THE NATIONAL TECHNOLOGY INITIATIVE IN THE AGRICULTURAL AND FOOD SECTORS

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Abstract

Türkiye, with its geographical advantages and the products it produces in the field of agriculture, is making significant progress in the agricultural field day by day. The effects of technologies used in agriculture within the food, agriculture, energy chain and the increasing impact on related sectors and application areas have made the development of domestic and national technologies in many areas within the agriculture and food production chain even more strategic. The concept of national, on the other hand, refers to what belongs to a nation. The National Technology Initiative is of critical importance as the key to our country's ability to protect the data of its citizens and to develop and produce strategically valuable technology products with its own capabilities. The National Technology Initiative aims to contribute to the sectoral roadmaps, which are prepared in order to increase production efficiency, increase the efficiency of input use and reduce foreign dependency with alternative sources through energy efficiency, with technological product-based targets in sectors such as food, agriculture and livestock. Among these sectors, agriculture, like all economic sectors, uses a wide range of modern technologies. After the pandemic, agriculture has become much more technology and information intensive. Today, it requires much more than farming, that is, more integration and integration with other sectors, necessitating integration through digitalization. Realizing a national strategy to support national technologies is a process that takes into account the country's own rural development goals and includes all stakeholders in the industry. Türkiye's agriculture will reach the position it deserves in the global competitive environment brought by the digital age, in addition to current policies, this National Technology Initiative will be handled with the right strategy and policies that take into account the needs and expectations of all stakeholders. In this study, national technologies developed in our country in the field of agriculture are discussed and important information about their use and studies in this field are presented. It is expected that the national technologies developed in this context will increasingly continue to contribute and support the producers and farmers in the production and productivity of our country's agriculture in the future.

Keywords

National technology initiative, Technology, Agricultural technologies, Digital technologies, Innovation

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1. National Technologies Developed in the Agricultural Sector

1.1 Drone and Unmanned Aerial Vehicle (UAV) Systems

In agricultural areas, it is critical to promptly obtain accurate information suitable to local conditions to utilize the resources in the best possible way. More and more sectors implement the use of drones. With this technology, agricultural activities such as aerial imaging, determination of moisture content and thus time for irrigation, crop monitoring, yield evaluation, diagnosis of diseases and spraying take less time (Figure 1). Remote sensing methods for real-time monitoring of the development of field crops are essential in precision agriculture applications with UAVs (Türker, 2021). Among the remote sensing devices, multispectral cameras offer an economical and reliable solution for agricultural practices and stand out with their lightweight alternatives for UAV use. In particular, it is difficult for farmers to check their fields if they are scattered across the land because of distance and time limitations. Thanks to this technology, aerial vehicles perform crop scouting and get the information that the farmers need. Among the current systems, the fixed-wing platform has the advantage of covering large areas efficiently, while the multi-rotor platforms can remain very stable in harsh conditions with heavy loads. Drones enable mapping for early soil analysis. This way, planting, irrigation and nitrogen supplementation planning can be carried out. The process of using drones to map or scout crops is quite simple. Many new agricultural aircraft models are equipped with flight planning software that allows the user to plot flights over the area to be covered. Then, the software creates an automated flight path and sometimes even prepares the camera footage. Global market analysis predictions show that there will be $1 billion in sales by 2024 in the agricultural drone market by and farmers will have significantly contributed to the technological development of drone software and mechanization used by drones by 2024 (Tan, 2015; Çakan, 2018).

