 °C in the Basin will not have a negative effect on the large enterprises which apply a breeding program however it will cause, in small enterprises which generally do not implement a breeding program, within the period from June to September, reduced sperm productivity, prolonged service period, increased calving interval, and consequently decreased average milk yield. On the other hand, if large enterprises in the Kucuk Menderes Basin make a breeding plan during extremely hot days, they will also be adversely affected by these changes. Modelings should be developed to be able to measure the amount of all these sperm losses.

### Effect on animal health

As a general rule in animal breeding, healthy animals can produce healthy products in a healthy environment and with a healthy feeding. One of the important parameters that may cause this chain to break and/or fail is the relative humidity and temperature in the environment where animals live. The increase in temperature and humidity in barns is predicted to increase the number of various types of harmful pathogens in the environment and animal body, and thus will directly affect the animal and animal products. Health problems of dairy cows due to overfeeding are highly likely to increase exponentially. It is predicted that as a result of these problems, breeders will encounter certain diseases such as low level of disease resistance, udder diseases, hoof diseases, respiratory diseases, liver deformations, and changes in follicular development in reproduction and that these problems will lead to an increase in the costs of disease treatment.

All these will also lead to a decrease in milk quality (due to the increase in the number of somatic cells), growth retardation in calving, and negative effects on milk fat rates.

Since these negative impacts can be kept under control in large enterprises, it is thought that they will constitute no significant problem. However, since preventive medicine practices have not developed in small enterprises, it is predicted that the production in these enterprises will be adversely affected.

When the pressure and risk factors of climate change on dairy cow husbandry are analyzed, it is considered necessary to provide breeders with cross-breeding and artificial insemination services oriented to dairy animals' races in order for current animal races to adapt to possible future climate changes. In the Kucuk Menderes Basin, there is a tendency from Holstein (Black Pied) race, which is a common dairy animal race and which will have problems in adapting to the temperature at the end of the climate change, towards Simmental (Yellow Pied) combined race, which is suitable for milk and meat production, and has more adaptation capacity. Accordingly, there is a need for planning on artificial insemination and incorporation of bulls into herds. Studies should be conducted in this matter by research institutes, and universities which practice animal breeding.

It is required to revise existing milk collection and cooling systems based on peak points in critical values and expected temperature rises in order to ensure that milk obtained from farms is delivered to milk processing dairies, factories and integrated facilities before it turns sour. More detailed and controlled systems should be developed for the storage, transportation, and ensuring the hygiene, of the milk especially without exposure to the sun and without interruption in the cold chain.

Efforts for the following subjects should be expedited during the milk production phase: dealing with animal shelters and husbandry conditions; ventilation of, cooling, and cleaning barns; supply of healthy water, and collecting, storing, processing, and processing of animal beddings, manures, and all wastes and transforming them into different production subjects (organic agriculture, biomass fuel etc.). In addition, alternatives for the use of renewable energy sources (solar, wind, biogas, etc.) should be considered.

R&D activities and good practices on milking and healthy storage of milk as well as on energy resources and hygiene should be taken into consideration.

## Conclusion

Although the studies about the effects of climate change on milk yield predict a yield loss of 5%, observations on husbandry in countries in which these studies were conducted, present that many enterprises use climate-smart practices. Naturally, the losses, in milk yield, of large-scale enterprises in the Kucuk Menderes Basin between 2021 and 2050, are predicted to be 3–5%. On the other hand, in enterprises that do not have climate control, do not practice preventive medicine, and do not have suitable animal shelters, it is highly likely that these rates would be much higher in terms of decrease both in milk yield and milk quality.

Considering the intensity of enterprises engaged in dairy cow husbandry in the basin, the fact that small-scale enterprises are predominant will lead to reductions up to 10% in milk yields due to climate change between 2021-2050. It should be considered that this rate can reach up to 15% when the indirect effects to occur in crop production are taken into account. Basin-specific modelings should be developed to more accurately measure the effect of climate change on milk yield.

## 8.4. Climate Change Risk Assessment in Dried Fig Production

The essentials of growing and cultivation of fig, a Mediterranean plant, in Turkey are generally determined by climate factors, and climatic characteristics especially such as temperature, precipitation, and wind direction have a significant impact.

Although fig (Ficus carica L.) is a sub-tropic plant, it can grow in many regions having a temperate climate. Fig, which demands places that are warm in winter, and hot and dry in summer, grows in regions where the average annual temperature is 18-20 °C. The fig requires even higher average temperatures for the period from fruit-blossoming to the end of the harvest (May-October), and this requirement reaches up to 30 °C especially during the fruit ripening and drying period (August-September). The fig is a deciduous plant and needs a little period of winter cooling. Temperatures of below -9 °C for a very short period of time can have fatal consequences for figs, and young fig trees are damaged by early frosts with a temperature of down to -3, -4 ° C in October and November. On the other hand, spring frosts with a temperature of -1 °C or lower at the end of March and in April damage new shoot growth and cause a reduction in crop. Temperatures down to -4, -7 °C at the end of winter cause damage to the winter crop and hence the fig wasp.

This report analyzes the effects of possible climate change on fig crop within the framework of researches and outputs, based on existing climate data. It should be taken into consideration that the following factors made the study on climate change difficult: differentiation of fig varieties in terms of characteristics; different climate requirements of table figs and figs for drying; the presence of male caprifigs and fig wasps, which are vital for the fig, and fruit blossoming occurring at different times. As a result of the worldwide search for climate change studies for figs, very limited results were achieved. The most important reason of this fact can be regarded that Turkey is the leader in the production of dried figs, and therefore, if a detailed study is to be conducted in these areas, it ought to be carried out by research institutes and/or universities in Turkey.

Since the effect of environmental conditions is very important in dried figs production, the high-quality products can be produced only in Büyük Menderes and Kucuk Menderes Basins (Özbek, 1978). In addition, ecological conditions, which are the most important factor affecting the dried figs production, can have significant impacts also on the quality of table figs (Polat and Çalışkan, 2009).

For the examination of the climate change scenario for figs, rather than analyzing the common fig trees, it is necessary to examine whether or not the fig wasps, which are necessary for the formation of fig fruit, and the male caprifig trees, which are necessary for the life cycle of the fig wasp, will be affected according to the climate change scenario.

