Sustainable Food Systems Theme Study Report

Sustainable Food Systems Working Group Report

March 2022

TSKB

Table of Contents

List of Figures 5
List of Charts ..... **Error! Bookmark not defined.**
Abbreviations 6
1. INTRODUCTION 7
1.1 Definitions 8
1.1.1. Sustainable Agriculture 8
1.1.2. Food Security 10
1.2 Background 12
1.2.1 Why Sustainable Agriculture? 12
1.2.2 Relationship between Agriculture and Climate 13
1.2.3 Agricultural Value Chain 14
2. AGRICULTURAL INDUSTRY AND THE CLOSELY-RELATED SECTORS 15
2.1 Agriculture 17
2.2 Food and Beverages 19
2.3 Packaging 22
2.4 Logistics and Retail 23
3. FINANCING SUSTAINABLE AGRICULTURE 25
3.1 Potential Investment Areas 25
4. SUSTAINABLE AGRICULTURAL PRACTICES AND TECHNOLOGIES 27
4.1 Examples of Best Practices 28
4.1.1. Soil, Fertilizer, Seed and Minerals 28
4.1.2. Water 30
4.1.3. Machinery and Equipment 31
4.1.4 Labor 31
4.1.5 Processing of Agricultural Products 33
4.1.6. Packaging, Storage and Transport 34
4.1.7. Sales and Consumption 35
4.2 Sustainable Agricultural Technologies 36
4.2.1. Precision Agriculture 37
4.2.2. Dry Farming 38
4.2.3. Soilless Agriculture (Hydroponics) 38
4.2.4. Vertical Farms 39

4.2.5. Processing, Transport, Sales and Consumption 40
5. FUTURE OF AGRICULTURAL POLICIES: GLOBAL AND TURKISH OUTLOOK 42
5.1 Farm to Fork Vision 42
5.2 Turkey's Policy Agenda for Food Security 45
5.3 The Intersection of Agricultural Production and Development Agenda 45
5.4 Linkage Between Sustainable Agriculture and SDGs 48
6. Conclusion and TSKB's Roadmap 51

Prepared by

Financial Advisory Department

Advisory Services and Marketing Department

Economic Research Department

Development Finance Institutions Department

Engineering and Technical Advisory Department

List of Figures

Figure 1: Food Security Index Results (2020) 10
Figure 2: Agricultural Value Chain 15
Figure 3: Sectors Related to the Agricultural Industry 16
Figure 4: Basic Size Information for the Agricultural Industry 17
Figure 5: Summary Indicators for Turkish Packaging Industry 22
Figure 6: Summary Indicators for Turkish Logistics – Freight Transport Sector 24
Figure 7: An “Agrivoltaic” application 27
Figure 8: Plant-based bioplastic bottles 26
Figure 9: Dry farming site in Lisinia, Burdur 27
Figure 10: Drip irrigation technique 30
Figure 11: Wheat harvesting and pre-processing 32
Figure 12: A product-specific tractor attachment 31
Figure 13: Child workers on the farm 32
Figure 14: Orange washing line 34
Figure 15: Automatic milking machine 33
Figure 16: Rooftop SPP at a cold storage 34
Figure 17: Food waste 36
Figure 18: Mapping crop health by using drones 39
Figure 19: Digital monitoring and management infrastructure 38
Figure 20: Soilless agriculture 39
Figure 21: Vertical farms 40
Figure 22: Synthetic meat in a lab setting 42
Figure 23: Electric logistics vehicle 41
Figure 24: Vegan leather production from plants such as pineapple, sugar beet and mushroom 43
Figure 25: Reverse vending machine for recycling 42
Figure 26: Main Steps of Action Under the EGD 43
Figure 27: Relationship between sustainable agriculture and SDGs 49

Abbreviations

TSKB	Industrial Development Bank of Turkey
FAO	Food and Agriculture Organization
EGD	European Green Deal
DDT	Dichloro-diphenyl-trichloroethane
EPA	United States Environmental Protection Agency
WHO	World Health Organization
UV-B	Ultraviolet B-rays
UV-C	Ultraviolet C-rays
CFC	Chlorofluorocarbon
HFC	Hydrofluorocarbon
EU	European Union
OECD	Organization for Economic Cooperation and Development
WB	The World Bank
IPCC	Intergovernmental Panel on Climate Change
IFPRI	International Food Policy Research Institute
SAF	Sustainable Aviation Fuels
LEED	Leadership in Energy and Environmental Design
EBRD	European Bank for Reconstruction and Development
PET	Polyethylene tetraphthalate
BPP	Biomass Power Plant
ILO	International Labor Organization
DITAP	Digital Agriculture Market
SDG	Sustainable Development Goals

1. INTRODUCTION

The world population is approximately 7.7 billion and is expected to reach 9.7 billion by 2050. Currently, 700 million people are trying to sustain their lives in extreme poverty while 800 million people are suffering from chronic hunger and 2 billion people are struggling with diseases caused by malnutrition.

Agricultural activities, the main source of nutrition, are blighted by numerous global issues that remain to be solved. It is estimated that 80% of arable land in the world is degraded, and 24 billion tons of soil is lost to erosion every year.[1] Coupled with the potential persistence of current trends and the new arable land to be developed, this means that we need to produce 70% more agrifood on just 5% more land to feed 9 billion people by 2050.[2]

Extreme weather events such as storms, floods, hail, forest fires and heat waves have increased in severity and frequency due to the climate crisis and now pose a serious food security threat for a large number of people as well as risks of product and income loss for farmers. The gradual decrease in the predictability of climatic conditions makes agricultural production planning difficult and causes a decline in agricultural production quantity (yield) in addition to a deterioration of soil health and productivity. Wild irrigation depletes limited water resources. The uncontrolled use of chemicals such as pesticides, fungicides and insecticides not only causes the soil to lose minerals and degrade but also damages biodiversity. It is confirmed that global water use has increased 100 times in the last century. It is estimated that one out of every two people living in the world will be suffering from moderate water stress by 2050.[3] Focusing particularly on our country, it is noted that Turkey has an increasing vulnerability in terms of heat waves, floods and overflows, mucilage, forest fires, sand and dust storms, and the threat of reduced water availability.[4]

Losses and inefficiencies occur at all stages of the agricultural value chain from fields and greenhouses to the end consumer. As a result, air, water, soil and natural ecosystems suffer in addition to food loss and waste, and limited natural resources are rapidly depleted. Complex multi-stakeholder structures on the value chain restrict efficiency and predictability, and price volatility and instability due to market dynamics make access to food even more difficult.[5] Since the share of agricultural production in the economy is relatively high in non-industrialized countries, inefficiencies and losses in access to food pose higher risks of social and humanitarian crises in such countries.

On the other hand, about one-third of the food produced globally goes to waste before it can be consumed. Considering the size of the population having problems in access to food and nutrition, the issue created by such an inefficiency is better understood. In addition, considering the energy and resources spent for large quantities of agricultural production that goes to waste, this causes significant amounts of greenhouse gas emissions.[6] Since climate change from agricultural production has negative

1 Source: Oliver Wyman: "Agriculture 4.0: The Future of Farming Technology", 2018
2 Source: Ernst & Young
3 Source: United Nations and Massachusetts Institute of Technology
4 Source: TSKB Adaptation Theme Report
5 Food and Agriculture Organization (FAO)'s global food price index increased by 33% year on year in October 2021. The economic recession caused by the Covid-19 pandemic and the failures in the supply chain had a multiplier effect on the course of events.
6 It is calculated that if food waste were a country, it would rank third in greenhouse gas emissions.

effects on agricultural activities, energy and resource inefficient agricultural activities create a vicious circle.

Policies as well as analysis-based solutions are developed by the public and private sectors, think tanks and non-governmental organizations to ensure sustainability and efficiency in agriculture. The European Green Deal (EGD) legislation stipulates that at least 40% of the budgets that the member countries will transfer for the common agricultural policy be allocated for efforts to curb climate change. Documents such as the zero-waste regulation, circular economy action plan, and "The Farm to Fork" strategy under the EGD include various titles related to sustainable agriculture. Likewise, a European Commission decision in March 2020 aims to carry out organic farming activities in at least 25% of agricultural areas and to reduce the use of water, energy and plastics to a significant extent. Textile[7] and livestock sectors are outside the scope of the report but interact with sustainable agriculture. They are also considered in developing integrated strategy, policy and solution proposals.

A review of the financing of sustainable agriculture and of the areas attracting investments highlight the reduction of food losses and the prevention of inefficiencies as well as technological progress, research and development in the interactive sectors of food and beverages, packaging, logistics and retail. The technological and financial focal points of improvements in the agricultural value chain include climate change mitigation, adaptation to climate change, transition to a low carbon economy, clean energy, resource efficiency, biodiversity, green and sustainable innovation.

1.1 Definitions

1.1.1. Sustainable Agriculture

First used by Australian agricultural economist Gordon McClaymont, the term sustainable agriculture became popular in the 1980s when environmental issues rose on the global agenda.

In the United States National Agricultural Research, Extension, and Teaching Policy Act of 1977, sustainable agriculture is defined as an integrated system of crop and animal production practices having a site-specific application that will, over the long-term,

- satisfy human food and fiber needs,
- enhance environmental quality and the natural resource base upon which the agriculture economy depends,
- make the most efficient use of non-renewable resources and on-farm resources,
- integrate, where appropriate, natural biological cycles and controls,
- sustain the economic viability of farm operations; and
- enhance the quality of life for farmers and society as a whole.

7 Calculations show that the textile industry is responsible for 10% of global greenhouse gas emissions and 20% of the amount of wastewater generated. 500,000 tons of plastic microfibers are mixed into the rivers, seas and oceans every year due to the washing of plastic-based textiles such as polyester.

Historically, besides the events raising mass environmental awareness such as the DDT[8] crisis of the 1970s and the ozone layer loss[9] of the 1980s, environmental and social disasters occurred in many parts of the world at rising scales. Therefore, different elements have been integrated into the scope of sustainable agriculture over time, including the following:

- Food security
- Conservation of environmental and natural resources: living life, soil, air, water and minerals
- "Climate-friendly technologies" to increase supply chain efficiency
- Circular economy
- Prevention of erosion, desertification and "eutrophication"[10] in water resources
- Maintaining the soil's nutrient and mineral cycle
- Conservation of natural vegetation and biodiversity
- Reducing the use of chemicals
- Organic farming
- Development of seeds with high resistance to extreme weather events, pests and diseases
- Sustainable and inclusive rural development

Sustainable agriculture has become inseparable from climate change, which is one of the key agenda items today. All sustainable agriculture efforts are shaped to ensure the realization of the aforementioned within the framework of integrated strategies. It requires a holistic approach to secure economic buoyancy by supporting natural life and ecosystems while increasing energy and natural resource efficiency within the agricultural value chain. Looking from this perspective, sustainable agriculture has an impact and importance beyond agriculture and the sectors it directly interacts with.

[8] When the use of DDT (dichlorodiphenyltrichloroethane) began in the 1940s to combat insect-borne diseases such as malaria and typhus, it was initially highly successful in disease control, and it was commonly used for agricultural purposes around the globe until the 1960s. However, the research done back then revealed that the chemical compound persisted in the environment for a very long time, accumulated in fatty acids and mixed with the atmosphere, resulting in a ban on its agricultural use by the U.S. Environmental Protection Agency (EPA) in 1972. As an exception, the World Health Organization (WHO) declared its support for indoor use in a 2006 decision, as malaria is still the leading cause of mortality in African countries. (Source: EPA)

[9] The ozone (O_3) layer is located in the upper parts of the atmosphere between the troposphere and the stratosphere and protects the world from harmful solar rays (UV-B and UV-C). In 1985, scientists performed some measurements in the part of the ozone layer above Antarctica and found that the ozone layer had thinned significantly over the years and was heading towards complete depletion within a few decades. In a scenario where ozone was depleted, it was predicted that ecosystems would deteriorate, skin cancers would increase rapidly, and biodiversity would be largely destroyed. It was then found that the main cause of the problem was the chlorofluorocarbon (CFC)-based chemicals used in aerosol cans of cosmetic products, air conditioners and refrigerators, which created a chemical chain reaction that destroyed the ozone layer when they reached the atmosphere. Due to public pressure and the necessity to take urgent action, the use of CFCs was prohibited by the Montreal Convention, which was signed in 1987 and entered into force in 1989. The Convention was signed in a matter of just 2 years and is still the only convention signed by all countries in the world, thus crowned as the most successful environmental action in history. The hole in the ozone layer has waned to date and is expected to close completely by the 2060s. However, hydrofluorocarbons (HFCs) used instead of CFCs are hazardous greenhouse gases, and the use of these chemicals was banned in 2016 to stop climate change. (Source: www.vox.com)

[10] Eutrophication is the phenomenon of overgrowth of phytoplanktons and serious damage to the ecosystem and biodiversity due to the regular accumulation of various nutrients and minerals in water resources. Examples of eutrophication include past instances of algae blooms and mucilage (sea snot) formations in the Bosphorus and Marmara Sea.