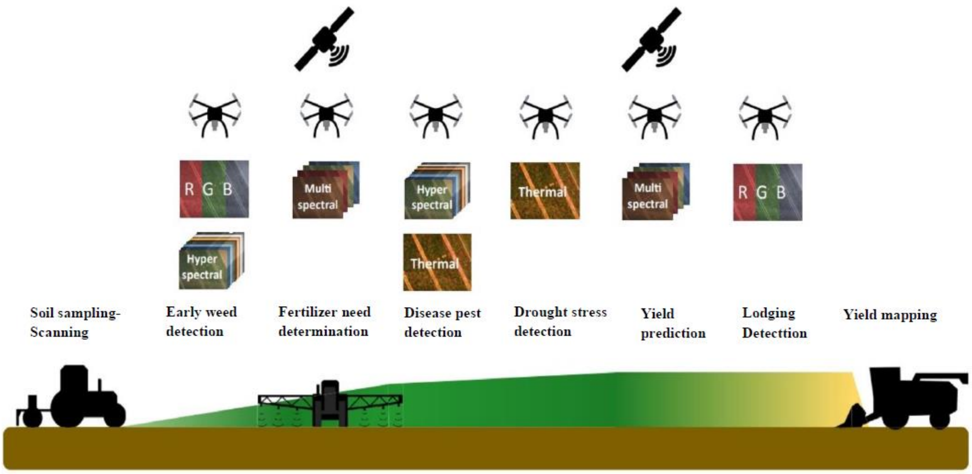

Figure 1. *The areas of usage of UAVs in precision agriculture (Türker, 2021)*

Spectral imaging and remote sensing are becoming widespread in fixed-wing or multi-rotor aerial vehicles. In cases where long distances are expected to be scanned in a short time, the advantages of fixed-wing platforms are used and where scanning is required in a specific region, the benefits of multi-rotor platforms are employed. In Türkiye, for national and native technology, the ASELSAN company has adapted the Mini Unmanned Aerial System (MUAS) and SERCE (Sparrow) systems, which were initially developed for the defense industry, for agricultural use in the General Directorate of Agricultural Research and Policies (TAGEM) project for the Ministry of Agriculture. MUAS consists of a compact and light fixed-wing aircraft, autopilot, payload and ground control station. With its modular design and payload, it can successfully perform reconnaissance and surveillance missions for all kinds of tactical needs. The electro-optical/infra-red (EO/IR) camera used in the payload can easily be swapped in the field without disassembling the gimbal. Within the limits of the aerial vehicle, different tasks can be performed by integrating different payloads other than the standard payload. The fully autonomous aircraft, seen in Figure 2, has a maximum take-off weight of 8 kg. It can carry a payload up to 1.2 kg, has a wing span of 3 meters, has a flight speed of 45 to 130 km/h, can stay in the air for 2 hours and has a mission radius of 1 km. It can be launched autonomously by simply throwing it by hand and can perform an autonomous landing on its fuselage or with a parachute. The system consists of two aircraft (including payload and autopilot) and a ground control station, which can be carried by two people (Aselsan, 2017).

Figure 2. *Mini Unmanned Aerial System (MUAS) (Aselsan, 2017)*

SERCE-1 is a multi-rotor (a rotary wing) unmanned aerial vehicle system equipped with different payloads, mainly for reconnaissance and surveillance missions and can perform fully autonomous missions. Designed to work in difficult conditions with its high payload capacity, SERCE-1 can operate day and night with its standard integrated camera. The fully autonomous aircraft, seen in Figure 3, has a maximum take-off weight of 6.5 kg. It can carry a payload of up to 1 kg. With the maximum take-off weight, it has a 30-minute flight duration and a 3 km communication range. It can withstand wind speeds up to 54 km/h. It has features such as autonomous take-off and landing, geolock, single point navigation, waypoint navigation and smart battery management. Autopilot software flies the aircraft within certain cycles and flight modes. “Roll from Heading” and “Heading from Cross-Track” have been optimized to increase return performance and for a better flight path, respectively.

This system was used to take agricultural images at the Field Crops Institute in Haymana, Türkiye. The images obtained after the first flight with its 6-band multispectral camera were converted into maps using the developed image processing workflow. RGB information, the image formed by infra-red channels and normalized difference vegetation index (NDVI) maps were obtained from each flight. The NDVI index map showing the plant growth as a result of a flight in 2017 is given in Figure 4.