### Change in Temperature

When the long years (1986-2007) climate data of the Kucuk Menderes Basin (Table 1) is reviewed, it is seen that the average annual temperature is 13.6 °C. According to the scenario at issue, the annual average temperature is predicted to rise to 14.6 °C between 2021 and 2050. In this case, it is not possible to mention a negative effect on fig production in terms of average temperatures. It can be even argued that it can have a somewhat positive effect.

The fig requires higher average temperatures for the process from fruit-blossoming to the end of the harvest (May-October), and this requirement reaches up to 30 °C especially during the fruit ripening and drying period (July-September). This is important also in terms of sun-drying, and higher temperatures cause damages to such as parched, small fruits and burned branches. Therefore, the highest temperature should not exceed 40 °C.

For temperature changes in terms of the phenological periods of fig, considering the table for temperature change in April, May, and June (Table 1), which is the period of active shoot growth, it is observed that the increase in temperature between 2021 and 2050 is 0.8-0.9 °C in May and June and that the average temperature reaches 21.9 °C in June.

Table 1: Change in temperature in active growing period

| Months | April | May | June |
|---|---|---|---|
| Long years (1986-2017) average temperature | 11.7 | 16.1 | 20.7 |
| Average temperature between 2021 and 2050 | 12.5 | 17 | 21.9 |
| Expected temperature difference | 0.8 | 0.9 | 1.3 |

According to the scenario at issue, it is understood that the changes in temperature during the active growth period have no negative effect on fig production. In addition to this, it is highly likely to see some imbalances during flowering and growth periods since temperature frequency ranges are predicted to increase. According to the climate change scenario prepared, it is expected that temperature changes that may occur in all these periods until 2050 will cause no critical change in the life of the product.

The biology and timing of both the pollination of the fig tree and insemination of the fig wasp are very complex issues which should be known separately for each period and their effects should be interpreted, to understand the importance of climate change in terms of figs. Therefore, it is of great importance to know which time intervals exist in the pollination biology of figs.

Although cultured figs are dioecious plants in terms of pollination biology (male and female trees are separate), the pollination does not depend on wind due to the fact that flowers are in the fruit. The fig tree has one of a kind pollination biology in which the pollination is accomplished, in the varieties that need pollination, by means of a wasp called Blastophaga psenes which has a symbiotic life with male caprifig trees. This wasp is colloquially known also as fig wasp. While some fig varieties do not require pollination, some varieties require pollination at certain periods and do not require at certain periods.

*There are four types of edible figs:*
*1. Those which bear spring and summer crops, through parthenocarpic means, without requiring pollination (Table figs),*
*2. Those which absolutely require pollination for fruit set (Figs for drying)*
*3. Those which do not require pollination for spring crop but require pollination to mature summer crop (San Pedro type),*
*4. Those which require pollination for spring crop but do not require pollination to mature summer crop (Adriatic type).*

*Fruit Blossoming in Male Figs:*
*a. Profichi or spring crop,*
*b. Mammoni or summer crop,*
*c. Mamme or winter crop.*

There are three types of blooming called as "fruit blossoming" in male and female fig trees. These blooming periods progress in parallel with the maturation of male and female flowers in the fruit. Besides, these periods are in harmony with different generations of Blastophaga psenes. Each three fruit crops are consecutive and when fruits get walnut-size in one of them, fruits of the subsequent bearing are hazelnut-sized.

The following bearing dates vary depending on regions and varieties. In general, bearing periods of Aegean Region were taken into consideration in this report.

- Profichi: Fig wasps emerge from the receptacles near to the shoot tip in February and March. Meanwhile, mammes are present on the one-year-old offshoots. Then mammes drop, and gall flowers in the profichi fruits mature in April. The maturation of fruits and male flowers is completed in June. The most copious fruit crops and pollens are in the profichi.
- Mammoni: It blooms in late May or June, 10-15 days before the maturation of the spring fruits. Maturation of the fruits is completed in late August or September. Mammoni has the least pollens.

- Mamme: It remains on the tree during the whole winter until April. The number of gall flowers in mamme fruits is high, and the number of male flowers is less. Hence, there is limited or no pollens in them.

The fruit blossoming in female figs consist of the followings: fiori or spring crop; pedagnuoli or summer crop; cimaruoli or fall crop.

- Fiori: It develops from the receptacles at or near to the tip of one-year-old offshoots. In dried figs, this crop usually drops before it matures. In some table fig varieties, it develops as a parthenocarpy and matures in June.
- Pedagnuoli (Main crop): In general, new shoots develop on axils. Blooming of flowers happens in late April and May. 35-40 days after the blooming, female flowers mature within June when they are hazelnut-sized. 40-45 days after this, the fruit pigment development starts and fruits ripen between August and October. Pedagnuoli is the main product and the harvest of mature fruits lasts for one to two months.
- Cimaruoli: Fruit blossoming happens in late August. Female flowers mature in September, and the fruits during fall. In varieties for drying, cimaruoli drops before maturation as there is no wasp pollination.

*Biology of Fig Wasp (Blastophaga psenes)*

Fig wasp spends all the metamorphosis stages of its life in the gall flowers of the male fig fruits. There are three generations corresponding to three fruit crops in male and female figs. Since male flowers in male fig fruits ripen about 6-8 weeks after female gall flowers, pollination and fertilization do not occur within the same fruit. The maturation of normal female flowers in female fig fruits occurs at the same time as the maturation of male flowers in male figs as well as the departure times of the matured fig wasp generation.

- In March-April, the blossoming of fiori in female figs occurs at the same time as the blossoming of profichi in male figs.
- In May, the pedagnuoli of female fig blossoms while the second crop, mammoni, blossoms in male figs. In June, while male and female flowers mature, fig wasps in male fig fruits also mature and go out of the fruit. Fig wasps go to mammoni fruits and lay their eggs onto gall flowers for the next generation as well as pollinate the pedagnuoli of female figs. The pedagnuoli forms the main crop, i.e. the summer crop. This artificial pollination which is performed by hanging the profichi fruits on female fig trees in fig orchards in the Aegean Region is called fig wasp pollination.
- The third crops blossom in August. These are cimaruoli in female figs and mammes in male figs. Fig wasps which, in the meantime, mature in mammoni take pollens from male flowers and step out and then go to the mamme and cimaruoli. Since the numbers of mammoni blossoming and male flowers are few, they include very few wasps.