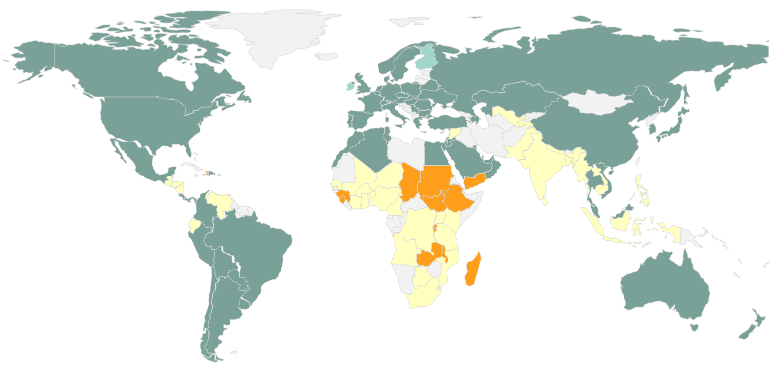
1.1.2. Food Security

The efforts to define food security in multiple aspects are united under the framework definition of the United Nations Committee on World Food Security. According to this definition, food security means that

"all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their food preferences and dietary needs for an active and healthy life."[11]

The Economist's Global Food Security Index provides an opportunity to benchmark food security across a set of 113 countries using a method that is based on numerical data. The index scores food security of the countries in 5 categories, namely "very good", "good", "moderate", "weak" and "very weak". According to the map depicting these categories, 62 countries of the world are classified in the "good" category, while only 2 countries - Finland and Ireland - are in the "very good" category. On the other hand, there is no country exhibiting a "very weak" outlook for food security.

Figure 1: Food Security Index Results (2020)



Score	Category
80+	Very Good
79.9 - 60	Good
59.9 - 40	Moderate
39.9 - 20	Weak
19.9 - 0	Very Weak
-	Not Included

Source: Economic Intelligence Unit, TSKB Economic Research

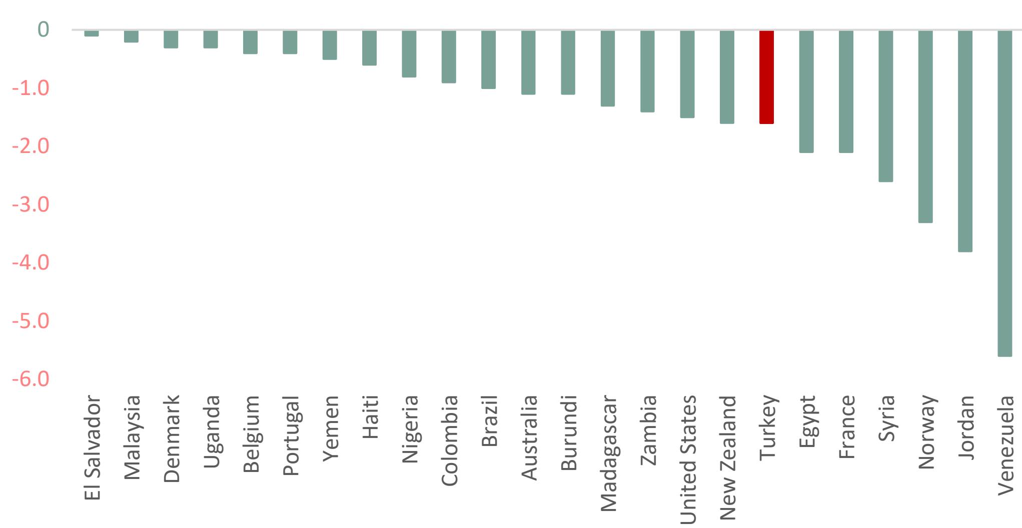
When the countries graded in the "good", "moderate" and "weak" categories are compared with each other, the economic and geographical differences become more evident. 16 out of the 18 European Union (EU) member states included in the index calculation are in the "good" category with two in the "very good" categories, while 2 out of the 29 Organisation for Economic Cooperation and Development (OECD) member countries are graded in the "very good" and 27 in the "good" categories. On the other hand, 10 out of the 12 countries with a "weak" outlook in food security are located in Sub-Saharan Africa, and these

[11] On the other hand, the concept of food safety is defined in the Regulation on the Inspection and Control of Food Safety and Quality, published in the Official Gazette No. 27009 of September 26, 2008 in Turkey, as "the entirety of measures taken to eliminate physical, chemical, biological and all other kinds of damage to food". These measures aim to make sure that - in the supply chain from production to consumption - the food does not contain or come into contact with microbiological threats such as allergens, bacteria, viruses or toxins which are harmful to human health. Therefore, although "food security" and "food safety" are interrelated, they refer to two different concepts.

are the same countries considered to be among low-income countries according to the World Bank's classification.

Historically, 89 out of 113 countries have made progress in the field of food security since 2012, the year when the index was first published, while the countries experiencing recession are economically differentiated from each other: Developed economies such as the USA, Denmark, Belgium and Portugal may at times present a deteriorating outlook in the field of food security, as may countries that experience political conflicts such as Yemen and Syria or are dealing with economic crisis such as Venezuela. Furthermore, 12 of the 27 Sub-Saharan countries in the list delivered a declining food security performance in the 8-year period between 2012-2020 and 10 other countries have already been listed as weak performers, two pieces of data demonstrating that the African continent is growing more vulnerable in terms of food security. However, fluctuations in precipitation regimes and rising temperatures as a result of the climate crisis are among the threats that can take food security vulnerabilities out of the African continent and into any other country.

Chart 1: Change in the food security index (selected countries with declining score compared to 2012)



Source: Economic Intelligence Unit, TSKB Economic Research

While Turkey ranks 43rd among 113 countries in terms of food security, it performs below the OECD average in all sub-categories. It ranks 3rd from the last among the European countries, outperforming only Serbia and Ukraine, and 7th among 15 countries from the Middle East and North Africa.

In terms of subcategories, it ranks 65th in affordability, 24th in availability, 43rd in quality and safety, and 53rd in natural resources and resilience. While the quality and safety sub-index is the category that makes the greatest contribution to Turkey's general index score with 78 points, the natural resources and resilience category makes the lowest contribution with 47.4 points.

Chart 2: Food Security Index, Turkey

Source: Economic Intelligence Unit, TSKB Economic Research

1.2 Background

1.2.1 Why Sustainable Agriculture?

According to the most recent statistics by the World Bank, our world is inhabited by 7.7 billion people. The United Nations projections expect the world population to reach 9.7 billion by 2050. On the other hand, the Global Food Crisis report shows that 155 million people in 55 countries around the world were struggling with an acute crisis of hunger in 2020. Increasing population and the threat of a deepening hunger crisis reveal that the widespread use of sustainable production practices in agriculture is important in terms of delivering food to all needy segments of societies.

The development of sustainable agricultural technologies is key not only for the future of mankind, but also for the future of our planet. Agricultural activities are responsible for 18% of global greenhouse gas emissions. Therefore, sustainable agricultural policies focusing on reducing the carbon footprint from agricultural production can also support the struggle against the climate crisis. On the other hand, water intensity is very high in agricultural activities: The food and agriculture sector accounts for 69% of total global water use. From that point of view, supporting sustainable agricultural practices for more efficient use of water may help curb the threat of water crisis.

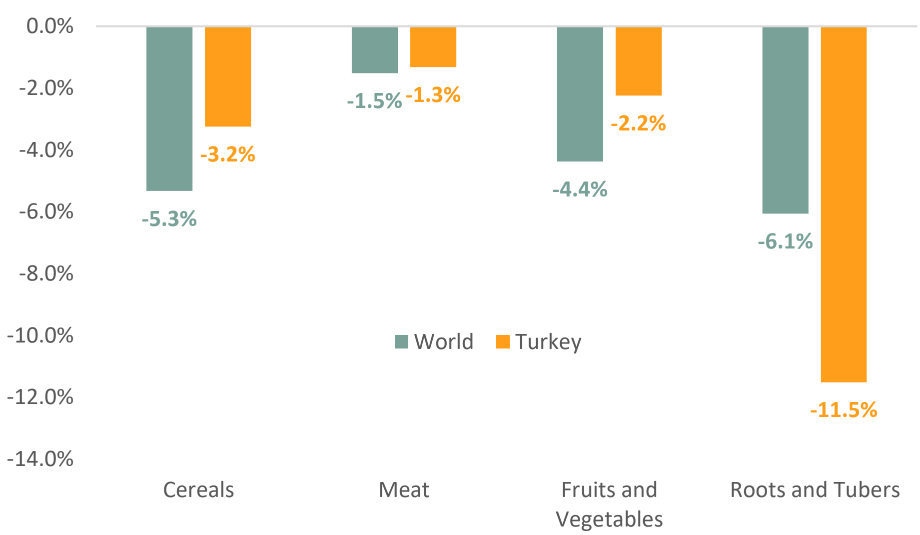
The rise in demand for agricultural products in an environment where the population continues to increase and the fact that harvest losses are more common an agenda item due to the climate crisis both draw public attention to the issue of food security. Supporting sustainable agricultural practices plays a major role among the policy steps to eliminate such vulnerabilities.

1.2.2 Relationship between Agriculture and Climate

The climate crisis intensifies concerns about the future of the mankind. The findings of the 6th Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) show that the surface temperature of the planet was 1,09°C higher between 2011 and 2020 than between 1850 and 1900. According to forecasts, the global temperature increase in the baseline scenario will reach 1.5°C in early 2030s and 2°C in early 2040s. The report states that climate-led extreme weather events will take place "more frequently and more severely" in the upcoming period and also draws attention to the thinning of the seasonal snow cover due to the warming atmosphere, the increasing frequency of heat waves in the seas, and the serious threats on marine ecosystems as a result of acidification in the oceans.

The devastating effects of the climate crisis pose a danger as they may trigger a further decline in the yields of basic agricultural products. The research by the International Food Policy Research Institute (IFPRI) on the impact of the climate crisis on agricultural products found that global annual food consumption per capita will reach 573 kilograms by 2050[12]. However, this may decrease down to 547 kilograms when the effects of the climate crisis are considered. In other words, estimates demonstrate that per capita food consumption in the world may decline by 4.6% due to the impact of the climate crisis.

Chart 3: The Impact of Climate Crisis on Per Capita Food Consumption (%, 2050)*



Source: International Food Policy Research Institute, TSKB Economic Research

*Compared to the scenario where there is no climate crisis

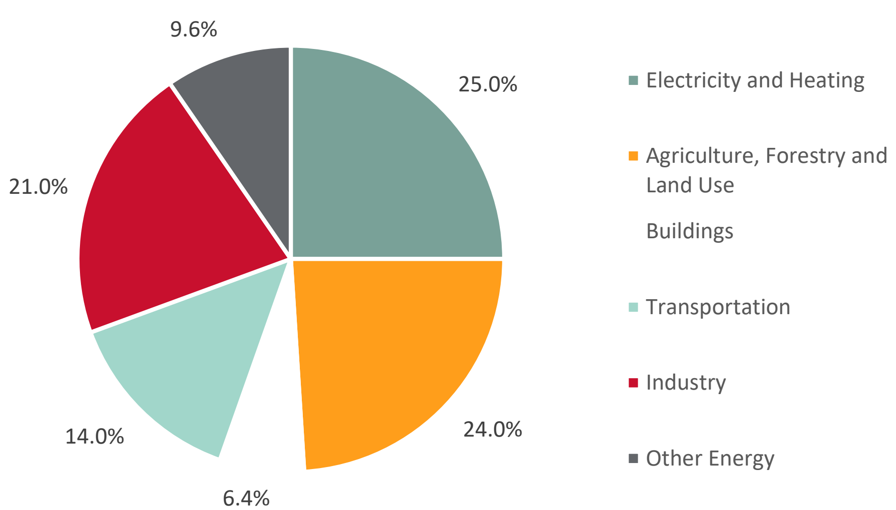
A similar picture prevails in Turkey as well. It is estimated that annual grain consumption per capita in Turkey will be 196 kg, fruit and vegetable consumption per capita will be 367 kg, and meat consumption per capita will be 38 kg by 2050. However, compared to the estimated per capita food consumption levels

[12] International Food Policy Research Institute. (2019). IMPACT Projections of Food Production, Consumption and Hunger to 2050. doi:https://doi.org/10.7910/DVN/BMPQGN

in the scenario where the impacts of the climate crisis are not considered, the said consumption estimates are lower by 3.2%, 2.2% and 1.3% respectively.

Although the climate crisis causes loss of yield in agricultural products, the production and consumption of agricultural and animal products further deepen the climate crisis. Emissions from agricultural production and land use in the world constitute 18% of the total greenhouse gas emissions.

Chart 4: Greenhouse Gas Emissions by Sectors (share, 2014)



Source: Intergovernmental Panel on Climate Change, TSKB Economic Research

However, academic studies show that not only food production, but also consumption and waste cause significant emissions. About a quarter of emissions from the production and consumption of food originate from food spoiled in the supply chain or thrown away by consumers. Therefore, waste food accounts for 6% of the world's emissions[13].

1.2.3 Agricultural Value Chain

The agricultural value chain covers all stages from the fields and greenhouses where basic food sources such as grains, vegetables and fruits are produced to the final consumers. These stages include planting, harvesting, processing, selling, distribution and final consumers respectively.

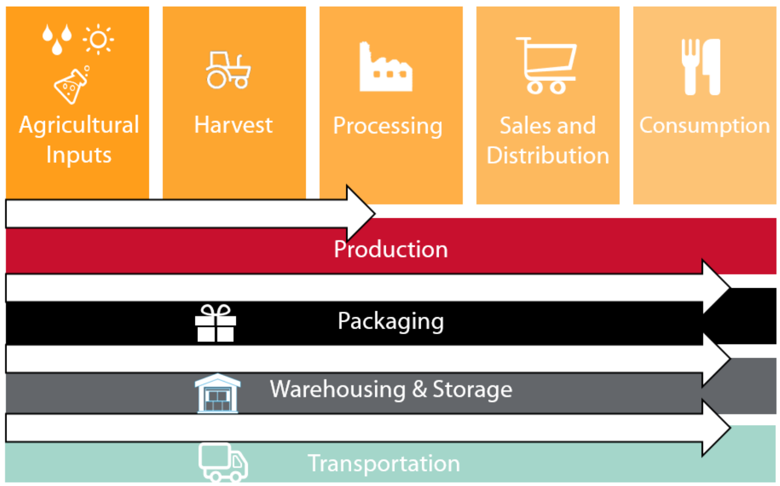
Primary resources, i.e. human, financial and natural resources, are used intensively at all stages of the value chain. These resources include soil, fertilizers, water and minerals in planting and harvesting

[13] J., P., & Nemecek, T. (2018, June 1). Reducing Food's Environmental Impacts Through Producers and Consumers. Science, 360(1), 987-992.

activities as well as secondary resources derived from natural resources such as energy, air, chemicals, raw materials, additives and packaging materials that are used at all stages.

