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The Importance of Smart Agriculture Practices for

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Abstract
Besides the natural causes of climate change, the consequences caused by the human factor are undeniable. It is seen that the issue is a global threat not only to humans but also to animals and plants. In this regard, from the 1990s to today, many present studies have been done on a global scale, and various steps have been taken within the scope of fighting against the impacts caused by the issue. When considering the changing conditions in the agriculture sector, which is one of the sectors directly affected by climate change, and the increasing population around the world, issues of the amount of food production, efficiency, and safety have come to the fore. Therefore, it is vital to decrease the negative impacts of climate change on agriculture and to adapt to this process in order to cope with the possible crises in the future and build a sustainable agricultural economy. This study aims to investigate national and international efforts made within the scope of fighting against climate change and examine the impacts of it within the global climate changes on the agriculture sector. Smart agricultural practices accepted as the reflection of developing technology in agriculture have also been considered in the scope of fighting against climate change. Accordingly, in this study, the smart agricultural practices used around the world and in Turkey, the sample practices, and areas of the usage are explained in detail.

Keywords
Agriculture Sector, Sustainability, Climate Change, Smart Agriculture, Agriculture 4.0

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İklim Değişikliği Sürecinde Sürdürülebilir Bir Tarım Ekonomisi için Akıllı Tarım Uygulamalarının Önemi

Özet

İklim değişikliğinin doğal sebeplerinin yanı sıra, insan faktörünün yol açtığı sonuçlar da yadsınamaz boyuttadır. Bu sorun, sadece insanlar için değil, hayvan ve bitkiler için de küresel bir tehdit olarak görülmektedir. Bu bağlamda, 1900'lü yıllardan günümüze kadar geçen süreçte, küresel çapta pek çok çalışma yapılmış ve sorunun yol açtığı etkilerle mücadele kapsamında çeşitli adımlar atılmaya çalışılmıştır.

İklim değişikliğinden doğrudan etkilenen sektörlerden birisi olan tarım sektörü açısından değişen şartlar ve dünya genelinde artan nüfus göz önünde bulundurulduğunda gıda üretim miktarı, verimliliği ve güvenliği konuları ön plana çıkmaktadır. Bu nedenle, tarım sektöründe iklim değişikliğinin yol açtığı olumsuz etkileri azaltmak ve bu sürece uyum sağlamak, gelecekte ortaya çıkabilecek olası krizlerle başa çıkmak ve sürdürülebilir bir tarım ekonomisi oluşturmak için hayati bir öneme sahiptir.

Bu çalışmada; iklim değişikliği ile mücadele kapsamında yapılan ulusal ve uluslararası çabalar ele alınmış ve küresel iklim değişikliği ve etkilerinin tarım sektörü üzerindeki etkileri incelenmiştir. Ayrıca, gelişen teknolojinin tarım sektörüne yansıması olarak kabul edilen akıllı tarım uygulamaları da iklim değişikliği ile mücadele kapsamında ele alınmıştır. Bu doğrultuda dünyadaki ve Türkiye'deki akıllı tarım uygulamalarının neler olduğu, kullanım alanları ve uygulama örnekleri detaylı bir şekilde açıklanmıştır.

Anahtar Kelimeler

Tarım Sektörü, Sürdürülebilirlik, İklim Değişikliği, Akıllı Tarım, Tarım 4.0

Introduction

The pace of global warming has increased drastically over the past century, and it continues to increase. The rapid increase in global warming is the impact caused by the human factor rather than the natural process. Human factor affects global warming and thus climate change through the industrialization process in which fossil fuel consumption increases. It is the impact caused by the human factor rather than the natural process. Greenhouse gases accumulating in the atmosphere due to the fossil fuels cause to earth's temperatures to rise gradually, the atmosphere to warm, sea water levels to rise due to melting glaciers, extreme weather conditions, and ecosystem degradation. These negativities are seen as a crucial issue that concerns every country. In this regard, international negotiations and agreements are made, evaluations on the basis of each country are done, and specific objectives for each country are determined.