Considering all these nested structures, the fact that how factors such as temperature, humidity, and wind direction and speed are affected in the period between March and August should be assessed collectively for the female fig, male fig, and fig wasp. Any break, as a result of climate change, in one of the links forming this chain will make the production of dried figs critical. In the studies, it could not be determined that the climatic vulnerabilities for each of these three living beings (female fig, male fig, fig wasp) are the same and in harmony with each other (Table 2).

Table 2: Critical temperature values for fig wasp and fig

| Climate | Minimum temperature demand in winter period | Maximum temperature demand in summer period |
|---|---|---|
| Fig wasp | -4°C> | 40°C < |
| Female Fig | -4°C> | 40°C < |
| Male Fig | -4°C> | 40°C < |

It is observed that the effect on these three living beings of climate change in the basin will be positive due to the decrease in the extreme minimum temperatures in the winter period, and will be negative due to the increase in extreme temperatures in the summer period (especially after 2040), and that the average temperatures of the summer period will not change. The extreme temperature that may occur, especially in the period from June to August during which pollination and fruit set take place, is predicted to cause yield and quality losses. The estimated climate change does not pose any risk in periods when fig and fig wasp are phenologically active. In particular, how the fig wasp will be affected by the sudden change in temperature frequency as a result of climate change is an important research topic.

### Fulfillment of cooling need

Since the fig requires very low values of cooling need, it is not expected to be affected by the climate change scenario.

### Change in precipitation

The optimal precipitation requirement of the fig tree is 625 mm per year. If the precipitation amount falls below 550 mm per year, trees should be irrigated; otherwise, they will be damaged. Especially in terms of dried figs, it is desired that precipitation to fall in the period from November to June and that the period from July to September which is the drying season to pass arid and cloudless (Göçmez & Seferoğlu 2014).

According to the climate change scenario, although the total decrease in the amount of precipitation is 3.07%, when it is combined with a temperature increase of 1 °C throughout the year, water stress of the product will increase even more. Calculations were made by means of the CropWat system to analyze the results of climate change and research the multiplier effect of precipitation decrease as well as temperature increase, in terms of fig tree which is a plant that is drought-resistant and does not like water during the fruit ripening period.

The purpose was to estimate both the rate of decrease in yield and the total water need in the basin required for fig only, according to the results from four different calculations performed with the CropWat calculation method. In this context, the followings were calculated: the amount of irrigation water required for fig in current climatic conditions; the amount of irrigation water required for fig based on the possible climate change scenario; the approximate yield loss to occur according to current climate data, if the fig is not irrigated, and possible yield losses also based on the climate change scenario, if the fig is not irrigated.

When processing data by means of the CropWat system, temperature and precipitation parameters were variable while others were kept constant.  The following assumptions were made in each four scenarios: the effective root depth is 170 cm, the soil type is red loam, and the plant length is 2.500 cm. For fig, the Kc1, Kc3, Kc4 values determined by DSI were taken as 0.16, 0.87, and 0.47 respectively. Results were obtained by entering the values of maximum, minimum, and average temperature data on monthly basis, and of monthly precipitation and relative humidity in the CropWat system, separately for both the previous years' averages and climate forecasts.

Accordingly, the results under irrigated cultivation conditions are presented in Table 3, and as seen in the table the results are quite striking. Based on the aforementioned climate change scenario in the Basin, while the amount of precipitation decreased by 4.03%, the plant water request increased by 5.78%. It is seen that the precipitation loss increase by 15.2% whereas effective precipitation decrease by 12.5%. As a conclusion of all these values, net irrigation water requirement increases by 100.37% according to the CropWat system. The reason for the high increase in the net irrigation water requirement is that the current precipitation level is very critical. Therefore, the decrease in effective precipitation by 12.5% makes the irrigation requirement compulsory. The important point here is that although it seems necessary to perform critical irrigation for the production of dried figs in the period from July to August, in fact, it should be made before the fruit ripening period. As a matter of fact, some growers have determined the need for irrigation water for the figs in the Büyük Menderes Basin and started to irrigate plants. It is thought that in the future, there will be a need for irrigation in both basins (Büyük Menderes and Kucuk Menderes Basins) at least once a year.

Table 3: Irrigation requirement based on climate change

| Change in irrigation requirement | Plant water demand (mm) | Total Precipitation | Effective precipitation (mm) | Precipitation Loss (mm) | Net Irrigation Water requirement (mm) | Number of irrigations |
|---|---|---|---|---|---|---|
| Based on Long Years Average (1986-2017) | 629.9 | 381.9 | 264.8 | 117.1 | 216.9 | 1 |
| Based on climate change scenario (2021-2050) | 666.3 | 366.5 | 231.7 | 134.8 | 434.6 | 2 |
| Difference | 36.4 | -15.4 | -33.1 | 17.7 | 217.7 | 1 |
| Increase (%) | 5.78 | -4.03 | -12.50 | 15.12 | 100.37 | 100 |

Although the CropWat system presented a considerable value in terms of net irrigation water need, how the yield loss will occur was also analyzed. While the thirst stress-related yield loss in the non-irrigated fig orchards in the Basin as compared to those irrigated according to the past years' average climate data is 20.2%, the climate change scenario indicates that this rate will reach 23.8%. Considering that most of the production of figs in the Basin is under dry conditions, it is calculated that the average yield loss caused by water stress between 2021 and 2050 will be around 3.6%. It should be noted that the CropWat system did not take the slope of the terrain into account and that the inclined lands are not terraced. Considering this aspect, it is predicted that the loss of harvest caused by water stress in the Basin between 2021 and 2050 as compared to current conditions would be at least 8-10%.

The climatic values that are entered in the system are the average change values between 2021 and 2050, and it is predicted that between 2041 and 2050, there will be further increases in temperature while further decreases in precipitation. This indicates that the irrigation water need will become much more critical and the harvest loss will increase even more.

Table 4: Effect on yield of precipitation decrease (water stress) based on climate change

| | Yield loss (%) |
|---|---|
| Yield loss in dry farming of fig in the current situation | 20.2 |
| Yield loss in dry farming of fig in case of climate change (2021-2050) | 23.8 |
| Harvest difference (%) | 3.60 |

it should be also noted that according to the climate change scenario, the relatively expanding frequency in precipitation and temperature values can have an adverse impact on the harvest and dried fig quality more than expected over years. It is predicted that this will cause product prices to much more fluctuate.