Figure 3. *SERCE multi-rotor air vehicle and gimbal + Headwall HS camera position (Aselsan, 2017)*

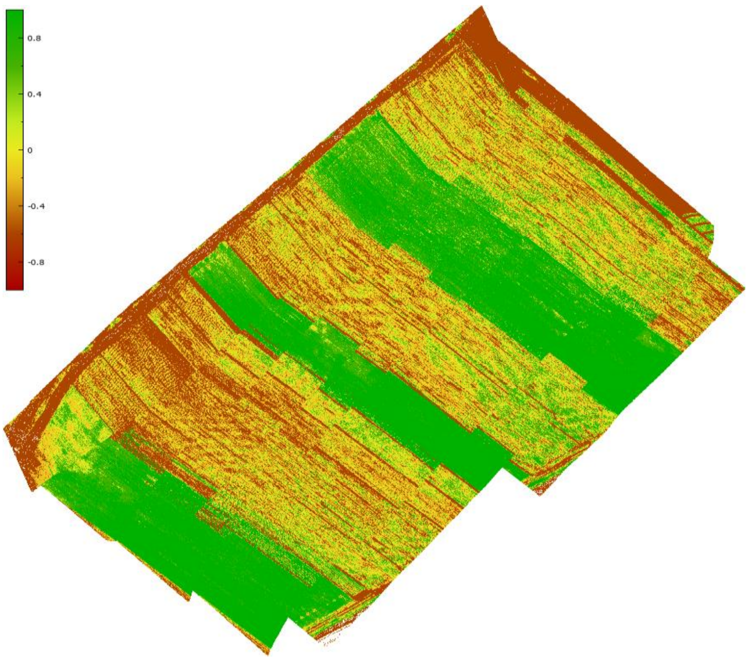

Figure 4. *The NDVI map obtained by MUAS (Aselsan, 2017)*

1.2 Research on electric tractors in Türkiye

A prototype electric tractor was built within the scope of a study initiated in 2019 by the Ministry of Agriculture and Forestry and led by the General Directorate of Agricultural Research and Policies (TAGEM). This 75 kW (105 hp) field-class electric tractor featured four-wheel drive (4WD) maneuvering and steering capability. It was reported that a battery capacity of 53 kWh had been achieved by connecting 236 prismatic LiPO4 batteries in series. The battery charging system was designed to be suitable for plug-in connection and a three-phase socket was used for charging. The battery charging system can be charged from single-phase sockets in case there was no access to three-phase and the software used in the tractor was completely native. The 386 nm of torque produced by the engine and the torque reserve value of 30 percent are considered quite sufficient for a tractor in this category (Anonymous, 2020). The field tests showed that it could work up to 7 hours daily.

1.3 Automatic Steering Systems and Autonomous Agricultural Vehicles

Along with Industry 4.0, many tractors and agricultural vehicle manufacturers started the production of autonomous vehicles, especially tractors and combined harvesters, that can be adapted to smart agricultural applications and regularly drive without the need for a driver. They have a sensing system using technologies and techniques such as radar, lidar, GPS, odometry, sensors and computer vision (Tan, 2015). Automatic steering systems have made it possible for faster and more precise tillage without leaving any gaps or overlapping regardless of weather, with less soil compaction, almost zero operator fatigue, zero error risk, convenience for subsequent work (harvest etc.) and savings in fuel, pesticide, seed, fertilizer and labor.

In general, these systems are meant to prevent human errors in agricultural activities. Automatic systems perform the steering (driving) by themselves with the different signal types and sensitivity values received from a satellite; thus, the work's efficiency increases. The use of these systems, especially in plants that need a certain space, such as corn, cotton and sunflower, helps to use inputs such as seeds, pesticides and fertilizers correctly to reduce costs. According to some academic studies, saving 10% of total expenses, 9% in fuel and 17% in time with automatic steering is possible. With the tractor and connected equipment exchanging data over a common protocol, reaching maximum efficiency with zero error (regardless of natural conditions) is now possible after entering the system parameters into the smart agriculture systems.