Problems caused by climate change have caused a transformation in many sectors compulsorily. In this regard, industries and business fields such as agriculture, livestock, forestry, and foreign trade and tourism affected by geography and climate conditions come to the forefront.

The agriculture industry around the world has also undergone a radical transformation because of climate change. The increasing human population on a global scale, food production amount, and efficiency of the production ve food safety have become highly controversial issues from the aspect of the agriculture industry. There is a necessity for global efforts to adapt to climate change in order to produce the food that the world population needs and sustain the production. Innovative approaches conceptualized as "smart agricultural practices" or "agriculture 4.0" come to the fore in order to minimize the effects of climate change in the agricultural sector. It's highly crucial that governments support producers and raise awareness in the period of transformation the agriculture industry will experience. This transformation brings with it a great financial need and the need for consultancy and guidance to adapt to new methods and approaches.

In the agricultural sector, an ecosystem created by automation, informatics, and machine systems working in an integrated way provide much more efficient results compared to agricultural practices carried out with traditional methods. Productivity increases in terms of the number of products, the costs incurred in this process, as well as environmental compatibility. Technologies,

which are used in planting, irrigation, agricultural spraying, making various measurements, and harvesting of lands, and which are used to operate many separate units such as drones, robots, sensors, data analysis systems, cloud systems, and Internet of Things as an integrated system, play a very important role for the sustainability of the agricultural sector. Otherwise, the new conditions arising due to climate change will cause serious damage to the agricultural sector in Turkey and all over the world.

All of the said innovative practices are within the scope of smart agriculture practices or agriculture 4.0. With the developing agricultural technologies, productivity increases while costs decrease. Therefore, it becomes possible to minimize product loss resulting from climate change. These technologies also contribute to the reduction of greenhouse gas emissions, which is the main cause of global warming. Through these technologies, it will be possible to make progress in terms of both the sustainability of the agricultural sector and the fight against climate change in countries where smart agricultural practices have become widespread.

In this study, international initiatives in tackling climate change are discussed and presented how and to what extent climate change affects the agricultural industry. At the point reached today, radical decisions need to be taken in many areas, especially in the agricultural sector, and major changes need to be implemented. In this context, smart agricultural practices have a significant role in the sustainable agricultural sector and in getting it to a better position than today. Accordingly, this study examines the improvement that has been made around the world with the prominent samples of the smart agricultural practices which the countries have made and presents the current situation in Turkey.

Fighting against Climate Change

Climate change occurring for natural reasons has increased rapidly with the effect of the human factor along with Industrial Revolution since the 1850s. Accelerating the global warming caused by the increasing use of fossil fuels after this period shows the direct effect of human factors on climate change. According to the United Nations Framework Convention on Climate Change (UNFCCC), the impact of the climate change is stated as "Natural changes in climate over a long period and the changes which are directly or indirectly resulted from human activities, and which degeneration of structure of the atmosphere" include the situations affecting ecosystem such as flood, aridity, the rise of the sea level as well as rising temperatures (Tuğaç, 2020: 224). All the adverse changes experienced threaten humans, plants, and animals, which means affecting the whole earth's ecosystem. One of the most controversial issues besides global warming caused by climate change has been greenhouse gas emissions. The two most important questions to be considered on greenhouse gas emissions are who is responsible for these emissions

and what should be done to decrease the amount of the emissions (Doğan & Tüzer, 2011: 161). The fact that these questions have ranked high on the world agenda gets countries to cooperate in the global scope and take responsibility.

The initial steps were taken by the United Nations (UN) at the Human Environment Conference held in 1972, and the United Nations Environment Programme (UNEP) was initiated as an organization that would deal with environmental issues. In the conference held in Stockholm, Sweden, it was acknowledged that it was inevitable to put in global efforts against global environmental issues. The first concrete plan of UNEP was implemented with Vienna Convention, and Montreal Protocol signed in 1987. Within the framework of the plan, the decisions taken to reduce the damages caused by the gas emissions in the atmosphere stand out within the scope of fighting against climate change (Köse, 2018: 60-66).