Given the capacity of adaptation to potential climate change in terms of precipitation, the fact that trees are not irrigated and that the need is at a critical level according to the CropWat system restricts the adaptability. On the other hand, cultivation of fig in mountainous and inclined areas and the lack of irrigation infrastructure in the region restrict the adaptive capacity. According to the examinations in the region, the capacity of present terraces is not sufficient to hold the precipitation water.

## Snowfall

Possible climate change decreases the likelihood of snowfall in the Kucuk Menderes Basin, especially in plain areas.

### Change in relative humidity

High air humidity is considered as the most important factor restricting the production of figs. The maximum air humidity in regions where fig is grown is desired to be maximum 40-45%, especially from July until the end of the drying season. In the Kucuk Menderes Basin, this is balanced by different types of ecosystem services such as wind. In the case of the increase in air humidity, fruits start to crack and decay and this leads to significant decreases in quality (Şen et al. 1993; Göçmez and Seferoğlu, 2014).

No critical deviation is expected for the change in relative humidity until 2050. The decrease of average relative humidity by 1.3% is predicted to slightly change the effectiveness of fungal diseases. The decrease in relative humidity during the fruit ripening period is predicted to have, in the future, a positive effect on dried fig quality.

### Fog

No study has been conducted on this weather event according to the climate change scenario.

### Hail

There are two types of effect. The first one is called "mechanical damage" which is the flower and fruit shedding and leaf and stem injuries. The other one is referred to as "disease formation" which is the damage caused by bacteria and fungus penetrating through injuries caused by hail.

However, the rate of hail events in the Basin within the past years is very low. Considering the characteristics of the hail occurrence, it is predicted that the frequency intervals brought by climate change will increase the rate of hail events in the Basin. It is thought that along with risks of drought, flood, etc., this will reflect in the agricultural insurance policies as a cost increase.

### Change in wind speed and direction

Strong winds that occur in late spring and early summer cause branches to rub each other, scars to emerge on the exocarp due to rubbing, and hence the fruit quality to decrease. Strong winds during the fig wasp pollination period are not favorable because they will prevent both the wasps to fly and the pollination. The long lasting sea breezes with high relative humidity during the maturity and drying season cause fruits to split and the quality to decrease. The dry land breezes cause the sugar content of fruits to increase and the wilting to occur faster (Kabasakal, 1990; Çobanoğlu et al., 2006).

The ideal conditions for the cultivation of dried figs are observed in Büyük Menderes and Kucuk Menderes Basins. While the period from July to September, which is the drying season is generally dry, the relative humidity is about 40-45% and the air temperature varies between 25 and 30 °C. Northeastern winds blowing before noon and eastern moist sea breezes blowing in the afternoon enable the fig to have such a quality that can be achieved nowhere in the world. The dry and hot eastern wind which is called "Simoom" reduces the quality of the fig.

Based on the possible climate change scenario, it is not known whether or not there will be any change in wind directions, in particular, the northeastern wind blowing before noon and the eastern sea breeze blowing in the afternoon, which, as a result, may have adverse effects on the fig cultivation. It should be noted that if there will be a change in the characteristics of these winds, fig production in the Basin would not be possible. How these two winds will undergo a change should be investigated by research institutes or universities by means of micro-climate analysis. Otherwise, the production of dried figs, in which Turkey is the world leader, may be exposed to a risk, especially in the Büyük Menderes Basin.

### Conclusion

Possible climate change between 2021 and 2050 has factors which can make the production of dried figs in the Basin more vulnerable as compared to all other products.

In order to assess the possible effects of climate change on, and the vulnerability of, the fig wasp, its climatic limits should be investigated very detailed.

In addition, it is of critical importance whether or not there will be a change in the northeastern wind blowing in the morning and the eastern moist sea breeze blowing in the afternoon during the fruit ripening period. If the wind regime changes and these two weather events disappear, the cultivation of figs for drying would be impossible in the basin. It is of utmost importance to conduct scientific researches on this issue, and to take measures in case results of these researches indicate that there will be a change.

Along with all these, temperature increases are expected to have also some positive effects. Extreme temperatures, however, may have negative reflections in yield and quality.

The decrease, which may be regarded very low, in the amount of precipitation critically increases the water need.

Assuming that the vital activities of the fig wasp are not affected and the northeastern winds and eastern sea breezes during the fruit ripening period remain unchanged, it is predicted that due to other climate stresses between 2021 and 2050, harvest intervals of the plant will increase and an average harvest loss of 5-7% will occur.

## 8.5. Climate Change Risk Assessment in Outdoor Ornamental Plants Production

When it comes to the production of ornamental plants, different species and production methods should be addressed. Like each species or variety may be affected at different levels by climate change, each production method will also be affected to a different degree by climate change. For this reason, it will be necessary to classify the ornamental plants produced in the Kucuk Menderes Basin under a certain discipline and to analyze climate change accordingly. The details of classification on this issue are given in Table 2. In this report, each ornamental plant group and each production technique will be addressed according to the critical risk situations if any, and the groups that do not constitute critical risk will not be mentioned due to the large scope.

Since the aim of the production of ornamental plants is not to obtain fruit, concepts such as pollination biology and cooling request these plants will not be examined. Only the critical risk effects of climate change on the vegetation period were subjected to the assessment, because the production of ornamental plants focuses on leaves, branches, trunks, and, for certain species, flowering.

The Flower Association of Queensland (2011) examined in detail the possible effects of climate change on, and measures that can be taken for, the production and marketing of ornamental plants in Australia. In this study, the effects of climate change on energy, water, soil, pests and diseases, weed, and marketing systems were analyzed. With reference to that study, a comprehensive assessment for the Kucuk Menderes Basin will be made in the scope of this report.

### Change in temperature

When the changes in temperatures in the active growth (Table 1) are examined, no negative result is seen in the production of ornamental plants. On the contrary, the average temperature increase of 0.9 °C in February, March, April, May, September, October, and November seems to be positive for almost every product group in terms of vegetative growth. On the other hand, since the average temperature increases also in winter months, it is predicted that this will cause periods of cultivation/plantation of seedling, seed, or cutting to shift to an earlier time by 1-2 weeks.