Production, packaging, storage, warehousing and transportation operations cover multiple stages of the value chain. While production activities include fields, greenhouses and food processing facilities, other activities take place throughout the entire value chain.

Figure 2: Agricultural Value Chain



Source: TSKB Advisory Services

In addition to food as the end product of agricultural production, primary and secondary resources are also lost in high amounts due to inefficiencies caused by the supply chain, technology and markets as well as overconsumption.

2. AGRICULTURAL INDUSTRY AND THE CLOSELY-RELATED SECTORS

Sustainability in the agricultural industry should be considered in view of the wider and comprehensive structure of the sector. While the sector addresses the value chain through the concept of "Farm to Fork", the ecosystem that starts with agricultural inputs is closely related to many sub-sectors until reaching end consumers.

In addition to structural issues in the Turkish agricultural ecosystem, the decrease in productivity is also a major problem. These non-productiveness issues start from the planting stage and persist until the last stage when products appear on tables. It is considered that investments to prevent food waste and food loss resulting from decreased productivity will grow even more important and receive highlight in the future. “Food Loss” typically refers to food lost earlier in the value chain stages such as production, harvesting, storage and transportation. While food loss is more intense in the first stages of the chain in undeveloped and developing economies, it is found to be most severe in the last stage of the chain in developed economies.

It is worth noting that food loss in the sector rises up to 50-55% in chains that are not well managed from farm to fork. On a stage basis, losses are as follows:

- Between 4% and 15% during harvest,
- Between 2% and 8% during transport to the point of sale,
- Between 5% and 15% in the lead-up for sale,
- Between 3% and 10% in the storage process,
- Between 1 and 5% in the consumption stage.

In addition, TURKSTAT announced in its statistics on municipal dump sites that food constitutes approximately 55% of all wastes in Turkey, followed by plastic wastes with 12% and paper/cardboard wastes with 11%.

Therefore, it is considered that any future steps in the related main sectors under "Sustainable Agriculture" and their sub-sectors will serve the sustainability of the sector as a whole. The report shares information on the outlook and size of the main sectors with which the agricultural sector is closely related as well as the main sub-sectors of those main sectors. It also evaluates key “sustainability” trends and investments in the sub-sectors. Related main sectors and their sub-sectors are presented in the table below.

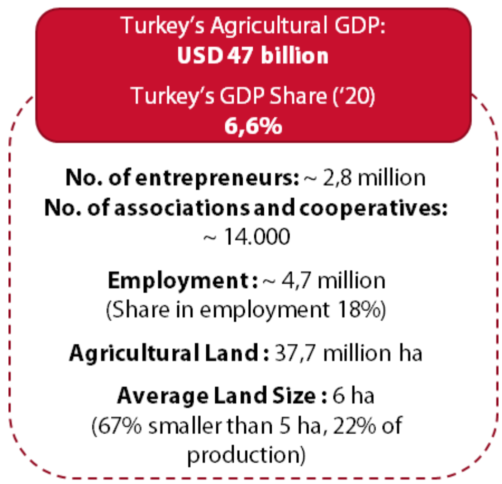
Figure 3: Sectors Related to the Agricultural Industry

Source: TSKB Advisory Services

2.1 Agriculture

The agricultural industry has two main sub-sectors. Namely, these are crop production and animal production. Agricultural GDP in Turkey was USD 47 billion in 2020, and its share in total GDP was 6.6%. The agricultural industry employs 4.7 million people, and its share in total employment is around 18%. The size of the agricultural industry in various aspects is presented in the figure to the right. Crop production in Turkey was at a similar level between 2017 and 2021, and agricultural planting slowed down in the 2020-2021 production season due to severe drought and the COVID-19 pandemic. Therefore, when the sub-categories of crop production are considered, it is calculated that the production of cereals and other herbal products decreased by 13% in 2021 year on year.

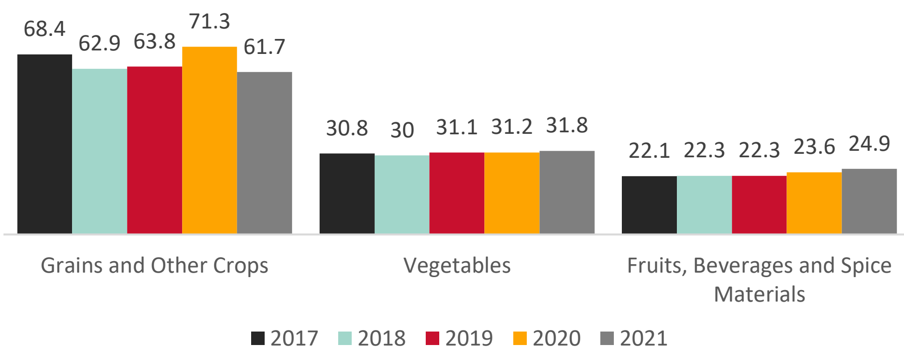
Figure 4: Basic Size Information for the Agricultural Industry



Source: Turkstat, Republic of Turkey Investment Office, TSKB Advisory Services

The growth of crop production on the basis of sub-categories is presented in the chart below.

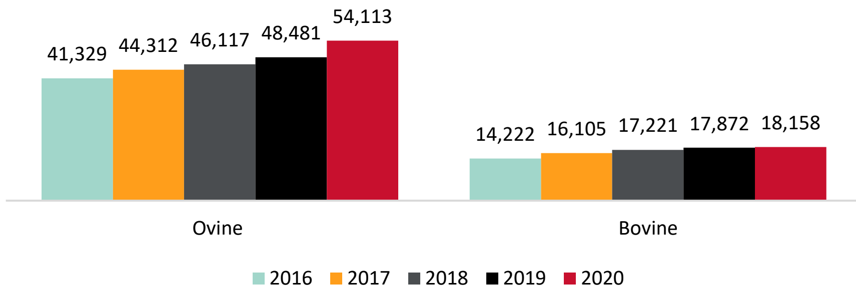
Chart 5: Growth of Crop Production in Turkey (million tons)



Source: Turkstat, TSKB Advisory Services

The growth in Turkish crop production is horizontal, but livestock population continues to rise in terms of animal production. The chart showing Turkey's livestock growth is presented below. While there is a busy, import-oriented outlook in the livestock and red meat categories, which are sub-sectors of the industry, there is an export-oriented outlook in the poultry sector. On the other hand, raw materials for feed, which are crucial for livestock activities, are procured through imports.

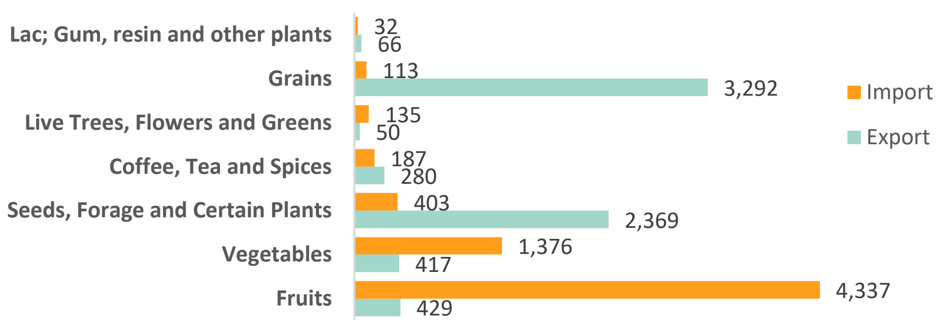
Chart 6: Growth of Livestock in Turkey (thousand)



Source: Turkstat, TSKB Advisory Services

While the agricultural sector in Turkey is basically divided into two as crop and animal production, there are various sub-sectors on a category basis in these two production areas. An analysis of the foreign trade composition of the crop production sector shows the sub-sectors with the largest potential. The crop production sector has a foreign trade surplus and is a net exporter. However, it is also observed at times that it is either a net exporter or a net importer on the basis of sub-sectors. The sectoral growth of foreign trade by sub-sectors and quantity in the first 11 months of 2021 is presented in the chart below.

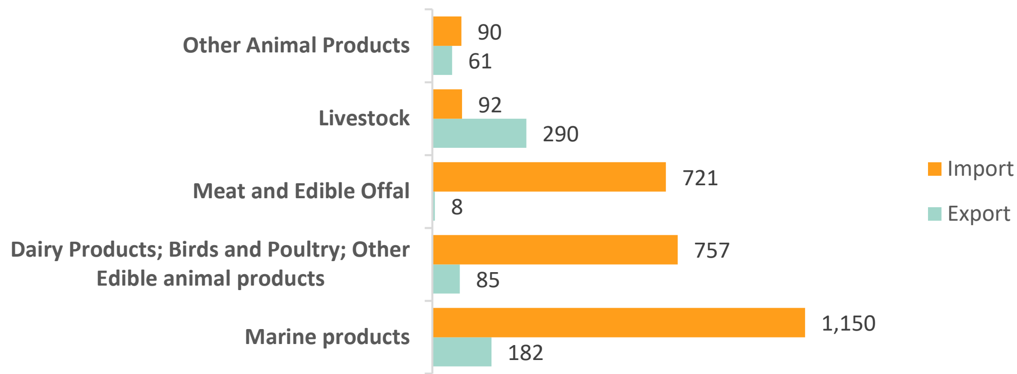
Chart 7: Foreign Trade of Turkish Crop Production Sector (USD million, First 11 Months of 2021)



Source: Turkstat, TSKB Advisory Services

An analysis of the foreign trade composition of the animal production sector shows the sub-sectors with the largest potential. The animal production sector has a foreign trade deficit and is a net importer. However, it is also observed at times that it is either a net exporter or a net importer on the basis of sub-sectors. The sectoral growth of foreign trade by sub-sectors and quantity in the first 11 months of 2021 is presented in the chart below.

Chart 8: Foreign Trade of Turkish Animal Production Sector (USD million, First 11 Months of 2021)



Source: Turkstat, TSKB Advisory Services

Various sustainability investments in the agricultural industry aim to eliminate decreased productivity and reduce food waste and losses. The related investments focus on restructuring the production and supply chain. Vertical agricultural production and soilless agriculture are among relevant examples. Furthermore, biomass investments making the recycling and reuse of wastes possible as part of renewable energy investments receive highlight. Other emerging investments in the sector generally fall under the categories of R&D and technology. Key investments particularly include the production of cultured meat to identify alternative protein sources and the establishment of agroecology living laboratories to contribute to a decline in the consumption of pesticides and fertilizers. In addition, technology investments include investments that will contribute to the use of all technological means in the agricultural industry, which brings together and employs fast Internet access, precision agriculture and artificial intelligence.

2.2 Food and Beverages

The food and beverages sector in Turkey is fragmented and is dominated by SMEs. Turkstat data for 2019 indicates that the turnover of the sector is USD 66.7 billion, and the number of companies in the sector is 51,987. In addition, the ISO 1000 list announced in 2020 includes 204 companies operating in the food and beverages industry.

Considering the foreign trade performance of the sector, it is concluded that the sector is a net exporter. Due to seasonality in operations and the working conditions in retail channels, the need for working capital is significant.

Production in the food and beverages industry has grown by approximately 3-5% in the last 5 years. The production index and CUR growth for the food and beverages sectors are presented in the charts below.

Chart 9: Food Production Index and CUR Growth

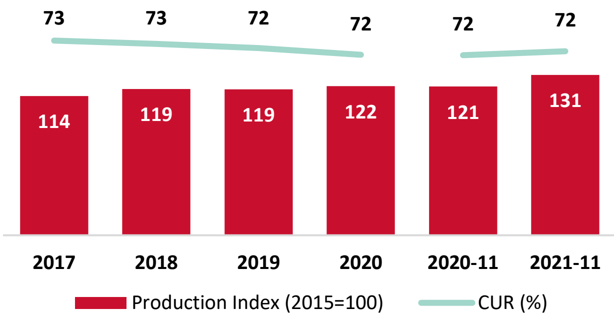
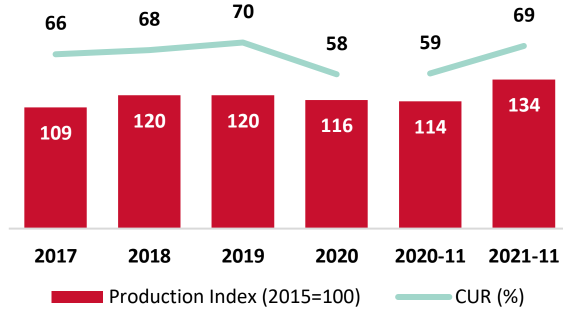


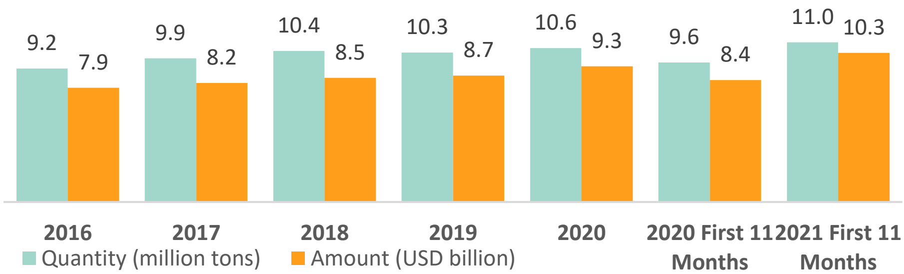
Chart 10: Beverage Production Index and CUR Growth



Source: Turkstat, CBRT, TSKB Advisory Services

Between 2016 and 2020, Turkey's compound annual growth rate in food and beverage exports rose by 4%. During these years, the most exported product groups were pastry products, vegetables and fruits. The exports of the food and beverages sector, which displayed a limited growth in 2020 due to the pandemic, increased by 22.6% in terms of amount year on year in the first 11 months of 2021 to reach USD 10.3 billion.