Intergovernmental Panel on Climate Change (IPCC) was created in 1988 by the United Nations Environment Programme and the World Meteorological Organization (WMO) to provide countries with information about climate change and its impacts of it. The objectives of the panel are to collect and analyze data on climate change, to report its social and economic impacts of it, and conduct research on the efforts which could be made to prevent the related problem (Sadioğlu & Ağıralan, 2020: 367).

IPCC has been recognized as one of the most important authorities in fighting against climate change since its establishment. One of the main reasons for this acceptance is that the report prepared in 1990 revealed the political importance of the change in climate, and by means of the report, the United Nations Framework Convention on Climate Change (UNFCCC) was initiated in 1990. Furthermore signing of the Kyoto Protocol in 1997, owing to another report by IPCC in 1995, consolidated the authority of the organization in this area (Doğan & Tüzer, 2011: 164-165).

The main objective of the United Nations Framework Convention on Climate Change (UNFCCC), accepted at the Rio Earth Summit in 1992, is to keep the concentration of the greenhouse gas accumulated in the atmosphere constant at a certain rate. This rate has been determined in accordance with the sustainability of global climate change. With the agreement signed, the countries are divided into three groups according to the principle "common but differentiated responsibilities and respective capabilities," considering their priorities of development and specific conditions. This distinction between the countries was made according to their levels of development and industrialization and the technologies they use. Accordingly, countries in the first group (Annex I) are obliged to limit greenhouse gases, protect and develop greenhouse gas sinks, report the measurements they take and the policies they follow to prevent the change in climate, and supply data on emissions

and current greenhouse gas emissions (Ministry of Foreign Affairs of the Republic of Turkey, 2020).

The countries in the second group (Annex II) are supposed to transfer environmentally friendly technologies to the developing countries, which are especially contracting or encouraging them to access, facilitate, and finance these technologies, besides the responsibilities the countries in the first group have. Whereas the countries in the third group (Non-Annexed Countries) are encouraged to reduce greenhouse gas emissions, collaborate in research and technology transfer, and protect the greenhouse gas sinks, they are not under a specific obligation. Turkey in Annex I and Annex II lists requested to be removed from Annex I list by presenting its specific conditions. Today there are 42 countries and the European Union (EU) in Annex I and, 23 countries and EU in Annex II, 154 countries in the group of Non-Annexed (Ministry of Foreign Affairs of the Republic of Turkey, 2020).

The United Nations Framework Convention on Climate Change (UNFCCC) sets no objective or no time limit to be achieved by the governments. Therefore countries do not endeavor in terms of fighting with climate change and decision-making. In the first meeting of the Conference of the Parties series in 1995, which started after UNFCCC, it was emphasized that the decisions taken should be legally binding. In the First Conference of the Parties (COP 1) held in Berlin, objectives for the developed countries to reduce greenhouse gases were set, and stated the severity of the situation. As a result of the negotiations known as the "Berlin Sanction," Kyoto The Protocol was signed at COP 3 meeting held in Kyoto, Japan, in 1997. According to the decisions taken, it was requested the countries industrialized in the period of 2008-2012 commit to reducing their greenhouse gas emissions to the extent of 5% from 1990. In addition, to combat climate change, it was emphasized that industralized counties should provide technology transfer and financial aid to the developing counties (Kaya, 2020: 174-175). The Paris Agreement was adopted by 195 countries and the UN at COP21 in Paris in 2015. With the agreement acknowledged as a significant turning point in combating climate change, it aims not to exceed +2°C, which is the critical threshold for global warming, and entered into force in 2020 (Keskin & Kökyay, 2020: 333).