1.4 The National Technology for Automatic Tractor Steering and Control System (OTAK)

The Automatic Tractor Steering and Control System (OTAK), which is seen as meeting the need for an integrated domestic system for precision agriculture that will increase agricultural productivity in Türkiye, has been developed with contributions from ASELSAN and TAGEM. OTAK is a system that enables the tractor to steer precisely, using differential global positioning system (DGPS) signals and the slope information from the tractor. With the automatic steering system, less doubling (overlap) happens in seed planting, tillage, fertilization and spraying. This saves both fuel and time. With the development of this prototype system, the aim was to gain important skills and to achieve nationalization regarding the automatic steering system for precision agriculture (Figure 5) (Gürlek and Lafçı, 2017). The project consisted of two main parts. These were as follows:

a) System Design and Integration of Tractors

Integration studies were carried out on one of the two tractors supplied by TAGEM. Once a structure that did not require further modification was achieved, the same modifications were carried out on the second tractor. In the initial stage, integration studies were carried out on a CASE İ-H model tractor with a closed cabin. Intermediate mechanics necessary for the assembly of the units were manufactured and mounted on the tractors. Afterward, the external cabling produced for the tractor was mounted and other units were assembled. In the subsequent stage, the same operations were performed on a VALTRA model tractor. Within the scope of software studies, the user interface (UI) software and navigation software (NS) were designed and their infrastructures created (Gürlek and Lafçı, 2017).

b) Field Tests

Field trials were conducted at ASELSAN's Akyurt facilities and on land owned by TAGEM in Haymana, Türkiye, to determine a suitable use of the developed system. The malfunctions and calibration errors in the system were eliminated based on the results.

Agricultural production is an activity of high strategic importance in the globalizing world economy. The increasing global competition has made using new technologies in agricultural production inevitable to increase the yield from agriculture in countries with limited arable agricultural areas like Türkiye. Advancements in microprocessors and other electronic equipment enable farmers to achieve their economic targets. Electronic guidance is among the systems that will be adapted soon in this new agricultural production approach. Today, in parallel with the development of big machines with great working capacity, the increase in working speeds in the field has made it very difficult for drivers to steer the machines/tools on parallel tracks. For this reason, modern steering systems are being developed and put at the disposal of farmers. OTAK is an automatic steering system that enables the steering of the tractor to be controlled automatically, depending on the terrain contours and profile desired by the user. With OTAK, the aim is to obtain a high yield and income from agricultural areas by using modern electronic guidance systems, taking some workload away from the farmers.

The project aims to shorten the cultivation times for agricultural lands, continue agricultural activities in bad weather conditions and to obtain the highest level of yield even from limited agricultural areas. The system makes it possible for the farmer not to have to steer at all, allowing him/her to focus more on the agricultural field. On difficult terrain, it is not possible to go straight for long distances with a tractor tiller. OTAK aims to reduce the fatigue of the farmer by minimizing the difficulties experienced by the farmer in using the tractor on such lands. Thanks to the developed system, an automatic steering system can be used for forming the ridges of crops between rows, in all kinds of soil cultivation, precise seed planting, spraying and fertilization.

The OTAK system, using sensitive DGPS signals, performs the necessary steering control for the tractor depending on the direction desired by the farmer. The farmer controls the speed. If the tractor moves onto a slope, the slope of the tractor is measured with the slope sensor and positioning errors due to the slope are corrected. In this way, the possibility of re-plowing the same area or leaving an unplowed area that may occur due to a positioning error caused by the slope can be minimized and yield losses are prevented. Current steering systems are imported and they are costly. The demand for such systems in our country is increasing day by day. OTAK system prototypes were developed to meet this need with domestic resources and produce national standardized automatic steering systems. Integration and testing procedures were carried out for two tractor models that are widely used in Türkiye, which TAGEM provided for the project. Within the scope of software studies, user interface (UI) software and navigation software (NS) were designed domestically (Gürlek and Lafçı, 2017).