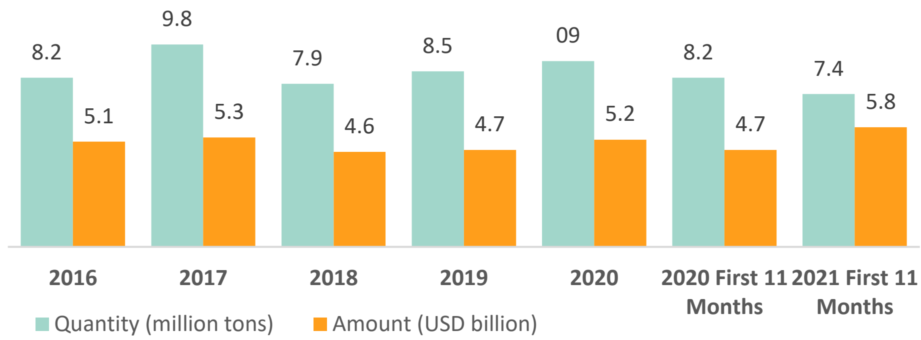
Chart 11: Growth of Exports in Turkish Food and Beverages Industry



Source: Turkstat, TSKB Advisory Services

Between 2016 and 2020, Turkey's compound annual growth rate in food and beverage imports rose by 0,5%. The most imported product groups during these years were animal and vegetable fats and oils, residues and wastes of the food industry, and coarse fodder for animals. Food and beverage imports presented a limited growth in 2020 as a result of the increase in global food and commodity prices due to the pandemic, before increasing by 23% in the first 11 months of 2021 year on year and reaching USD 5.8 billion.

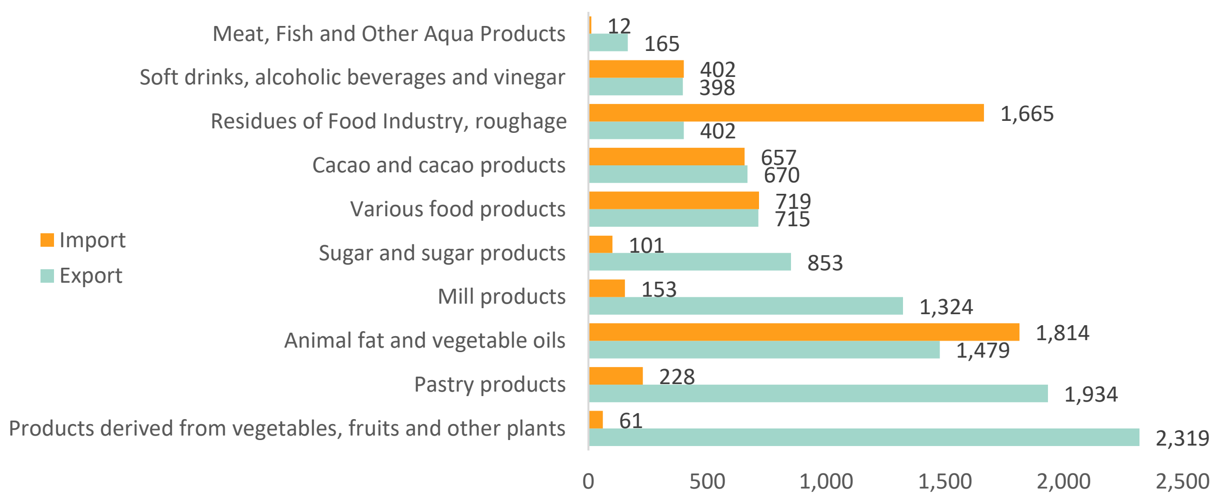
Chart 12: Growth of Imports in Turkish Food and Beverages Industry



Source: Turkstat, TSKB Advisory Services

The Turkish food and beverages industry has many sub-sectors. An analysis of the foreign trade composition of the food and beverages sector shows the sub-sectors with the greatest potential. The food and beverages sector has a foreign trade surplus and is a net exporter. However, it is also observed at times that it is either a net exporter or a net importer on the basis of sub-sectors. The sectoral growth of foreign trade by sub-sectors and quantity in the first 11 months of 2021 is presented in the chart below.

Chart 13: Foreign Trade of Turkish Food and Beverages Sector (USD million, First 11 Months of 2021)



Source: Turkstat, TSKB Advisory Services

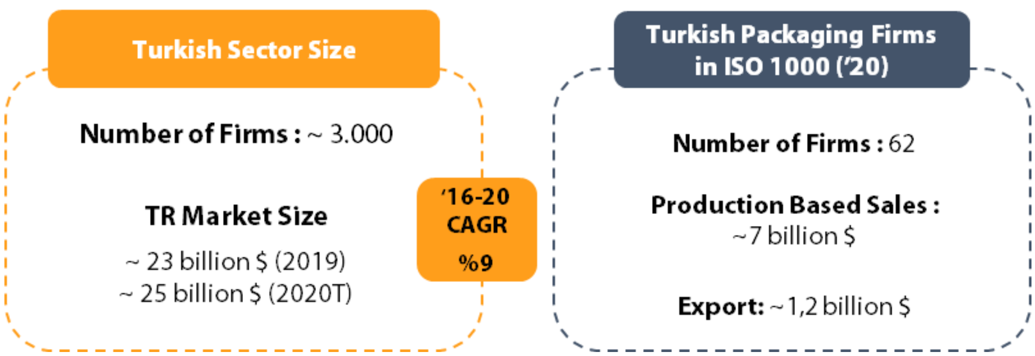
In the food and beverages sector, sustainability investments mainly focus on food safety and traceability as well as R&D and automation. Regarding food safety and traceability, investments aim to secure the transparency and sustainability of the products in the supply chain. For R&D, product differentiation is performed, followed by investments on new generation dietary habits (supporting the immune system, focusing on high proteins and plants, etc.) demanded by consumers. For automation, process equipment and packaging investments stand out.

2.3 Packaging

The packaging process is an integral part of food production. Packaging protects food products, prevents degradation of their properties and enables their transportation. Therefore, the food and beverages industry holds a key position in the packaging industry. In addition to the food and beverages industry, the use of packaging is quite intensive in cosmetics, pharmaceuticals and chemistry sectors. Efforts to improve quality in the packaging industry and the rationalization of the main and auxiliary materials used in production as well as environmental compliance measures are still in place.

By the end of 2020, Turkish packaging industry is expected to reach a size of almost USD 25 billion. Furthermore, the ISO 1000 list announced in 2020 includes 62 companies operating in the food and beverages industry. Summary indicators for the year 2020 in the Turkish packaging industry are presented in the tables below.

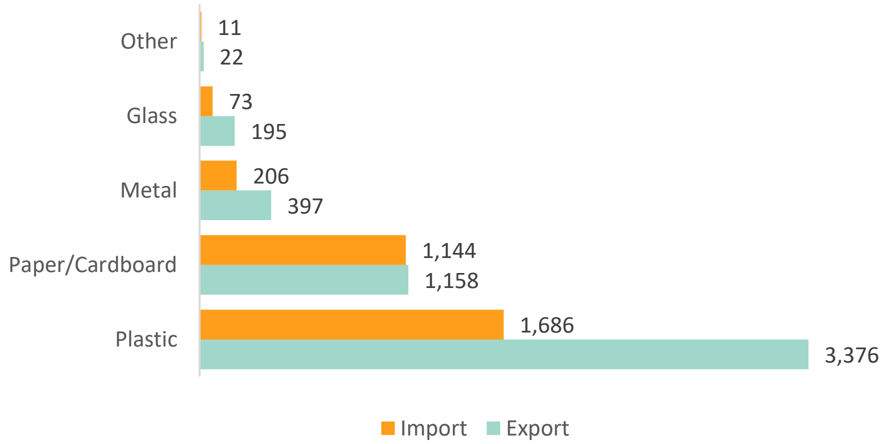
Figure 5: Summary Indicators for Turkish Packaging Industry



Source: ASD, TSKB Advisory Services

An analysis of the foreign trade operations in the Turkish packaging industry indicates a general foreign trade surplus in all sub-sectors, with the industry being a net exporter. Plastic packaging ranks the first in the sector's foreign trade as well as production. Plastic and paper/cardboard packaging are categories that are used extensively for agricultural and food products. The growth of foreign trade in the Turkish packaging industry in the first 11 months of 2021 is presented in the chart below.

Chart 14: Foreign Trade of Turkish Packaging Sector (USD million, First 6 Months of 2021)



Source: ASD, TSKB Advisory Services

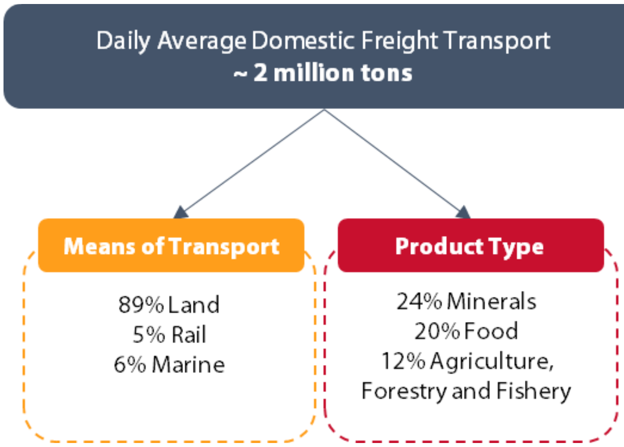
Some investments on raw material exchange and recycling, following the sustainability theme, have been made in the packaging industry. Other investments have also been made to enable the use of plant materials (biopolymers) in plastic packaging, which has an important share in the sector, as well as the production of renewable plastic packaging. In addition, design improvements have also been invested in. Thus, resource efficiency can be achieved by reducing packaging materials. Design improvements also eliminate space problems during transportation, save fuel and facilitate storage.

2.4 Logistics and Retail

The logistics sector assumes a key role at every stage of the value chain in the agriculture and food sector in Turkey, while the retail sector plays an important role in the transportation of products to consumers. Therefore, the steps to be taken in the logistics and retail sectors indirectly contribute to sustainable agriculture.

Although freight transportation has an important place in the Turkish logistics sector, approximately 89% of freight transportation is done by road, 6% by sea and 5% by rail. It is estimated that approximately 2 million tons of cargo is transported in Turkey on a daily basis. 20% of such cargo consists of food products, while 12% consists of agricultural, forestry and fishery products. Summary indicators for freight transport are presented below.

Figure 6: Summary Indicators for Turkish Logistics – Freight Transport Sector



Source: LODER, TSKB Advisory Services

Certain fleet/warehouse and technology investments for sustainability have been made in the freight transportation sector. Investments in cold storage and refrigerated vehicles for the cold chain, which is especially important for agricultural and food products, have been made as well as technological investments for route and load optimizations to provide cost advantages.

The share of the Turkish retail sector in GDP is around 20%. Food retailing is not affected from economic activities as much as general retail trade since food products are an essential requirement. In the first 11 months of 2021, the general retail trade sales volume index recorded a double-digit growth owing to the demand which was delayed due to the COVID-19 pandemic. The growth of the general retail trade and the food retail sales volume index is presented in the chart below.

*Chart 15: Retail Sales Volume Index Change**
(2015=100, fixed prices, seasonally-adjusted, avg.)

*The averages are provided for the years 2016-2020, while the change is calculated based on November data in Nov 2021.

Source: Turkstat, TSKB Advisory Services

Certain supply chain/logistics and technology investments for sustainability have been made in the retail sector as well. In particular, warehouse and distribution center investments for distribution to retail channels as well as vehicle investments to provide access to end consumers/sales points are present. Regarding technology investments, software investments for digital transformation and e-commerce sales channel receive highlight.

3. FINANCING SUSTAINABLE AGRICULTURE

3.1 Potential Investment Areas

Investments directly and indirectly supporting sustainable agriculture in addition to activities on the value chain are delivered in various areas to increase primary and secondary resource efficiency and prevent loss and waste.

Potential investment areas can generally be grouped under the following headings:

- Increasing sectoral adaptation of drip irrigation systems: capacity investments towards production and trade of necessary equipments
- Increasing agricultural mechanization: production of tractors, tractor attachments, farming equipment
- Electric or hydrogen-powered & refrigerated transportation fleets
- Increasing warehousing capacity and quality: climate-controlled warehouses instead of open air or inadequate indoor storage
- Precision (intelligent) farming applications
- Renewable power generation and storage
- Environmentally-friendly, biodegradable packaging materials with a low carbon footprint
- Chemical additives causing less damage to nature
- Energy and resource-efficient processes
- Effective waste management
- Green supply chain

These headings also include innovative approaches to the development of new production technologies, materials and management methods. Investments can only bear positive results if technological advances are complemented and combined with the right legislative support, incentives and financial mechanisms in a way that creates synergy. The application of globally-popular technological trends such as renewable power generation, energy storage, electrification, hydrogen economy and digitalization to sustainable agriculture creates major investment opportunities in terms of productivity and increased income.