Considering the related international studies, it's apparently seen that Turkey acted in a will to participate in collaborations. On 19 December 1991, Turkey signed the Montreal Protocol, which is one of the first international treaties on this issue. Also, Turkey as a member of the Organization for Economic Cooperation and Development (OECD), joined the list of UNFCCC in 1992, yet signed the agreement on 24 May 2004. Turkey contracted the Kyoto Protocol, which was created during the period Turkey was not a member of UNFCCC in 2009 and accepted to commit to the requirements of the agreement. After signing the agreement, national efforts to address climate change have

increased. Accordingly, the National Declaration on Climate Change in 2007, the Strategy of Climate Change in 2010 and the Climate Change Action Plan in 2010, and the Climate Change Adaption Strategy were published (Tuğaç, 2020).

Turkey signed the Paris Agreement on 22 April 2016 with 175 parties. It added the two important annotations, one of which is to benefit from technological developments the developed countries have and to get financial aid as a developing country, but not to commit to supporting other developing countries. The other one is not to make a binding commitment regarding the reduction of emissions considering the economic growth and population increase of the country (Ministry of Foreign Affairs of the Republic of Turkey, 2020). Unlike the former treaties, The Paris Agreement aims at not only reduction of the greenhouse gas emissions but sustainable development, human rights, global migration, and decarburization as well (Kıvılcım, 2015: 1). Turkey also develops policies and action plans in accordance with these factors.

The Climate Change Action Plan developed by Turkey is based on the main titles such as energy, construction, industry, transportation, waste, and agriculture sectors. The Climate Change Adaption Strategy published in the same year tackles the water management system, agriculture and food safety, ecosystem services, biological diversity and forestation, risk management of natural disasters, and human health issues (CCAP, 2011)

In the First National Declaration on Climate Change in 2007, it was stated that the impacts of the process would be seen as a decrease in winter precipitation, possible loss of surface water, soil degradation, increase in summer temperatures, coastal erosion, and flood. This possible situation would affect water and soil resources which are crucial for food production and estimated rural development. In the Mediterranean Region, one of the affected by climate change, according to the Fourth Evaluation Report by CCAP, it was stated that there would be an increase in general temperature from 1°C-2°C and in the number of the days which would be extremely hot in the interior regions (İDEP, 2011: 4).

In this regard, it's foreseen that Turkey could have a climate that could be hotter, drier, and more erratic for rainfall. Accordingly, it's thought that change in climate could affect food production negatively and cause problems regarding food safety. Considering the importance of the agriculture industry for Turkey, it's necessary for product-oriented policies to be developed within the scope of climate change.

Climate Change and Agriculture Industry

Climate change affects agriculture through the factors such as the amount of production, price of the products, food safety ve product range. Erratic rainfall, extremely dry weather, and the concentration of carbon dioxide in the

atmosphere will bring negative changes in the amount of the products and productivity, soil structure, and water resources. The changes in weather conditions cause losses in agriculture due to the changes in the harvest season.

While extreme heat causes pathogenic organisms to thrive and to increase forest fires, heavy rainfall results in decreasing oxygen content and increasing humidity, so becoming bug-infested in soil. The changes in temperatures affect surface and underground water reservoirs depending on rainfall and snowfall. Due to high temperatures, increased evaporation results in low water in reservoirs used for irrigation, even drying up. On the other side, it causes more moisture to evaporate in the atmosphere, and precipitation falls more than normal as rain, which puts settlements and agricultural lands at the risk of flooding.

The agricultural industry, which is one of the leading sectors affected by climate change, has an impact of accelerating the process as well by increasing greenhouse gas emissions. Practices such as livestock and rice production, which cause intense methane emissions, significantly increase the volume of greenhouse gases in the atmosphere. Considering the factors which contribute to greenhouse gas emissions, it's the energy consumption that takes the first place with 26%. Besides, industrial production is responsible for 19% of global greenhouse gas emissions; agricultural activities contribute 14% of GHG emissions; transportation produces 13% as well (Bayraç & Doğan, 2016: 36-37).