The expected extreme temperatures between July and August are likely to stop the growth and cause some sunburns in the production, whether potted or not, of perennial ornamental plants. Seasonal flowers cannot be subjected to assessment at extreme temperatures since they are not in production planning during this period.

Apart from that, it is expected that perennial bush types produced as ground covers will not be affected much due to their resistance to heat. The effect of climate change on coniferous pine types growing in the mountainous regions of the basin (around Bozdağ) will be very limited as the response of these trees to the extreme temperatures is relatively less.

Quality will increase as climate change will have a positive effect, except for in July and August, on the vegetative growth of plants in the Basin. Uprooting interval will decrease for ornamental plants which are perennial plants requiring uprooting. The prolonged vegetation period, especially in the arboriculture of deciduous types and fruits, will shorten the harvest dates. The important point here is that the shortening of the harvest date means the shortening of the marketing time as well. Small businesses that utilize manual labor for harvest will need to quickly start using mechanization.

In addition, it is expected that the increase in winter temperatures will provide a positive contribution for the seeds to germinate and the cuttings to set.

The adaptive capacities of the enterprises that produce ornamental plants in the basin are high because they practice intensive cultivation in relatively small areas and their organizational characteristics are well developed. The use of shading nets is becoming widespread.

Table 1: Change in temperature in active growing period

| Change in temperature in vegetation period | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Months | February | March | April | May | June | July | August | September | October | November |
| Long years (1986-2017) average temperature | 5.4 | 7.9 | 11.7 | 16.1 | 20.7 | 24.1 | 24 | 19.6 | 14 | 9 |
| Long years (1986-2017) extreme temperature | 10.6 | 13.7 | 18.2 | 22.6 | 27.4 | 31.3 | 31.7 | 27 | 19.6 | 13.3 |
| Average temperature between 2021 and 2050 | 6.2 | 8.8 | 12.5 | 17 | 21.9 | 25.6 | 25.5 | 20.9 | 15 | 9.9 |
| Extreme temperature between 2021 and 2050 | 11.4 | 14.5 | 19.1 | 23.4 | 28.9 | 33 | 33 | 28.3 | 21.7 | 15.2 |

During the assessment of varieties and species to be demanded in the production stage of ornamental plants, a table was prepared that indicates which ornamental plants are heat-resistant, and which ornamental plants have low tolerances (Table 2).

The Plant Heat Zone Map was developed in 1997 by the American Horticultural Society. The plant heat zone map is developed by the long years' average number of days with a maximum air temperature of above 30 °C. The map consists of twelve different regions. The first region shows the coldest region where the average annual number of days with a maximum temperature above 30 °C is less than one, and the twelfth zone shows the hottest region where the average annual number of days with a maximum temperature above 30 °C is more than two hundred and ten.

The plant heat zone map, which was developed for the first time in 2009 with 1975-2006 data, has been developed again by using Geographical Information Systems (GIS), by reflecting the changes in temperature due to elevation difference, and by updating with 1971-2010 data. Among the observed centers, Ardahan is the center of population which has the lowest value with 2.15 days in terms of the average annual number of days when the maximum temperature is above 30 °C, and it is located in the second region. Ceylanpınar district of Şanlıurfa is the center of population which has the highest value with 153.2 days, and it is located in the tenth region. The first region shows the coldest zone on the new map that was developed by deriving heat hardiness values for areas where the temperature could not be measured by means of correlation between the temperature and elevation data. (Figure 1, MGM).

The production of xerophytic plants which are responsive to climate change is also important in terms of adaptation. As a highly advantage region for growing bush-type plants, the Kucuk Menderes Basin has a great potential to grow xerophytic plants for landscaping purposes. It is predicted that xerophytic plants with low water demand can easily find a place in the market in landscaping areas planned by municipalities and public administrations and in the coastal areas. The fact that ornamental plants producers take these varieties into account will be important for the production of sustainable ornamental plants in addition to climate change.

### Change in precipitation

The purpose of the climate change studies was to achieve results through the calculation of water losses and related yield losses for all plant products. It is not possible to make an assessment by means of the CropWat system since there is no single product when analyzing ornamental plants and Kc values for ornamental plants have not been studied. On the other hand, there is information about which ornamental plants are drought-resistant and which ornamental plants have thirst-tolerance, both in the production stage and in the assessment stage of varieties and species to be demanded in the future. However, as it was not obtained from reliable sources, it was not considered as appropriate to present this information in a table.

It is known that in the Kucuk Menderes Basin, irrigation water is supplied through wells. According to the climate change scenario, it is predicted that there will be a decrease of 3.07% in the amount of precipitation in the Basin between 2021 and 2050 and hence water flow rates will decrease, which, as a result, will potentially cause groundwaters to go down deeper. This is expected to increase the water supply cost in the context of energy and investment. Since water consumption will vary from plant to plant, it is likely that there will be a fair amount of yield losses at this stage. However, it is not possible to provide a numerical value for these losses.

In addition, water consumption will increase in productions in which surface irrigation or manual irrigation by hose is applied.

Since the evaporation from the surface effect will be much more effective for the producers of potted perennial, annual, or seasonal flowers, it is predicted that the need for irrigation water will be much more than the types produced in the soil. All these data increase the probability of a slight loss of yield due to irrigation. What is certain is that the costs will increase.

### Change in relative humidity

The annual average decrease in relative humidity by 1.3% is expected to have a positive effect, as it will result in a slight reduction in fungal diseases.

### Fog

No study has been conducted on this weather event according to the climate change scenario.

### Hail

It is predicted that the hail and storms events to occur as a result of possible climate change will cause physical damages and increase the spread of diseases and pests. These events can cause plant losses and also can reduce the product quality due to deformations on the product.

There are two types of effect. The first one is called “mechanical damage” which is the leaf and stem injuries. The second one is so-called “disease formation” which is the damage to plant caused by bacteria and fungus penetrating through injuries caused by hail.

The rate of hail events in the Kucuk Menderes Basin within the past years is very low. Considering the characteristics of the hail occurrence, it can be argued that the frequency intervals brought by climate change will increase the rate of hail events in the region. If the annual ornamental plants are damaged by hail, they would be completely wasted. If perennial plants are damaged by hail, it would be impossible to sell them within the same year. If the hail damage is light, they can recover within one year to be ready for sale, but if the hail damage is very severe, all product will be wasted.