Precision agriculture can be summarized as an innovative agricultural production approach that combines machinery and equipment which work in a coordinated and interconnected manner over the Internet with digital monitoring and control technologies and incorporate trends such as dry farming and vertical farming. Precision agriculture includes AI-backed analysis and estimation tools, sensors measuring the parameters that affect the yield and product quality in farms and greenhouses, and remote monitoring and management technologies which enable the translation of field data into meaningful information using big data analytics. New generation machinery and equipment developed as part of precision agriculture increasingly employ technologies such as electricity, hydrogen fuel and energy storage in line with the themes of transition to low carbon economy and clean energy.

Packaging investments consist of R&D activities by new technology material developers as well as process investments by manufacturers using packaging materials. Industries such as food and beverages, cleaning, cosmetics and chemicals are turning to the economic and ecological design of plant-based materials instead of plastic packaging that pollutes the nature. In parallel with the increasingly-popular circular economy, material producers, food processing plants and end consumers prefer environmentally-friendly packaging more while supporting less consumption as well as recycling and reuse of packaging materials that have a negative impact on the environment.

Figure 7: An "Agrivoltaic" application

Source: www.pv-magazine.com[14]

Figure 8: Plant-based bioplastic bottles

Source: www.thedieline.com

In terms of the supply chain, licensed cold storage has gained greater significance in recent years and helps reduce the losses in storage and transportation stages. Climate-friendly investments such as digital technologies tracking the route that products follow until they reach end consumers as well as tracking energy and resource utilization at each individual stage, combined with machinery and equipment selection to increase energy and resource efficiency, provide companies with significant efficiency gains in the long run. The transition to electric/hydrogen fuels in vehicles such as trucks, trains, airplanes and ships preferred in international and overseas food and agricultural product transportation, and the use of sustainable aviation fuels (SAFs)[15] such as plant-based bioethanol in aviation are other factors supporting the development of a green supply chain.

[14] The system design that combines solar power generation and agricultural activities is called agrivoltaic and has been attracting an increasing amount of investment in recent years.

[15] Sustainable aviation fuels can be derived from plant-based sources such as algae, camelina, jatropha, halophytes and cellulosic wastes as well as from domestic wastes and waste oils. Many airline companies currently use SAFs by mixing them with kerosene, the traditional jet fuel, at certain ratios. Rolls Royce performed a successful test flight using 100% SAFs on a Boeing 747 jet for

Figure 9: Dry farming site in Lisinia, Burdur

Source: www.winally.com

4. SUSTAINABLE AGRICULTURAL PRACTICES AND TECHNOLOGIES

Agriculture is a strategic sector because it sets the first step in industrialization thanks to the economic value, employment and investment volume it creates directly or through its related sectors.

Our environmental problems have become more evident in the aftermath of the global climate crisis and stipulate sustainability in agriculture as well as in all sectors. Looking at the historical development of the agricultural sector, it is found that mechanization sets the first instance of parting ways with traditional, labor-based agriculture. Today, mechanization is bolstered by digital infrastructures allowing sustainability-based precision agriculture practices.

Agricultural research continues apace to ensure that best practices and technologies are identified, developed and applied in the field to optimize yield, product quality and natural resource use, with continuous improvement being made in these areas. A key factor that enabled the economic breakthrough in China in the second half of the last century was the induction of a large population into the middle income group by redressing poverty through progress in agricultural production. Today, countries such as the Netherlands and Israel not only lead the development of agricultural technologies but also feed their populations with high quality food thanks to their agricultural knowledge and technology, all the while exporting huge amounts of agricultural inputs and products compared when their surface area is concerned.[16] The most industrialized countries such as the United States and Japan are also leaders in sustainable agriculture.

---

the first time in October 2021. The global aviation industry is responsible for about 2% of greenhouse gas emissions. The use of plant-based SAFs is considered carbon-neutral, as it will practically release the carbon captured by the plants during their lifetime. It is possible to assume that raw materials such as domestic wastes and waste oil will have even greater positive effects. The global SAF market has a size of USD 72 million in 2020, and the industry is expected to grow at a high pace to reach a value of USD 6 billion by 2030 (source: Allied Market Research)

[15]With its annual agricultural product exports standing at USD 79 billion, the Netherlands ranks 2nd only behind the US. (source: www.investopedia.com)

[16] With its annual agricultural product exports standing at USD 79 billion, the Netherlands ranks 2nd only behind the US. (source: www.investopedia.com)

4.1 Examples of Best Practices

4.1.1. Soil, Fertilizer, Seed and Minerals

The key features of industrial agricultural production include high yields by planting the same products every year in large fields and greenhouses, and the use of fertilizers and chemicals in high quantities. Although large-scale production bears positive results in terms of high yield and standard product quality, it leads to a loss of minerals in the long run, thereby causing soil degradation, as well as invoking erosion and soil loss consequently. In addition, it is a form of production with a high environmental and carbon footprint due to intensive water consumption and the use of machinery and equipment operating on fossil fuels.

The rapid decrease in the total area of arable land and the deteriorating soil quality aggravate the pressure of food security on the increasing world population every year. Therefore, the accurate preparation and maintenance of field and greenhouse soil for agricultural activities are critical. Considering that the main cause of global forest loss is the cutting down of trees to open agricultural areas, the importance of using the soil correctly and efficiently is made evident once again.

Some of the best agricultural practices that ensure the protection and quality enhancement of soil, air, water and minerals, i.e. the most important natural resources for agriculture, are grouped under the concept of "restorative agriculture".

Nitrogen, phosphorus and potassium are major soil minerals, and they are the most important nutrients for plant growth and quality. Nitrogen is essential for plants, as it is a part of the chlorophyll molecule, which enables plants to produce food and energy using sunlight and carbon dioxide, and is also an element found in amino acids that form proteins - the building blocks of life. During the pre-industrial era when the natural balance was preserved, the nitrogen cycle in the world was sufficient to nurture the agricultural lands. However, the use of nitrogen-containing fertilizers and chemical input materials is needed in agricultural production since the post-industrial developments have caused the natural balance to deteriorate significantly[17]. Nitrogen-retaining bacteria (rhizobia and similar ones) in the soil are beneficial for both the soil and the crops grown. Planting cover crops such as alfalfa bring benefits such as retaining nitrogen and other minerals in the soil and preventing algae growth as well as erosion.

Phosphorus is the second most important soil mineral after nitrogen. Unlike nitrogen, phosphorus and potassium cannot be produced synthetically. Natural mineral rocks are used as sources of phosphorus and potassium. Phosphorus is required for all metabolic processes related to plants such as photosynthesis, respiration, energy transfer, rooting, seed formation and disease resistance. However, prolonged and extensive external supplementation by phosphorus leads to eutrophication, killing beneficial microbial life.

When choosing fertilizers, the types of products produced in the field or greenhouses should be taken into account, and the right fertilizer should be used to the required extent. It is calculated that

[17] Developed by the German chemists Fritz Haber and Carl Bosch in 1909, the Haber-Bosch process allowed for the production of synthetic fertilizers containing ammonia through nitrogen synthesis from the air. This revolutionary invention in agriculture ended the trade of bird droppings (guano), which had been used for ammonia fertilizers for many years and was one of the most valuable commodities of the period, and laid the foundations of agricultural chemistry. Haber and Bosch won the Nobel Prize in Chemistry in the following years.

approximately 60% of all fertilizers used globally are lost through coalescence into the nature. Excessive use of fertilizers deteriorates the soil quality, pollutes the underground and surface water resources, and creates huge economic losses due to wastage. The use of biochar, the natural output of some specific types of biomass power plants (BPP), as a fertilizer is both very nutritious for the soil and an effective circular economy practice in terms of reuse of wastes. Care should be taken to store fertilizers in dry and clean areas.

Large-scale industrial agriculture practices concentrating on single crop cultivation increase the risks of eutrophication and erosion as mentioned above. Recommended best practices for soil health include choosing and planting local products fit for the geographies where the fields and greenhouses are located, rotating crops over the years, and fallowing for pre-planned durations. In the selection of seeds and seedlings, genetically modified plants should be avoided whenever possible, and species that adapt to the local climate and soil structure and have high pest, disease, temperature and drought resistance should be selected.

It is a productivity-enhancing practice to attract living organisms such as ladybugs and bumblebees, which pollinate plants, to fields and greenhouses. It is important to monitor the variety and density of poultry and insects in the field and greenhouse and to use the right type and amount of pesticides depending on the presence of beneficial and harmful living organisms. Attention should be paid to the formulation and active ingredients of pesticides. Products that cause the least harm to natural life and the environment should be selected, and their use should be kept under strict control.

The best way to combat the living organisms and weeds that harm agricultural products is by detecting natural enemies and attracting them to fields and greenhouses. Since the use of pesticides and chemicals causes adverse effects on biodiversity and the environment in any case, pest control using natural enemies stands out as the best option for the protection of biodiversity, natural vegetation and product diversity.

The correct preparation of the soil is critical for the preservation of soil health and the harvest of high yield and quality products in the long run. Proper aeration of the soil helps maintain its mineral and carbon-retention capacity, but overplowing for aeration purposes leads to the loss of soil minerals. Therefore, the soil needs to be aerated at the right time and to the correct extent. Irrigation to restore the moisture lost by the soil in the dry season, planting suitable seedlings to prevent loss of carbon retention capacity in areas with heavy winds, using windbreakers and cleaning weeds from the soil are other best practices recommended for soil preparation.

Preventing soil losses due to erosion and eutrophication is vital for sustainable agriculture. To that end, it is required to raise the knowledge and awareness levels of stakeholders on the entire value chain, particularly starting from the farmers engaged in agricultural production in fields and greenhouses, and to mainstream best practices. Sustainable agriculture is of vital importance for the protection of natural ecosystems and living life, and for mitigating the impacts of climate change, while producing agricultural products of high quality and quantity.

4.1.2. Water

It is estimated that one out of every two people in the world will suffer from water stress by 2050. The agricultural value chain is estimated to be responsible for 69% of global water use. Although the use of best agricultural practices and climate and environmentally-friendly technologies continues to become widespread, traditional farming methods are still used in most of the agricultural activities. From a water point of view, it is seen that the use of water in agriculture is largely in the form of wild irrigation, which causes wastage and the depletion of natural resources.

Drip irrigation is an alternative to wild irrigation and refers to the particular technique of feeding water to the soil and plants in drops through the drainage holes opened in the pipes or hose installations laid in fields and greenhouses. Drip irrigation has been used for many years. It is a technology representing widespread technological knowledge and is simple to install. However, small-scale farmers suffer from high costs and barriers regarding access to finances for the installation of a drip irrigation infrastructure, a problem persisting in our country as well as the rest of the world.

Driven by today's technology, drip irrigation systems can be integrated with Internet-based digital infrastructures. The data from sensors measuring the temperature and humidity of the soil and the drone and satellite images obtained are processed by computer algorithms to estimate and calculate the sugar and water amount carried by the plant body. Such data is transmitted to the control mechanisms of drip irrigation systems, enabling automatic and precise water supply to only those points needing water, thus allowing for greater economy and savings. Irrigation of soil and plants at the right time and to an accurate extent is critical for yield and product quality.

Figure 10: Drip irrigation technique

Source: www.marketresearch.biz

Numerous public, private and NGO projects are run both globally and nationally to replace wild irrigation with drip irrigation, backed by research and studies to reduce water use in agriculture and increase water efficiency.

4.1.3. Machinery and Equipment

Best sustainable agriculture practices include many sub-items, and mechanization in agriculture can provide positive contributions reducing human labor and increasing application efficiency. In addition to tractors with advanced features, today's agricultural technology allows for the manufacturing of attachments for tractors or independent machinery and equipment that can plant seeds and seedlings, hoe, spray pesticides, till, spade, top-dress with fertilizers and even harvest, which are manually performed in traditional agriculture.

Mechanization in agriculture offers significant gains in terms of yield and product quality compared to traditional agriculture, and it is a technological transformation that has risen considerably, especially in industrialized countries. The use of technological machinery and equipment in agriculture stands out as an accelerator for the diversification and dissemination of best agricultural practices.

Overall, there is a significant relationship between the level of mechanization and the average size of agricultural land. Mechanization can be technically applied more easily in large pieces of land, and therefore, this transformation can be financed relatively easily in agricultural production units with high income. The small and scattered nature of agricultural fields, which is a major structural issue for our country in agriculture, constitutes an obstacle to mechanization.

Figure 11: Wheat harvesting and pre-processing

Source: Agco

Figure 12: A product-specific tractor attachment

Source: John Deere

4.1.4 Labor

The agricultural sector has traditionally provided a higher employment compared to its share in the gross domestic product. The most common employment problems of the sector are the high level of informal employment, the low share of farmers and producers in commercial incomes in a complex and multi-player supply chain, the low education levels among agricultural workers, and the high rate of child labor and illegal workers. However, there are also masses of people who quit agricultural production since the input costs in the agricultural sector have increased excessively due to import dependency and global commodity prices, and the profit margins of farmers have decreased significantly. These issues are also experienced in agriculture and its related sectors in our country. Cooperatives and professional organization, which are a key component of finding solutions to problems, are not sufficiently common and effective.

Eradicating poverty and decent work, two of the UN Sustainable Development Goals, are regarded as goals that are directly related to the problems experienced in agricultural labor. Seasonal agricultural workers in our country are employed for work under challenging conditions, for minimal fees or for peanuts, and minors are forced to work in the fields instead of attending education. These are problems that cause public sensitivity and require urgent solutions. Similar issues are observed in many underdeveloped and developing countries around the world.