Shrinking of farmlands, decreasing water resources, food needs of the growing human population, and the increase in demand for protein-rich food bring productivity in agricultural production to the forefront (Tarım ve Makine Sanayi Etkileşim Raporu, 2020). According to the Global Report on Food Crises published in 2019, 55 counties and 135 billion people who live in these regions experience acute food insecurity (Global Report on Food Crises, 2020: 20). According to the report, the reasons behind the food crises are conflicts, economic instabilities, and extreme weather events. With a possible global crisis, economic, social, and political problems will likely emerge. Hence it's crucial to diminish the negative impacts of the change in climate on the agricultural sector and adapt the sector to the process.

Gradually challenging conditions and climate change threaten traditional agricultural production. Today new implementations will be needed in the future in terms of sustainable products in the current farmlands. In this context, new production techniques by technological developments should be carefully studied. Within the scope of combating the impacts of the changing climate on agriculture and adaption to the process, legal and cooperative regulations, policies, and strategic plans based on issues production, consumption, food safety, product prices, manufacturing support, biological diversity,

and agricultural R&D are required. Smart agricultural practices are also the result of innovative approaches that have emerged in this context.

Smart Agricultural Practices (Agriculture 4.0)

The productivity growth to be achieved in agriculture could be possible by using the data compatible with each other. Agricultural mechanization, which is also one of the tools of this goal, means to achieve the goal with agricultural operations and the use of energy. The mechanization process in the agricultural sector has increasingly continued since the beginning of the 20th century. Human and animal labor has been replaced with machines. Agricultural mechanization increases the productivity of human labor, and it reduces the costs as well (Özgüven et al., 2010: 93).

Integration of the new technologies in the agricultural process stands out productivity, dependency on climatic conditions, and new production areas. The agricultural mechanization process has thrived within food quality, production efficiency, prevention of potential global food crisis, possible precautions, and necessary use of technology (Kabaş, 2019: 3). These issues are the main factors of sustainable agriculture. The management of the risks created by the changing climate and integration of the adaption efforts take a substantial place among the priorities of sustainable agriculture. Regarding risk management, it's required meteorological measurements of rainfall, temperature, and wind, to connect an integrated automatic control system, to use developing technology in order to analyze climatic data and risks properly, to raise awareness about the use of modern technologies and to make these technologies available for all producers (Zaimoğlu, 2019: 19).

The biggest problem in Turkey regarding the use of machines in the agricultural sector is that the farmlands are divided into small plots, which causes a serious operation problem in terms of the cost/benefit balance. Farmlands are required to be suitable for agricultural operations in terms of topography and size. In that, there is a positive relationship between the size of the farmland and the mechanization implementations in terms of efficiency. For this reason, new technologies will be applied easily, and productivity will be promoted by consolidating scattered and small-sized plots. On the other side, the land consolidation provides a significant advantage in terms of carbon emissions as well (Koçtürk & Avcıoğlu, 2007: 23).

The traditional methods such as seed selection, the methods of soil and plant nourishment, cultivation method, and irrigation method are not sufficient to prevent the agricultural sector from the adverse effects of the changing climate. In this regard, the tools such as sensor, camera, and orbit, which provide instantaneous data, should be used in an integrated system from which the data are getting, and the required interventions should be made without delay (Kirkaya, 2020: 5).

Till today, there have been three revolutionary periods in industrialization with different results. In the first-period steam, machines were included in the production process; in the second period, steam was replaced by electric energy; and in the third period, information technologies were included in the process. A new period has started owing to developing technology and science. The agricultural sector has been affected by this transformation, therefore, addressed the implementations called "Smart Agriculture / Agriculture 4.0" to keep face with these new conditions.

The concept of Smart Farming means the application of advanced Information and Communication Technologies (ICT) to agricultural practices. By bringing the solutions together within agricultural activities, such as the plant breeding, changing the genetic structure of seeds, sensitive equipment used in production, global positioning systems (GPS), unmanned aerial vehicles (UAV), internet of things that allows the equipment to be connected constitutes the concept of the smart farming. All kinds of agricultural machinery can be equipped with sensors, which because of digitalized agricultural sector and thanks to IoT, stay in interaction with each other during the production process. These smart technologies from which the data comes reveal the quality of soil, weather events, and minerals, which are necessary for the products and water demand, provide to collect data on the soil and the weather and analyze it quickly. Thus the producers can save both cost and time. (Türker et al., 2015: 290-291).