### Change in wind speed and direction

Ornamental plant cultivation is the least affected production type by severe winds due to the shortness of plants' heights. For this reason, it is not likely to be adversely affected except for natural events such as extreme storm or whirlwind.

### Conclusion

The effect of possible climate change to occur in the basin between 2021 and 2050 on the current production of ornamental plants in terms of climatic risk will be positive for some species, varieties, or sub-species, negative for some of them, and ineffective for some others. What is important here is that the demand will be the factor to determine which products will be grown in the Basin. Assuming that ornamental plant consumers live in big cities, it should be determined whether access to irrigation water sources will be possible throughout the country due to climate change, and that to what extent will the cost of irrigation in cities change. Considering that climate change will increase the need for irrigation water throughout the country, it is predicted that even if it will be possible to grow ornamental plants in the Basin, production of some varieties having a critical water need will discontinue, and instead, production of varieties with high drought-tolerance and low water-stress will be widespread.

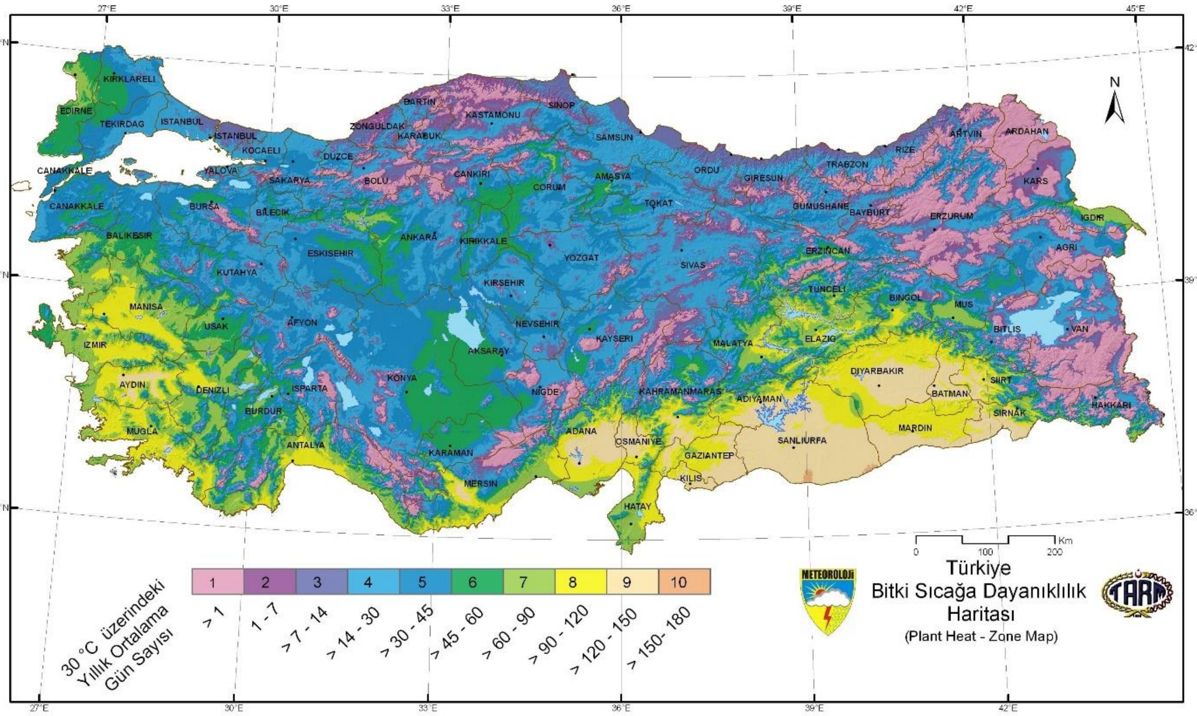
Quality will increase as climate change will have a positive effect, except for in July and August, on the vegetative growth of plants in the basin. Uprooting interval will decrease for ornamental plants which are perennial plants requiring uprooting or rootball. All these factors will bring about additional costs, such as for storage.

Significant increases are expected in production costs due to climate change. On the other hand, actions for the expectation that harvest losses will occur in total should not be taken according to the climate scenario at issue. Some varieties that are sensitive to water stress may suffer a yield loss ranging from 2 to 5 percent due to human factors or the insufficient supply of water. However, considering the expectation that the quality of many species will increase due to climate change, it is thought that these yield losses will be tolerable.

In the field studies, it has been observed that recently, the production of tree/bush-type outdoor plants has superseded the production of seasonal ornamental plants. During this process, the adaptation of small family businesses and landscaping companies in the Basin to possible effects of climate change can be ensured by means of providing cultivation techniques and appropriate inputs and developing marketing systems.

If growers of ornamental plants in the Basin can successfully predict the future demand, it will be highly likely that they will be able to make use the climate change in a positive manner by changing product patterns (tending to heat-resistant varieties with low water need).

Figure 1: Plant heat zone map for Turkey




*Source: MGM (General Directorate of Meteorology)*

Table 2: Outdoor ornamental plants grow in Turkey and their hardiness

| Plant Name | Latin Name | Form | Hardiness zones |
|---|---|---|---|
| Silverberry | Elaeagnus commutata | Bush | 2a |
| Siberian peashrub | Caragana arborescens | Bush | 2a |
| Rock cotoneaster | Cotoneaster integerrima | Bush | 2a |
| Red barked dogwood | Cornus alba 'Sibirica' | Bush | 2a |
| Common juniper | Juniperus communis var. depressa | Bush | 2b |
| Ohio buckeye | Aesculus glabra | Tree | 2b |
| Ponderosa pine | Pinus ponderosa | Tree | 2b |
| Hackberry | Celtis occidentalis | Bush-Tree | 2b |
| Boxelder maple | Acer negundo | Tree | 2b |
| American elm | Ulmus americana | Tree | 3a |
| Apple | Malus domestica | Tree | 3a |
| Birch | Betula pendula | Tree | 3a |
| Russian olive | Elaeagnus angustifolia | Tree | 3a |
| Highbush cranberry | Viburnum opulus | Bush | 3a |
| Dog rose | Rosa canina | Bush | 3a |
| Lilac | Syringa vulgaris | Tree | 3a |
| Maidenhair tree | Ginkgo biloba | Tree | 3a |
| Creeping pine | Pinus mugo | Tree | 3a |
| Rhododendron Indian azalea | Rhododendron southern Indian hybrids | Bush | 3a |