2019 data by the International Labor Organization (ILO) shows that there are 152 million child workers in the world, 73 million of whom are in "hazardous work". This means that one out of every 10 children is employed as a worker. By far, agriculture ranks the first in child labor with a rate of 70.9%.

Figure 13: Child workers on the farm

Source: Niğde News

On agricultural employment, policy makers, professional organizations and supply chain stakeholders need to come together and produce common solutions. Here are some best practices to implement in terms of labor:

- Ensuring that workers in the agricultural value chain work under healthy working conditions
- Securing legal guarantee for workers’ rights
- Establishing cooperatives and professional organizations that will effectively protect the interests of farmers against traders and large food businesses
- Ensuring that farmers earn a fair income in return for the agricultural products they produce.
- Increasing the education levels of the personnel employed to ensure equal economic opportunities
- Preventing rural flight by securing and enhancing rural development
- Rendering agricultural activities appealing for people seeking employment

4.1.5 Processing of Agricultural Products

Food and agricultural product processing facilities that process agricultural intermediate products and turn them into finished products for end consumers produce industrial type and scale of products. Products such as milk and dairy products, seafood, meat, vegetables and fruits, vegetable and animal oils, animal feed, fertilizers, cereal products and starch are produced in these processing facilities. When sectors interacting with agriculture are considered, plastic, paper, cardboard, glass and metal packaging manufacturers, livestock products, and processing plants that produce textile products from wool, cotton and natural fibers are also considered in that category.

Industrial facilities set the second layer in the value chain after fields and greenhouses, and there are certain focal points for sustainability regardless of sector and product:

- Energy efficient production
- Raw material and water efficiency
- Efficiency and value-added digital transformation applications
- Industrial transformation compatible with circular economy
- Traceability product life cycle approach with a “cradle to cradle” perspective in raw materials and finished products
- Nature, environment and climate-friendly materials
- Supporting small producers to implement best agricultural practices

Based on that perspective, all investments and improvements that touch the focal points are considered as activities falling under the scope of sustainable agriculture. For instance, purchasing energy-efficient electric motors at a cheese factory, investing in equipment and treatment solutions at a textiles factory to reduce and reuse wastewater, or establishing rooftop SPPs to meet a certain part of the internal consumption at a meat factory are all investments to improve sustainability. All facilities that directly process agricultural products and produce products that constitute input for the production of finished products should make investments to satisfy the aforementioned focal points and establish relevant management and control systems, regardless of the sector and mode of production.

Figure 14: Orange washing line

Source: Verfood Solutions

Figure 15: Automatic milking machine

Source: www.gea.com

The transformation of the industry to realize a clean and circular economy is one of the main strategies of the EGD. It is thus of great importance to make the necessary investments and to realize process transformations in order to reduce the use of raw materials and natural resources, and to recycle and reuse them in accordance with the circular economy principles.

Collecting field data at every stage of production and establishing digital monitoring and management infrastructures to transform the acquired data into meaningful and actionable information are critical technology approaches to ensure sustainability and minimize the effects of climate change. As the use of digital transformation for this purpose increases, it is better understood that the creation of sustainable industrial structures is an indispensable element.

4.1.6. Packaging, Storage and Transport

The value chain stages between the processing of agricultural products into finished products and their delivery to end consumers differ depending on the structure of the product, region and supply chain. It is calculated that 10-30% of the total production is wasted during the packaging, storage and transportation stages.

Such losses are closer to the upper limit of the scale, particularly in countries with an underdeveloped storage and transportation infrastructure, and these countries also experience the most intense risk of food security, causing a great vulnerability. The level of food losses at these stages is also high in our country. The main sources of problems include the following:

- storehouses and warehouses lacking the infrastructure to keep products at the right temperature, light and humidity levels,
- outdoor storage operations where the aforementioned infrastructure is not available,
- absence of refrigerated vehicles or inadequate equipment in the supply chains of products such as meat, poultry, fish, milk and dairy products that need to be transported within a cold chain.

In recent years, investments in warehouses with infrastructures that allow suitable storage conditions for large industrial organizations, particularly in parallel with the licensed warehousing legislation, are regarded as relevant positive developments.

Figure 16: Rooftop SPP at a cold storage

Source: Dorte Food

Manufacturers of packaging materials perform R&D activities and make relevant investments to reduce production costs and contribute to the environment and sustainability, to develop biodegradable materials, to reuse recycled materials as raw materials and to reduce material volume and weight. Public awareness-raising campaigns to feed waste paper, cardboard, plastic and glass packaging products back into production, and the implementation of appropriate legislation and incentives to increase the amount of collected materials have emerged as contributing factors. The production technologies of paper and glass packaging materials allow for the use of up to 100% recycled materials as raw materials. In plastic packaging production, cost reductions that will enable the transition of bio-based plastics rather than fossils to economies of scale can be attained in different technologies. However, such technologies cannot be commercialized at desired levels due to the lack of legislation and incentives. From this point of view, it is the management styles, public awareness, behaviors and habits rather than technological investments that bear significant importance in establishing environmental and circular industrial structures.

Similar problems are also experienced in the fields of land, air and sea transportation. In order to perform environmentally-friendly transportation operations, vehicles using fossil fuels must be replaced with vehicles with electric motors or hydrogen fuel cells, and the required electrical energy must be obtained from renewable energy sources such as wind and sun. 16% of global greenhouse gas emissions originate from transportation, and commercial transportation as well as the associated transportation activities that serve agricultural trade also have a significant share in the total. From that perspective, a critical component of sustainable agriculture is clean and environmentally-friendly transportation operations.

4.1.7. Sales and Consumption

The World Health Organization data suggests that 600 million people suffer from diseases caused by the consumption of contaminated food every year, while 420,000 die of the same cause. The USA has the most reliable food supply chain in the world, but still, one out of every six people in America experience food-borne poisoning every year, while 128,000 are hospitalized and 3,000 die.[18] Among the main causes of food poisoning and food-borne diseases are bacteria, viruses, parasites, molds, toxins, allergens and pollutants making their way into the human body due to improper production, processing, warehousing and storage conditions. Although food safety is important at every stage of the agricultural value chain, the most critical stages are apparently the sales and consumption stages.

Agricultural products are sold through small-scale and chain markets, retail stores and electronic channels. In order to prevent product deterioration and ensure efficiency in sales channels, the first step is to install refrigerators and coolers at sales points, which ensures that products are kept in healthy conditions. It is required to establish the infrastructures that offer appropriate storage conditions, particularly to deliver the products transported in cold chain to end consumers without any deterioration or spoilage.

The last link of the sustainable agriculture value chain is the points of final consumption. A great deal of food waste occurs at food consumption points by humans. The major causes of food waste are as follows:

- overbuying,
- serving size at restaurants, hotels and similar mass consumption points being too big,
- failure to sell products before the expiration date due to inadequate planning,

[18] Source: US Federal Government

- consumers having acute expectations in terms of size, shape and color in products sold in markets and greengrocers,
- accidents and carelessness during product handling.

Considering that huge amounts of food - almost one third of global production - go to waste without being consumed, it is critical to bring about behavioral changes in consumers to prevent food waste by increasing the education and awareness levels of consumers and service providers at the consumption stage.

Figure 17: Food waste

Source: Sarah Reingewirtz, Pasadena Star-News, SCNG

4.2 Sustainable Agricultural Technologies

The ultimate goal of the technologies used and developed on the agricultural value chain through the sustainable agriculture approach is to prevent losses and inefficiencies at every stage, to produce high quantity and quality outputs while ensuring sustainability in the processes.

The negative effects of climate change increasingly impose themselves all over the world, water resources are rapidly depleted, and air pollution is among the top ten causes of human mortality. These facts reveal the urgent need for adopting approaches such as clean energy, green transformation, decarbonization, and circular economy in all sectors and economic activities. In addition, besides being “climate-friendly”, new technologies developed as part of sustainable agriculture have the potential to bring solutions that meet other priorities.

While there are proven technologies in terms of maturity, there are also sustainable agricultural technologies that are being tried out and need reduced costs and increased awareness to be commercialized. Precision agriculture, a key trend in this field, offers a holistic transformation opportunity that is based on digital and data-driven developments and covers the entire agricultural value chain.

In addition, dry farming, which employs resources to the extent they are needed, as well as technologies such as soilless agriculture and vertical farms, which eliminate the dependence on a field or greenhouse and enable agricultural production in cities and urban settlements, stand out as factors that transform the agricultural value chain.

Various new materials, technologies, management approaches and business models have been developed to prevent loss and wastage while increasing productivity in the processing, sales, distribution and consumption stages for agricultural products, which set the value chain stages following fields and greenhouses.

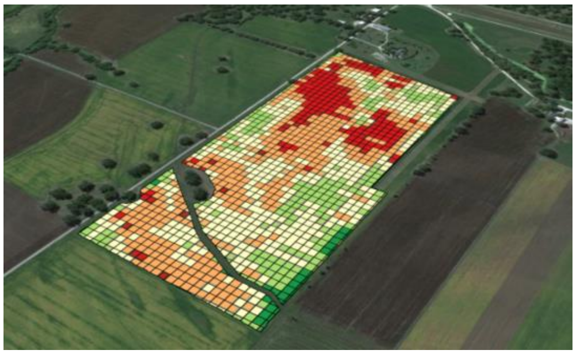
4.2.1. Precision Agriculture

Precision agriculture is the name given to the entirety of the new generation farming and livestock practices which aim to achieve the most ideal seed and plant development as well as maximum harvest and product output by employing digital technologies that present functions such as remote monitoring, advanced estimation, automatic reporting and control. In precision agriculture, a data-oriented management approach is applied to keep productivity at the most ideal levels at every stage of agricultural production. Sensors are used to collect data about the variables affecting productivity, followed by communication and data transfers over IoT-based networks. The collected data is analyzed together with data such as location-based land structure and weather forecast. Subsequently, agricultural input use and interventions are planned and implemented with precision. Data analytics supports the right planning and investment decisions to achieve the best yield and product quality in the short, medium and long term. It also enables the monitoring of plant and animal health and the minimization of agricultural input consumption, which are the main cost items. Thanks to the accurate, data-driven estimation feature in precision agriculture, all trends that may adversely affect the yield and product quality are identified in advance, and measures are timely taken to solve potential problems before they emerge. In addition to the automation of machinery and equipment, machinery and equipment such as tractors, drones, seed planters, pesticide dosage machinery and drip irrigation systems can be operated autonomously (self-managed) through artificial intelligence add-ons.

To cite examples of some technology and usage scenarios as part of precision agriculture, the humidity, temperature and conductivity of the soil can be measured at regular intervals with underground sensors, and thanks to the data obtained, drip irrigation programs can be set regionally where the relevant variables are not within normal ranges, instead of the entire field or greenhouse area, and soil nutrients can be given as supplements. When satellite and drone images are processed with image processing technologies, the color tones of plant stems are examined to estimate the amount of sugar they contain, which can provide valuable information about the health status of the plant. Other than the normal color scale, minor differences that cannot be perceived by the human eye can offer clues to fungus, underdevelopment or poor product quality. Using location-based soil characteristics and historical weather data allows for selecting the type of seeds that will secure the best results and automatically making field- and greenhouse-specific annual agricultural management plans. Autonomous tractors can travel in the field to follow the most ideal route plans, minimizing the labor requirement and production costs.

Precision agriculture also has sub-branches arising from the application of its principles to different agricultural inputs. These present a great potential in terms of preventing inefficiencies in the agricultural value chain and producing solutions to the food security problem of the rapidly-increasing world population. The most prominent of these sub-branches are dry farming, soilless agriculture and vertical farms.

Figure 18: Mapping crop health by using drones



Source: www.agricultu.re

Figure 19: Digital monitoring and management infrastructure

Source: FFTC-Agricultural Policy Platform

4.2.2. Dry Farming

All kinds of plants and agricultural products need certain amounts of water for their growth. Dry farming essentially refers to agricultural production activities in which water is used only as needed. The drip irrigation system and the irrigation recipes determined specifically for a product allow for the most economical consumption of water. Another benefit of dry farming is that it allows agricultural production even in barren lands that receive little rainfall, since water is supplied directly to the roots of the plants and to the soil in the amount needed by the plant. To that end, dry farming is a precision agriculture practice based on data-driven management of water consumption.

4.2.3. Soilless Agriculture (Hydroponics)

In soilless agriculture, some special liquid or solid media other than soil and agricultural lands are used for plant growth. Such media include materials such as rock wool or vermiculite. Vermiculite is a clay mineral formed by the natural erosion of mica and containing magnesium aluminum silicate. It is an additive added to the potting soil as it improves the air intake capacity of the soil as well as water drainage. The nutrients and water required for plant growth are given to the rock wool, vermiculite or similarly functioning material in which the plant is placed, thereby providing root nutrition.

The medium other than soil can also be such that an aqueous solution is used as a suspension. Plants suspended in nutrient-rich liquids with adjustable oxygen content can be grown efficiently under artificial lighting at similar wavelengths to sunlight. One of the key advantages of soilless agriculture is that it eliminates dependence on soil. It also offers protection from external factors such as erosion, eutrophication, drought and extreme weather events and provides the opportunity to reach ideal yield and product quality through a timely use of agricultural inputs in the most accurate quantities. Furthermore, hydroponic farming systems are mostly used in combination with digital monitoring and control mechanisms. Crop losses due to pests, diseases, fungi and weather events can be significantly reduced in controlled hydroponic production free from external factors. The hydroponic agriculture sector is globally expanding at an increasing pace and is expected to reach a size of USD 18 billion by 2025.[19]

Figure 20: Soilless agriculture

Source: www.thebluefarming.com

4.2.4. Vertical Farms

Vertical farms are an alternative agricultural production method that does not require agricultural lands and uses artificial lighting to replace sunlight in indoor environments such as buildings, containers, warehouses and houses. The lighting enables the selection of the most suitable wavelengths for plant growth among the wavelengths from sunlight, and the selected wavelength is applied to the environment with the ideal timing.