With the digitalization, agricultural vehicles such as tractors, harvesters, and plough have been converted into smart machinery, which reduces the workload of the producers and contribute to saving nature as well. The digital machinery provides high precision cultivation and harvesting. For instance, thanks to satellites in ploughs, the farmland which is cultivated can be measured precisely, and the whole land can be harvested completely (Zaimoğlu, 2019: 81).

The cloud systems, which provide data sharing among the users and can be used at any time for various devices, help to monitor the weather conditions which are crucial for the production and to measure the heat of the soil, to control irrigation systems, and take precautions to sudden weather changes such as forst, but they enable the producers living in different areas to share the data with each other as well (Ünal & Topakcı, 2013: 752).

The Internet of Things (IoT) used as one of the smart agricultural applications enables the producers to collect data, which is which seed to be used on their lands, the required amount of the fertilizer, changing conditions in climate, monitoring all the external conditions, from the machinery and computers they use while producing. Today, IoT technologies are mostly used in Israel and Thailand in the agricultural industry (Ercan et al., 2019: 260-261).

Cloud systems and IoT technology supplied from the big data, when interpreted with the proper analysis techniques, enable the producers to make strategic decisions and manage the possible risks. Though big data is not a primary production issue in the sector, it plays an important role in minimizing the concern about food safety and increasing the efficiency of the supply chain (Duman & Özsoy, 2019: 543). Accordingly, the big data enables us to compare the opportunities and plan the future cultivation and harvesting through the various calculations. It also enables to the management of the risk of harvested crop spoilage and increases the feed efficiency in livestock farms.

These systems are used actively in many areas. To make the cost of using of high technology affordable, the farmlands should be large scale. Uzun et al. (2018) presented that autonomous harvesters provide a better harvest; farmlands can be sowed and fertilized more precisely with autonomous tractors, agricultural machinery, and parts of fertile lands which are difficult to access can be sown with the help of robots.

It's foreseen that robots will be replaced with traditional machinery in the future of agricultural production. The existing robots which harvest, sow, fertilize, disinfect, battle weeds, and pest control are used in the sector at present. UAVs which enable the producers to save time and workload are one the most important technologies. It has become possible to follow the crop growth process, analyze the fertility, and perform the operations such as irrigation and fertilization of the cultivated land faster and more easily by means of UAVs. Besides UAVs, the robots which perform spraying and weeding processes also prevent all the crops from being contaminated by the pesticides harmful to human health by detecting the weed and spraying pesticides[1] used against the weed (Demir & Başayiğit, 2020: 13).

It's water that is one of the components vital for agricultural production. Regarding smart agricultural applications, the most significant benefit of the irrigation systems is to protect the water resources by preventing excessive irrigation. On the other side, it prevents the loss of soil and crop caused by excessive irrigation. Smart irrigation systems detect the amount of water the crops need by checking up on various factors, one of which is especially soil moisture. These systems, combined with the cloud and IoT technologies, enable to save time and cost substantially (Taştan, 2019: 230).

Smart Agricultural Technologies in The World

Netherlands, Israel, and Taiwan, which are leading ones in the agricultural sector, adopted smart agricultural technologies earlier than many other countries. In Agriculture 4.0: The Future of Farming Technology report published by the European Agricultural Machinery Association (CEMA) it is presented

1 Pesticide: The mixture of substances intended for preventing, controlling, repelling and mitigating harmful organisms.

that smart farming technologies are going to be the most important factor that will affect the agriculture until 2030 and a driving force for the sustainability of the agricultural activities in the European Union. The USA, which is one of the leading ones in terms of the use of the technology, both encourages the producers to use integrated technologies for the production and provides training to use farming technologies. Thanks to these incentives and supports, agricultural production, which is worth 300 billion dollars, is produced annually (Akıllı Tarım Platformu, 2019). Some examples of countries that actively use the prominent practices within the scope of "Smart agriculture / Agriculture 4.0" are given below.