| | | | |
|---|---|---|---|
| Creeping juniper | Juniperus horizontalis | Bush | 3a |
| European spruce | Norway spruce | Tree | 3b |
| Eastern White Pine | Pinus strobus | Tree | 3b |
| Border forsythia | Forsythia intermedia | Bush | 4a |
| White flowered horse chestnut | Aesculus hippocastanum | Tree | 4a |
| Norway maple | Acer platanoides | Tree | 4a |
| Burning bush | Euonymus alatus | Bush | 4a |
| Box elder | Acer negundo | Tree | 4a |
| Japanese maple | Acer palmatum | Tree | 4a |
| Japanese Rose | Rosa rugosa | Bush | 4a |
| Red horse chestnut | Aesculus x carnea | Tree | 4a |
| Red-barked dogwood | Cornus alba | Bush | 4a |
| Rhododendron mollis hybrids | Rhododendron mollis hybrids | Bush | 4a |
| Japanese crabapple | Malus floribunda | Tree | 4a |
| Bloodtwig dogwood | Cornus sanguinea | Bush | 4a |
| Dutchman’s pipe | Aristolochia durior | Bush | 4b |
| Rose of sharon | Hibiscus syriacus | Bush | 5a |
| Walnut | Juglans regia | Tree | 5a |
| Judas Tree | Cercis siliquastrum | Tree | 5a |
| Goumi | Elaeagnus multiflora | Tree | 5a |
| Golden rain tree | Koelreuteria paniculata | Tree | 5a |
| Evergreen candytuft | Iberis sempervirens | Bush | 5a |
| Japanese false cypress | Chamaecyparis pisifera | Tree | 5a |
| Kousa dogwood | Cornus kousa | Bush | 5a |
| Mahonia | Mahonia aquifolium | Tree | 5a |
| Pontic rhododendron | Rhododendron ponticum | Bush | 5a |
| Pecan | Carya illinoinensis | Tree | 5a |
| Yellow azalea | Rhododendron luteum | Bush | 5a |
| Stewartia koreana | Stewartia koreana | Tree | 5a |
| Dawn redwood | Metasequoia glyptostroboides | Tree | 5a |
| Zelkova serrata | Zelkova serrata | Tree | 5a |
| Almond | Amygdalus communis | Tree | 5b |
| White forsythia | Abeliophyllum distichum | Bush | 5b |
| Crape myrtle | Lagerstroemia indica | Tree | 5b |
| Chinese redbud | Cercis chinensis | Tree | 6a |
| Giant sequoia | Sequoiadendron giganteum | Tree | 6a |
| Scotch broom | Cytisus x praecox | Bush | 6a |
| Yoshino cherry | Prunus yedoensis | Tree | 6a |
| Japanese spindle | Euonymus Japonica var aurea | Bush | 6b |
| Heavenly bamboo | Nandina domestica | Bush | 6b |
| Japanese holly | Ilex crenata ‘Convexa’ | Bush | 6b |
| Japanese camellia | Camellia japonica | Bush | 6b |

| | | | |
|---|---|---|---|
| Lawson cypress | Chamaecyparis lawsoniana | Tree | 6b |
| China-fir | Cunninghamia lanceolata | Tree | 7a |
| Laurel-leaf cistus | Cistus laurifolius | Bush | 7a |
| Sasanqua camellia | Camellia sasanqua | Bush | 7a |
| Rhododendron | Rhododendron prinophyllum roseum | Bush | 7a |
| Holly osmanthus | Osmanthus heterophyfllus | Bush | 7a |
| Golden chain | Laburnum x watereri | Bush | 7a |
| Thorny olive | Elaeagnus pungens | Tree | 7a |
| Evergreen spindle | Euonymus japonica | Bush | 7a |
| Japanese laurel | Aucuba japonica | Bush | 7b |
| Himalayan cedar | Cedrus deodara | Tree | 7b |
| Monkey puzzle tree | Araucaria araucana | Tree | 7b |
| Chinaberry tree | Melia azedarach | Tree | 7b |
| Purple rock rose | Cistus x purpureus | Bush | 8a |
| Darwin's barberry | Berberis darvinii | Bush | 8a |
| Barberry | Berberis vulgaris | Bush | 8a |
| California lilac | Ceanothus impressus | Tree | 8a |
| Monterrey pine | Pinus radiata | Tree | 8a |
| Coast redwood | Sequoia sempervirens | Tree | 8a |
| Loquat | Eriobotrya japonica | Tree | 8a |
| Olive | Olea europaea | Tree | 8a |
| Jelly palm | Butia capitata | Tree | 8b |
| Myrtle | Myrtus communis | Tree | 8b |
| Rhododendron | Rhododendron Purple Splendor | Bush | 8b |
| Aralia ivy | Fatshedera lizei | Bush | 8b |
| Oleander | Nerium oleander | Tree | 8b |
| Poinsettias | Euphorbia pulcherrima | Bush | 9a |
| Chinese Rose | Hibiscus rosa-sinensis | Bush | 9a |
| Camphor tree | Cinnamomum camphora | Tree | 9a |
| Blue jacaranda | Jacaranda mimosifolia | Tree | 9a |
| Brazilian pepper tree | Schinus terebinthifolius | Tree | 9b |
| Australian pine tree | Casuarina equisetifolia | Tree | 9b |
| Orchid tree | Bauhinia variegata | Tree | 9b |
| Kenyan shower | Cassia fistula | Tree | 10a |
| Christmas star | Euphorbia pulcherrima | Bush | 10a |
| Bougainvillea | Bougainvillea spectabilis | Winder | 10a |
| Ethiopian banana | Ensete ventricosum | Tree | 10a |
| Rubber fig | Ficus elastica | Tree | 10a |
| Cuban royal palm | Roystonea regia | Tree | 10a |
| Green Ebony | Jacaranda acutifolia | Tree | 10a |

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| *Source: MGM (General Directorate of Meteorology)* |

# Annex-9: International and national good practices

For international and national good practices, please see the separately prepared PDF file with the same name.