Vertical farms present numerous advantages over traditional, open field farming. First of all, since the production is isolated from climate change and weather events, the risks of product and quality loss are largely eliminated. Yield and product quality can be predicted much more accurately, enabling a more accurate planning of annual production and resource use. As crop losses due to pests and diseases are also minimized, agricultural input costs and insurance costs against crop loss can be reduced significantly.

Another major benefit of vertical farms is the use of production units stacked on top of each other instead of production on two-dimensional surfaces, and the yield from the unit area is much higher. This is impossible to achieve in traditional agriculture and plays a positive role in establishing new enterprises and reducing food security risks.

[19] Source: Grand View Research

Instead of agricultural lands, vertical farms are mostly established in urban centers where consumption is concentrated. Production is close to the places of consumption, which allows for direct supply from producers to consumers, while reducing the complexity of the value chain as well as the number of players in it. Product losses and inefficiencies in packaging, transportation and storage can be minimized, and the income share of manufacturers from production is higher. As a result of a simple and efficient value chain, agricultural products meet consumers at more affordable prices, which reduces food inflation and increases the economic value created by agricultural production.

Figure 21: Vertical farms

Source: Bloomberg

Precision farming techniques and digital infrastructures are used extensively in vertical farms. High-tech, efficient production makes it easier for all stakeholders of the value chain to enjoy greater economic returns. The rapid development of vertical farms worldwide confirms the aforementioned economic advantages. By 2025, the global market size is expected to reach USD 15.7 billion, which is over three times more than the 2019 size.[20]

4.2.5. Processing, Transport, Sales and Consumption

To ensure sustainability in the agricultural value chain, as stated, the use of clean energy, raw material and natural resource efficiency, production processes suitable for circular economy, cradle-to-cradle approach in new product development and product traceability, environment and climate-friendly materials are the main focal points as well as digital infrastructures, which play a key role in the realization of sustainable innovation and investments.

In addition to trends such as precision agriculture, dry farming, soilless agriculture and vertical farms which stand out in fields and greenhouses, there are prominent technology focuses and investment areas beyond the value chain. Environment-friendly and climate-friendly technologies as well as emerging

[20] Source: Statista

investment areas that are closely related to the processing, transportation, sales and consumption stages of the agricultural value chain increase efficiency in those stages, prevent loss and waste, contribute to the circular economy can be grouped as follows:

- Digital transformation in industry
- Energy-and resource-efficient production processes and supply chains
- Electrification: electric- and hydrogen-fueled vehicles, machinery and equipment
- Renewable energy, energy storage, smart electricity grids
- Eco-labeling, traceability of products and processes
- Synthetic meat[21], vegan leather, ocean waste plastic packaging and similar production forms

In the agricultural value chain as well as the food and beverages, packaging, logistics, retail, livestock and textile sectors that interact with agriculture, intensive R&D and technology development activities are carried out in the specified areas for the stages beyond the fields and greenhouses. The expectations of stakeholders on the value chain from their suppliers regarding sustainability has increased, sustainability is sought more as a prerequisite in commercial relations, and end consumers have started to prefer sustainable companies more commonly in their product and service purchases, which are all positive developments to that end.

Figure 22: Synthetic meat in a lab setting

Source: Oxford University

Figure 23: Electric logistics vehicle

Source: Smith Electric Vehicles

---

[21] To produce one kilogram of meat, 15,500 liters of water, 6.5 kilograms of grain and 36 kilograms of roughage are consumed. Synthetic meat refers to meat produced with the help of genetic engineering in a laboratory environment as an alternative to traditional meat production. Formulas that present the flavor of meat despite not containing real meat are also developed with soy-based and different chemical combinations (source: Heinrich Böll Foundation, Friends of Earth Network-Meat Atlas Report, TSKB Advisory Services)
The synthetic meat market is estimated to constitute 1% of the global meat market, but this rate is expected to rise to 10% by 2030 (source: Barclays Research, TSKB Advisory Services)

Figure 24: Vegan leather production from plants such as pineapple, sugar beet and mushroom

Source: www.freshnlean.com

Figure 25: Reverse vending machine for recycling

Source: www.recyclingtoday.com

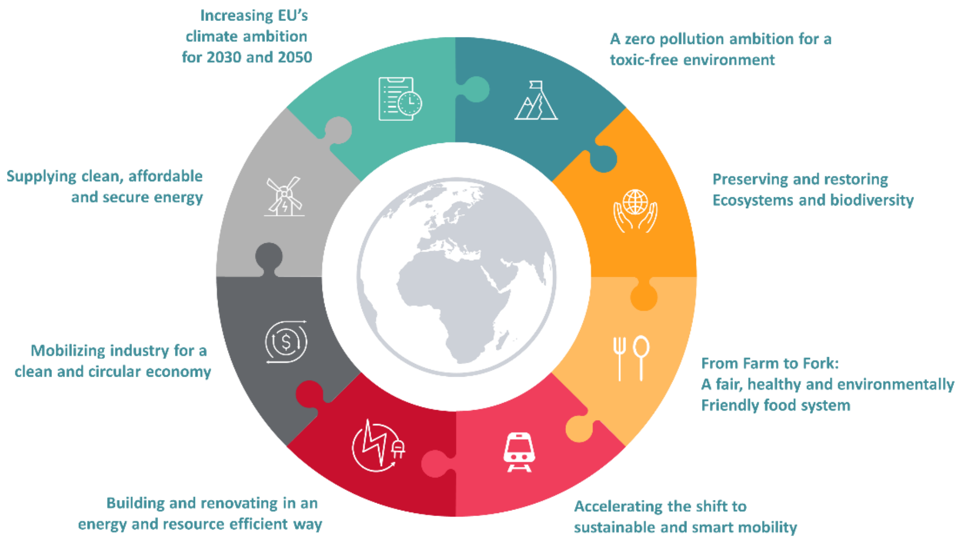
In our world, the negative effects of global climate change are felt more intensely with each passing day. Rapidly depleted and polluted natural resources and increasing food security risks threaten the existence of future generations. Therefore, it is vitally important to implement technologies and best practices that will ensure sustainability in agriculture without losing time, increase the awareness and education levels of all people, and ensure sustainability-focused behavior change.

5. FUTURE OF AGRICULTURAL POLICIES: GLOBAL AND TURKISH OUTLOOK

5.1 Farm to Fork Vision

One of the most comprehensive policy frameworks planned to be implemented in the world for sustainable production methods of agricultural products and the safe distribution and consumption of food is the European Green Deal, which was adopted by the European Parliament in 2019. With an awareness of the impact of climate crisis on food security, the European Union integrates its policy steps towards being carbon neutral by 2050 within the framework of the “European Green Deal” in order to support sustainable, fair and green development while mitigating the effects of climate crisis. In the new order, ambitious objectives are listed on many issues from supplying clean, cheap and safe energy to supporting climate-friendly circular industrial activities and the efficient use of resources.

Figure 26: Main Steps of Action Under the EGD



Source: European Commission, TSKB Economic Research

The EU, which aims to be carbon neutral by 2050, published a strategy document to cover agriculture and food systems under the name of the "Farm to Fork Strategy". The objectives set out within the scope of the EU's strategy document represent a holistic approach towards cutting emissions in the food and agriculture industry, starting from production technologies and extending to distribution channels and consumer preferences. This strategy will initiate a transformational move which requires optimal use of nature-based, technological, digital and satellite-based solutions. The content of this strategy includes objectives such as transforming production by halving total use of chemical pesticides by 2030, reducing nutrient losses by at least 50% and allocating 25% of the total agricultural land to organic farming.

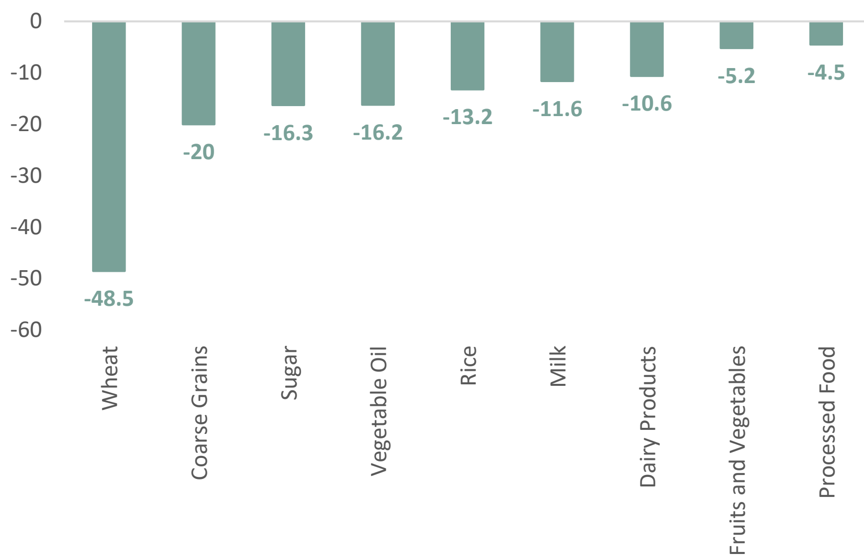
Although the literature studies on estimating the impact of the Farm to Fork Strategy on the EU and global economy have only just begun to emerge, they point out to possible decreases in both agricultural production in the EU and competitiveness in export markets[22]. The main idea is that restrictions on the use of agricultural inputs such as pesticides, fertilizers, antimicrobials and others may outpace technological innovation in agriculture, thereby accelerating a decline in agricultural production, which in turn can lead to inflation in food prices and a decline in welfare.

Production estimates reveal that wheat production is expected to decrease by 48.5%, rice by 13.2%, and fruit and vegetable production by 5.2% in the 8 to 10 years after the full implementation of the measures. The decrease in production is expected to have implications on exports as well: If the Farm to Fork Strategy is fully implemented, exports of fruits and vegetables from the EU to the rest of the world are expected to decrease by 5.3% over the next 8-10 years, while exports of rice and coarse grains will decrease by

[22] Beckman, J., Ivanic, M., Jelliffe, J., Baquedano, F. G., & Scott, S. (2020). Jayson Beckman, Maros Ivanic, Jeremy Jeliffe, Felix G. Baquedano and Sara Scott, United States Department of Agriculture Economic Research Service.

82.2% and 34.2%, respectively. In order to evaluate the effects of that on Turkey's exports to the EU, the policy steps within the scope of the strategy need to be clarified.

Chart 16: Percentage changes in agricultural production that will be created by the EU-wide Farm to Fork Strategy*



Source: Beckman et al. (2020), TSKB Economic Research

*Within 8-10 years

Recognizing that the transformation of agricultural production systems is an important component in the fight against the climate crisis, the European Green Deal stipulates that at least 40% of the budget allocated to the common agricultural policy of the member states for 2021-2027 is channeled to anti-climate change efforts. To that end, while agricultural activities aiming to mitigate carbon emissions are rewarded, alternative solutions such as the use of biofertilizers and biogas power generation are encouraged.

The EU aims to support the adoption of sustainable and circular business models not only in production but also in packaging and distribution of food products. Many objectives such as the use of environmentally friendly materials in food packaging, conducting work on reformulation in the food industry for the transition from foods which are high in fat, sugars and salt to healthier and more nutritious foods, supporting the use of responsible marketing channels and minimizing food losses by reviewing the stages in the food production line are planned to enter the agenda of EU member states[23].

[23] European Commission (b). (2020). Farm to Fork Strategy. Brussels: European Commission.

5.2 Turkey's Policy Agenda for Food Security

In the 2019-2023 Strategic Plan of the Ministry of Agriculture and Forestry, the objectives are grouped under 7 main goals, and almost all of these goals include objectives for ensuring food security. Within the scope of the strategy, the following goals are considered among the policy steps to ensure food security:

- To secure supply of plant-based and animal products,
- To develop appropriate policy tools for a sustainable agriculture sector,
- To provide accurate and up-to-date information on food safety,
- To ensure the protection and efficient use of soil and water resources,
- To curb the negative effects of flood and drought,
- To increase the capacity to combat desertification and erosion,
- To measure the possible effects of climate change on agriculture and to develop suggestions for taking precautions,

Furthermore, the Ministry of Treasury and Finance noted in the Economic Reforms Action Plan that the climate crisis and the disasters experienced in connection with this crisis "caused the changes in crop planting behaviors, which in turn affected food prices having a significant weight in the inflation basket" and aims to establish an Early Warning System for the prevention of food price fluctuations and its impact on inflation. The actions aimed at reducing food loss and waste as covered by the plan include steps such as selling on the Digital Agricultural Market (DITAP) the food products left unsold in fields and in the wholesale fruits and vegetables markets, developing the cold chain to prevent vegetable and fruit losses, and developing contracted agriculture mechanisms.

The Ministry of Commerce has put actions such as the efficient use of water resources, limiting soil pollution by reducing the use of pesticides, antimicrobials and chemical fertilizers while maintaining land consolidation registration activities to increase efficiency in land use on its agenda among actions for sustainable agriculture in the Green Deal Action Plan. At the same time, the policy steps proposed in the First Water Council held by the Ministry of Agriculture and Forestry include the reduction of loss and leakage in water transmission, the reuse of wastewater, increasing irrigation efficiency, increasing efficiency in food production and agricultural yield, determining the water footprint and increasing training activities.