Taiwan

Taiwan is leading both for production and use of the smart farming technologies in the world. Taiwan, which produces substantial systems such as LEDs that make UAVs, irrigation systems, solar panels, IoT, artificial photosynthesis possible, and vertical farming systems, has a strong position, especially in the Asia market (Chuang et al., 2020: 4).

Taiwan, which is an island country and does not have sufficient farmlands especially attaches importance to closed farming technologies. Accordingly, lightning technologies which lead plants to photosynthesize artificially are vital. Ranking second in the world in terms of the production of LED, Taiwan has transferred its success into agriculture. At the same time, the country which also works on robot and UAV production has an opportunity to harvest at any time of the year by means of special lights imitating sunlight in smart greenhouses (Kılavuz & Erdem, 2019: 139-140).

Attaching significant importance to indoor farming techniques in order to feed its population, Taiwan has vertical farming facilities which are more than ten times in height. In these facilities, besides controlling all kinds of weather conditions, alternative practices such as classical music, which is considered to contribute positively to the growth of the plants, are tried. By producing the components used within the smart farming practices, Taiwan both thrives its global commercial competitiveness and provides a strategic advantage.

In search of improving further in this sector, Taiwan provides various incentives such as tax reductions to the companies producing these technologies. It also encourages the practices such as good agricultural practices (organic farming) and a food safety management system to raise the sector to international standards (Hsu et al., 2020: 3).

Netherlands

The Netherlands, like Taiwan, attaches great importance to developing farming technologies because it does not have sufficient farmlands. The Netherlands, which sees the protection of the environment as valuable as

productivity in the agricultural sector, builds its smart farming practices in this direction. LED lights that imitate sunlight are used in greenhouses to produce sustainable agricultural products and cause less damage to the environment. Therefore, by using much less energy, a significant gain is achieved in terms of carbon emissions, costs are reduced, and sustainable production is made every period of the year (Ercan et al., 2019: 262).

Dutch producers have achieved great success regarding high technology in agriculture thanks to highly efficient irrigation systems, hybrid seed technologies, renewable energy systems, robots, big data analysis, and integrated automation systems. Thanks to this success, the Netherlands exported 94.5 billion euros of agricultural products in 2019 (Ministry of Trade of the Republic of Turkey, 2020).

Israel

Considering its geography and surface area, Israel, which is thought to not have a comparative advantage in agriculture, has become a globally prominent country regarding agriculture thanks to its intensive R&D activities. Introducing the drip irrigation system, Israel, is one of the few countries that can interfere with seed genetics. The country, which is self-sufficient in agricultural food production and can gain production even on the lands which is not suitable for farming with the latest technology, also exports a significant amount of agricultural products. Israel, which has scarce soil and water resources, has implemented many successful practices such as efficient irrigation systems, drought-resistant seed varieties, and storage operations that increase the durability of post-harvest products (Arıcıoğlu et al., 2020: 5-6). Thus Israel has achieved a comparative advantage that it does not have with natural conditions, thanks to the smart farming technologies it uses.

Israel, which allocates 17% of its budget to R&D studies within the agricultural sector, focuses on computer-controlled drip irrigation, biological pest control, and the production of new fruit and vegetable varieties. Having a serious problem regarding freshwater resources, the country also works intensively on water recycling and saltwater treatment systems (Kirmikil & Ertaş, 2020: 7-8).

In the greenhouse in Arava, an agricultural production center located in the middle of the desert, irrigation and fertilization are carried out by means of integrated computer systems, harmful plants are tackled, and energy is obtained with solar panels. Accordingly, crops can be grown on land which is not suitable for agriculture, and substantial cost savings can be made. Due to the desert climate, heating and cooling operations are done to compensate for the very low temperature at night and very high temperature during the day in this facility, which helps to obtain several times more efficiency. This

sample stands out among the smart agricultural practices in Israel in terms of its capacity and efficiency (Gelb et al., 2009: 22).