## Annex-10: Field Visit, Meetings and Interviews with Persons and Organizations

| Institution/Function | Visited Units | Date of Visit | PERSONS |
|---|---|---|---|
| Ministry of Agriculture and Forestry | İzmir Provincial Directorate of Food, Agriculture and Livestock | 8.03.2018 | Nursel Koçyiğit Tekalmaz, Ms. Hacer, Kurtuluş Bingöl |
| İzmir Commodity Exchange | İzmir Commodity Exchange | 14.03.2018 | Pınar Nacar |
| Aegean Exporters Association | Aegean Exporters Association | 14.3.2018, 26.4.2018 | Necdet Kömür, Oğuz Aşçıoğlu, Ece Tırkaz |
| İzmir Metropolitan Municipality | Agricultural Projects Branch | 26.4.2018 | Ahmet TOMAR |
| Ministry of Development | Izmir Development Agency | 8.03.2018 | Hülya Ulusoy Sungu, Sinem Özdemir Durmuşlar |
| Council of Higher Education | Ege University, Faculty of Agriculture | 8.03.2018 | Assoc. Prof. Tolga Esetlili |
| Ministry of Agriculture and Forestry | Bornova Olive Research Institute | 8.03.2018 | Mehmet Ulaş, Murat Özaltaş |
| Ministry of Agriculture and Forestry | Tire District Directorate of Food, Agriculture and Livestock | 9.03.2018 | İlhan Çaylan |
| Ministry of Agriculture and Forestry | Odemis District Directorate of Food, Agriculture and Livestock | 9.03.2018 | İbrahim Altıntaş |
| Ministry of Agriculture and Forestry | Kiraz District Directorate of Food, Agriculture and Livestock | 9.03.2018 | Teoman Er, Ms. Melek |
| The Union of Turkish Agricultural Chambers | Tire Chamber of Agriculture (Producers focus group meeting) | 9.03.2018, 27.4.2018, 23.05.2018 | A group of farmers and Halil İBİŞOĞLU (Chairman of Chamber of Agriculture) |
| The Union of Turkish Agricultural Chambers | Torbalı Chamber of Agriculture | 24.4.2018 | Yılmaz GİRGİN (Chairman of Chamber of Agriculture) |
| The Union of Turkish Agricultural Chambers | Odemis Chamber of Agriculture (Producers focus group meeting) | 9.03.2018 | A group of farmers |
| Cooperatives | Demircili Agricultural Development Cooperative | 11.03.2018, 24.05.2018 | Hüseyin Coşkun |
| Cooperatives | İğdeli and Nearby Villages Agricultural Development Cooperative | 9.03.2018 | Süleyman Top and Mr. Deniz |
| Cooperatives | Tire Milk Producers Agricultural Development Cooperative, | 9.03.2018 | Erdem Gürcü |
| Cooperatives | Bademli Agricultural Development Cooperative | 10.03.2018 | Selcuk Bilgi |
| Cooperatives | Gödence Agricultural Development Cooperative | 13.03.2018 | Selahattin İşeri, Halil İbrahim Özgören |
| Cooperatives | Tariş Olive and Olive Oil Union | 12.3.2018 Monday | Mert Murat, İsmail Çırak |

| | | | |
|---|---|---|---|
| Feed, Medicine and Equipment Dealers and Private Veterinarians | Input suppliers and private veterinarians in Tire, Odemis, and Bayındır. | 10.03.2018 | Various individuals/dealers |
| Ministry of Environment and Urbanization | İzmir Provincial Directorate of Environment and Urbanization, Branch of Environmental Management and Control | 14.03.2018 | Şükran Nurlu |
| Retailers and Local Supermarkets | Boyumar and local wholesale/retailer supply chain | 12.3.2018, 23.05.2018 | Yücel Muhtar Kazaz |
| Local Exporters | Atınç Agricultural Products Inc. - Selcuk | 13.03.2018 | Mustafa Atınç, Hüseyin Atınç |
| Local Milk Collectors and Processors | Small/medium scale dairy farms locally collecting and processing milk in Tire and Odemis | 10.03.2018 | Various individuals |
| Milk Processing | PINAR SÜT | 12.03.2018 | Dilek EMİL |
| Pomace oil processing | Girgin Pomace Oil - Odemis | 9.03.2018 | Muammer Girgin |
| Cooperatives | Chairman of Bayındır Floriculturists Cooperative | 25.4.2018, 25.05.2018 | Ersoy SÜMERKAN |
| Producers Associations | ÇİÇEKBİR Bayındır Indoor and Outdoor Ornamental Plants Growers Association - Bayındır | 25.4.2018 | Mehmet ÇIPLAKLI |
| Universities | - Ege Uni. Faculty of Agriculture, Landscaping Dept | 24.04.2018 | Prof. Dr. Vecdi KUCUKERBAŞ |
| Universities | Ege Uni. Bayındır Vocational School Of Higher Education - Bayındır | 24.04.2018 | Hasan KARAKOÇ, Dr. Meltem Yağmur WALLACE, Dr. Ali SALMAN, Ayhan KESİCİ |
| Local Producers | Kardelen Arboriculture - Odemis | 25.4.2018 | Selahattin ALTUN |
| Research Institutes | Fig Research Station - İncirliova/Aydın | 27.4.2018 | Selim ARPACI |
| TARİŞ | TARİŞ Fig Union | 27.4.2018, 25.05.2018 | Mustafa BİRCAN, Rahmiye DEMİRCİ |
| Industrialists | TAT Gıda Sanayi A.Ş. - Torbalı | 24.05.2018 | Orhan KANUR, Orhan DURU |
| Industrialists | İrem Tarımsal Ürünler San. ve Tic. Ltd. Şti - Odemis | 25.4.2018 | Yasin BALKAN |
| Industrialists | ÖZGÖRKEY Tohumculuk Agricultural Product Development and Fruit and Vegetable Raw Material - Torbalı | 24.05.2018 | Başak ÜNVER, Abidin Fehmi VAROL |
| Industrialists | Neşecan Süt Ürünleri San. ve Tic. Ltd. Şti. | 23.05.2018 | Ali ÇAĞINDI |
| Brokers | İzmir Vegetable and Fruit Brokers Association - Buca | 26.4.2018 | Orhan DOĞAN |