A closer look at food packaging practices demonstrates that the Zero Waste regulation gains greater importance as part of supporting circular production and consumption systems. The Zero Waste regulation aims to reduce waste generation or prevent waste by using resources more efficiently, and to recycle waste in cases where it occurs. It plays a key role in preserving food with environmentally-friendly materials in our country and thus reducing plastic packaging waste from food packaging.

5.3 The Intersection of Agricultural Production and Development Agenda

It is important to mainstream sustainable agricultural practices to increase the resilience of agricultural products against the effects of the climate crisis and to provide food security for the growing population by using resources more efficiently. The FAO positions sustainable agriculture and food systems around 5 core principles:

- Increasing productivity, employment and value-added in food systems
- Protect and enhance natural resources
- Improving livelihoods and foster inclusive economic growth
- Enhancing the resilience of people, communities and ecosystems
- Adapting governance to new challenges.

In line with the principles above, the sustainability of agricultural production is inseparable from the gender equality perspective in consideration of its ability to support inclusiveness in agricultural employment. According to the World Bank statistics, 25% of women employed around the world work in the agricultural sector. When analyzed on the basis of country groups, 79% of women in the lowest income countries mention agricultural activities as their primary source of livelihood[24]. However, female producers have very limited access to key factors of production such as farmland and capital and to opportunities for hiring workers, purchasing inputs and marketing their products[25]. However, when women have equal access to agricultural production factors as men, female workers manage to improve agricultural crop harvest by 20-30% and increase the agricultural production in developing countries by 2.5-4%[26]. The same statistics conclude that the women-led increase in agricultural production contributes to a decrease of 12-17% in the number of people fighting hunger globally.

Although female labor plays a key role in agricultural activity, women in the world are 13% more likely than men to experience food insecurity. Moreover, the gender gap in food insecurity is deeper among the relatively poorer and less educated[27].

Research shows that the share of women while distributing food within the family decreases more than men, particularly during periods of rising food prices[28]. Similarly, the share of food consumption in total income is higher in female-headed families. This indicates that there are fewer financial resources for non-food expenditures in families where women are single parents. Ensuring food security can contribute to the economic empowerment of women in terms of making food economically accessible by enabling women to allocate more resources to non-food expenditures.

The climate crisis may affect the migration movements of those who live on agricultural activities. For instance, according to a study conducted in the Sub-Saharan Africa region, 50% of the net internal migration flows in the region occurred due to the decline in agricultural production as a result of changes in temperature and precipitation regime and the consequent decrease in the incomes of rural residents[29]. Furthermore, another study conducted in agriculture-based economies reveals that a 1 °C rise in temperatures increases the number of international migrants by 5%[30]. From this point of view, sustainable agricultural practices can support rural development and limit rural flight.

---

[24] FAO (2020). The Female Face of Farming. http://www.fao.org/gender/resources/infographics/the-female-face-of-farming/en/: http://www.fao.org/gender/resources/infographics/the-female-face-of-farming/en/

[25] Razavi, S. (2009). The Gendered Impacts of Liberalization: Towards "Embedded Liberalism"? United Nations Research Institute for Social Development.

[26] Asian Development Bank; FAO. (2013). Gender Equality and Food Security.

[27] Broussard, N. H. (2019). What Explains Gender Differences in Food Insecurity? Food Policy, 83, 180-194.

[28] FAO(c). (2014). Women's Resilience to Food Price Volatility. United Nations.

[29] FAO IFAD IOM WFP. 2018. The Linkages between Migration, Agriculture, Food Security and Rural Development. Rome. 80pp. (http://www.fao.org/3/CA0922EN/CA0922EN.pdf). Licence: CC BY-NC-SA 3.0 IGO

[30] Cai, R., Feng, S., Pytliková, M., & Oppenheimer, M. 2016. Climate variability and international migration: The importance of the agricultural linkage. Journal of Environmental Economics and Management, 79:135–151.

Agricultural production is directly related to the use of water resources. Considering the water used in agricultural production as part of food security, the first thing that comes to mind is irrigation water, but surface and ground waters as well as precipitation and soil moisture also play an important role in production. Research by Rosegrant et al.[31] reveals that the total amount of water used in food production will increase by 0.7% each year starting from 2000 and rise from 6,400 km^3 per year to 8,600 km^3 by 2025 and to 9,060 km^3 by 2050. On the other hand, in their research conducted in 201 different riverbeds they examined between 1996 and 2005, Hoekstra et al.[32] report that they observed water scarcity for at least one month of each year. According to FAO estimations, in order to meet the food needs of the growing population, world food production must increase by 60% and the amount of usable water by 15% until 2050. However, it is expected that by 2025, 1.8 billion people will live in areas in 'absolute scarcity' with less than 500 cubic meters of water per capita per year, and two-thirds of the world's population will live in regions experiencing water scarcity with an annual water availability of between 500-1,000 cubic meters per capita. Therefore, in response to the increasing demand for agricultural production, dwindling water resources constitute a major risk factor for food security. This risk becomes more visible when the data specific to Turkey is analyzed. Turkey is positioned as the country that allocates the highest share from total water extraction to agricultural irrigation among the OECD countries. According to Aquastat data, 84.9% of the total water extracted for water consumption is used for agricultural irrigation. This rate is well above the 30.9% reported across the EU member states.

Along with water resources, the amount of arable land, soil biodiversity and the moisture level of the soil can be considered around food security as they closely concern the future of food supply. The FAO reports that 99% of the world's food supply is produced by soil farming practices. While 37% of the total land in the world is used for agriculture, 33% of the soil on our planet has been destroyed as a result of desertification. It is noted that landslides may cause a 50% loss in crop yield, and the economic loss due to deforestation and erosion may vary between EUR 1.5 and 3.4 trillion per year[33].

Soil can also affect food security as an element that maintains the continuity of water cycle. While the soil provides efficiency in the production of agricultural products with its moisture content, it also contributes to preventing the danger of flooding in heavy precipitation periods by absorbing water and by purifying the water from polluted materials by filtering it naturally. Increasing the amount of water retained in the soil contributes to:

- yield increase when the soil is rich in minerals and biodiversity,
- reducing crop losses caused by drought,
- recharging underground water resources and thus protecting the water level in the wells,
- continuity of water flow into rivers and streams[34].

While research shows that smart irrigation systems are among the solutions against the increasing threat of drought, it is noted that countries lacking the opportunity to develop such irrigation technologies are

[31] Rosegrant, M. W., Ringler, C., & Zhu, T. (2009). Water for Agriculture: Maintaining Food Security under Growing Scarcity. Annual Review of Environment and Resources, 34, 205-222.
[32] Hoekstra, A. Y., Mekonnen, M. M., Chapagain, A. K., Mathews, R. E., & Richter, B. D. (2012). Global Monthly Water Scarcity: Blue Water Footprints versus Blue Water Availability. PLoS ONE, 7(2).
[33] ELD Initiative. (2015). The Value of Land: Prosperous Lands and Positive Rewards Through Sustainable Land Management
[34] Benites, J., & Castellanos-Navarrete, A. (2003). Improving soil moisture with conservation agriculture. Farming Matters, 19, 6-7.

also among the regions that can be geographically affected by drought the most, and that some of these countries are even in danger of a hunger crisis[35,36]. Therefore, positioning the current situation of food security against the perspective of water resources should be one of the priority issues among the financing channels and policy steps aimed at enabling developing countries, particularly those in the aforementioned regions, to manage water resources more efficiently and effectively. As a developing economy, evaluating Turkey's current position in terms of water resources and food security will also contribute to combatting the effects of climate change and guiding economic development finances.

As a result, mainstreaming sustainable agricultural practices can limit the effects of the climate crisis on agricultural production by encouraging more efficient use of natural resources such as water and soil, as well as secure women's economic empowerment by creating inclusive employment and slow down uncontrolled migration movements from rural to urban areas. From this point of view, it can be argued that the gains from sustainable agriculture can bring gains under many other development themes.

5.4 Linkage Between Sustainable Agriculture and SDGs

Sustainable agriculture is directly related to many of the United Nations Sustainable Development Goals (SDGs) due to its value chain, the sectors it interacts with, and the many concepts and sub-items it contains. The best practices and technologies referred to for the realization of sustainable agricultural practices point to the ways and methods to be employed for the realization of the targeted SDGs for all stakeholders.

The main problems of workers employed in fields and greenhouses are that they work under harsh conditions and low wages, they cannot get their share of income from agricultural production due to complex and multi-player supply chains, child labor is common, agricultural workers do not have enough educational opportunities to secure economic guarantees and support rural development, the already-unjust agricultural economic order is even more unequal to women and children.

[35] Canales-Ide, F., Zubelzu, S., & Rodríguez-Sinobas, L. (2019). Irrigation systems in smart cities coping with water scarcity: The case of Valdebebas, Madrid. Journal of Environmental Management, 247(1), 187-195.
[36] UN Water. (2021). The United Nations World Water Development Report 2021.

Figure 27: Relationship between sustainable agriculture and SDGs

Source: United Nations, TSKB

In addition to all these, the workers' population is more adversely affected than other stakeholders by the material damages caused by climate change and related extreme natural events, in the emergence of which unsustainable agricultural activities have a share. Efforts to mitigate the problems related to the human dimension of agricultural value chain also serve Goal 1 - "No Poverty", Goal 3 - "Good Health and Well-Being", Goal 4 - "Quality Education", Goal 5 - "Gender Equality", Goal 8 - "Decent Work and Economic Growth" and Goal 10 - "Reduced Inequalities".

As a result of the intersection of food security with many development themes such as climate, gender and natural resources, there are direct links between SDGs and food security. While Goal 2 - "No Hunger" and Goal 6 - "Clean Water and Sanitation" draw attention among them, it is possible to say that Goal 3 - "Good Health and Well-Being" can be achieved if access to nutritious food and clean water is provided.

In the context of ensuring food security, the mainstreaming of sustainable agricultural practices will contribute to regional economic development and thus the realization of Goal 8 - "Decent Work and Economic Growth", while contributing to the improvement of the income gap between the urban and rural areas and thus the realization of Goal 10 - "Reduced Inequalities". In addition, supporting sustainable agriculture is also important in terms of economic empowerment of women who live on agricultural activities in rural areas. Climate change endangers the future of water resources and causes loss of yield in agricultural production. The steps to combat climate change are also closely related to Goal 13 - "Climate Action".

Various technology and investment areas such as digital transformation in the industry, clean energy, efficiency in the use of energy raw materials and natural resources, eco-labeling and traceability, which relate to the processing stage of the agricultural value chain, are associated with Goal 9 - "Industry, Innovation and Infrastructure". Best practices and technologies in the subsequent stages of transportation, storage, sales and consumption, including the processing stage, are related to Goal 12 - "Responsible Consumption and Production".

To ensure sustainability in agriculture, it is required to address problems and implement solutions within a holistic perspective covering all elements of the agricultural value chain. Ultimately, the main purpose of the sustainable agriculture theme is to meet the food and fiber needs of the entire world population, while protecting limited natural resources, ensuring the health and vitality of biodiversity, and helping the presentation of the environment and natural ecosystems to the benefit of all humanity without deterioration. From this point of view, it is possible to say that the theme of sustainable agriculture plays a key role in the realization of Goal 13 - "Climate Action", Goal 14 - "Life Below Water" and Goal 15 - "Life on Land".

6. Conclusion and TSKB's Roadmap

The technological and financial focal points for improvements in the agricultural value chain include themes such as climate change mitigation, climate adaptation, transition to a low carbon economy, clean energy, resource efficiency, biodiversity, and green and sustainable innovation. To that end, a series of meetings have been held with both public institutions and sector-based representatives. In addition, studies on the size, planning and financing of investments that can contribute to the principles of Sustainable Agriculture and interactive themes will continue.

Although our country is among the top 10 countries in the world in terms of the added value created by the agriculture and food sector, it ranks 20th in land productivity and 30th in labor productivity. This indicates that we have structural problems to resolve. The major structural problems we face include the following:

- Multi-plot and scattered organization of cultivated lands,
- High costs of basic input,
- Lack of sustainable agriculture and ineffectiveness of good agricultural practices,
- Low yield and quality in grains, inefficient use of natural resources, lack of planning,
- Rural flight, aging agricultural population, lack of education, difficulty in accessing finances, low level of financial literacy,
- High informality, unpaid employment, child employment, low income,
- Problems in cooperative structures, inefficiency of markets,
- Inability to measure the effects of incentives and supports, deficiencies in matching,
- Lack of mechanization and technology, low R&D, refraining from innovation, not using digital agricultural technologies,
- A supply chain structure with multiple intermediaries,
- Failure to store products under the right conditions,
- Low dissemination of information, not benefiting from faculties of agriculture and laboratories,
- Insufficient cooperation between academia, public sector and private sector.

At TSKB, the theme of Sustainable Food Systems will continue to be developed, and we will maintain our efforts to solve the structural problems of our country and to support increasing awareness and practices on sustainable agriculture.

TSKB has significant experience, knowledge and customer portfolio in the food and beverages, packaging, logistics and retail sectors, which are sectors that relate to and interact with sustainable agriculture. In addition, TSKB has long years of experience in the use of renewable energy, a best practice in sustainable agriculture, and in the financing of and advisory services for investments improving energy and resource efficiency.

Sustainable Food Systems is a key agenda item both in public policies and for international development finance institutions. When sectors interacting with agriculture are also included, it is clear that sustainability investments have been increasing steadily over the years. To that end, TSKB will continue to work to improve its sphere of influence in this area.

MECLİSİ MEBUSAN CAD.
NO:81 FINDIKLI İSTANBUL 34427, TURKEY
T: +90 (212) 334 50 50 F: +90 (212) 334 52 34