Smart Agricultural Practices in Turkey

In the near future, due to climate change, it has been understood that the optimal production amount and the price will not be formed by considering only market mechanisms, and it has emerged that the agricultural industry is an important and strategic sector that cannot be left to this mechanism. In this regard, studies have started to produce not only food but also all components that the industry needs and have to be imported due to insufficient production, with innovative practices such as smart agriculture.

A considerable part of the agricultural business in Turkey is in the form of a small-scale family business, which leads to the subsistence of agricultural production and the absence of concerns such as productivity and marketing. High input costs also increase food prices on a unit basis due to the low amount of production. There is a serious decrease in water resources as a result of unconscious irrigation as well (Kılavuz & Erdem, 2019: 148).

Regarding the agricultural practices, efficient use of water resources, consolidations of lands, training especially small-scale family farmers, the start of production in a way that is suitable for economies of scale, cooperativeness, and agricultural development sector with incentives and guidance provided by the state have both an economic and strategic importance (Kirmikil & Ertaş, 2020: 3-4). The agricultural sector, which needs more support than others, should be supported regarding agricultural R&D, smart agricultural techniques, water management, and farmer training rather than the direct income support.

Considering the potential impact of smart agricultural practices on the economy, various policies have been developed and various studies, one of which is the Smart Agriculture Feasibility Project, which was implemented in 2015 in cooperation with TUBITAK Space Technologies Research Institute and Ankara University Faculty of Agriculture have been initiated. Within the project, the Central Anatolia Region has been selected as a pilot region, and studies have been initiated to develop new models for agricultural activities in the region. The goal of the project is to develop irrigation and fertilization models regarding smart agricultural techniques. At the same, it is aimed to create productivity maps with remotely accessible devices and to analyze various data to detect agricultural diseases (Akıllı Tarım Platformu, 2019: 11-12).

Another example of recent work in the agricultural sector is Doktar Agriculture and Livestock Information Systems Research and Development Industry and Corporation, which was established within the Ege University within the scope of TUBİTAK support to provide services to producers in agricultural technologies. Thus, it is aimed to develop technologies and carry out studies

that will appeal to 130 thousand registered farmers, 117 different crops, 800 thousand hectares of farmlands, and agricultural products worth 1.5 billion TL (Ercan et al., 263).

Smart farming practices are also supported by the private sector in Turkey. Cloud solutions, M2M services, remote access systems, greenhouse and poultry monitoring applications, and data collection and data analysis offered by companies, especially such as Türk Telekom, Turkcell, and Vodafone to the producers are prominent applications (Akıllı Tarım Platformu, 2019: 14-15).

Conclusion

Climate change affects the agricultural sector directly and profoundly. Agricultural activities carried out with traditional techniques accelerate the changes in climate; on the other hand, they face the danger of unsustainability due to this issue. Factors such as the shrinkage of the arable lands, decrease in productivity and production amount and increase in costs seriously obstruct continuing production with the traditional methods. In this regard, smart agricultural techniques should become widespread in the sector, and the producers should be made aware of the issue. In addition, the incentives and supports provided by the state are also crucial.

Costs of high-tech equipment and systems to be used within the smart farming practices might be unaffordable, especially for the producers who are family-owned. Therefore, it would be appropriate to bring producers together under the guidance of the state and/or supported by government incentives. R&D studies to be carried out in the area will reduce costs and make these technologies and systems available. Especially equipment and systems produced with domestic facilities are highly important. In this regard, it's necessary to support domestic companies engaged in R&D and production in the field of smart agriculture applications.

Unlike the developed countries, to reveal the current situation in the transformation process of Turkey's agricultural sector, identification of potential in the area and a long-term roadmap should be created. Accordingly, the public and private sectors should act in coordination. Public incentives should be supported by private sector consultancy and guidance. Consequently, it will be possible that the transformation process will be completed in a short time, and the producers in Turkey will compete with the producers who use the smart farming applications in the developed countries.

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