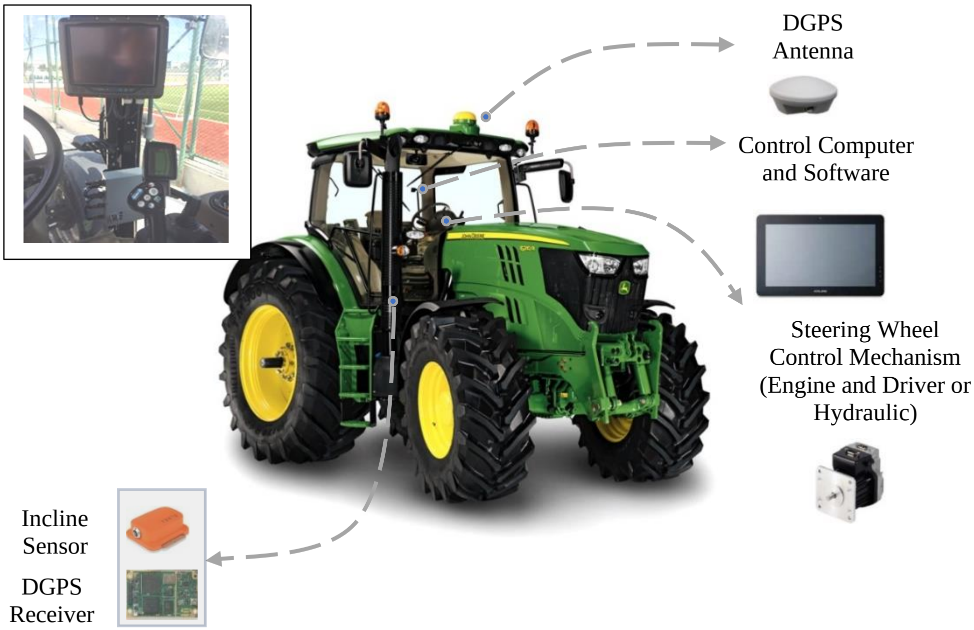

Figure 5. *The OTAK system (Gürlek and Lafçı, 2017)*

1.4.1 User Interface (UI) and System Interface (SI)

The user interface (UI) programs the field border, the recording, determination of the row and recording of the determining rows, loads the recorded field borders and rows later and enters the widths and distances between the blades of the equipment – such as plough, sweep, seeds attached to the tractor and the parallel tracks – and allows them to be adjusted according to new equipment dimensions. Figure 6 shows the start screen of the UI on the panel computer and the names of the buttons on this screen.

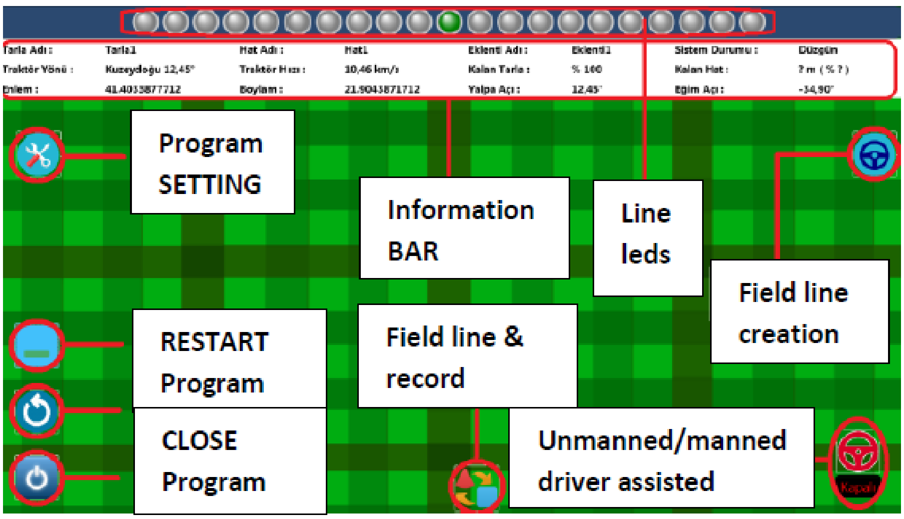

Figure 6. *User Interface in OTAK*

When the system is turned on, there is a white panel that shows the field and row number selected at the top of the screen, along with the latitude, longitude, orientation, bank angle and slope angle of the tractor's current location, the instantaneous speed of the tractor, the percentage of the area and row to be plowed in the selected field and the attachment and status of the system. There are 21 LEDs at the top of the panel. These LEDs light up in color tones that increase up to red to show deviations from the programmed row in the driver-assisted usage mode (Figure 7). A screenshot from the field tests made with the system developed in this way is given in Figure 7.

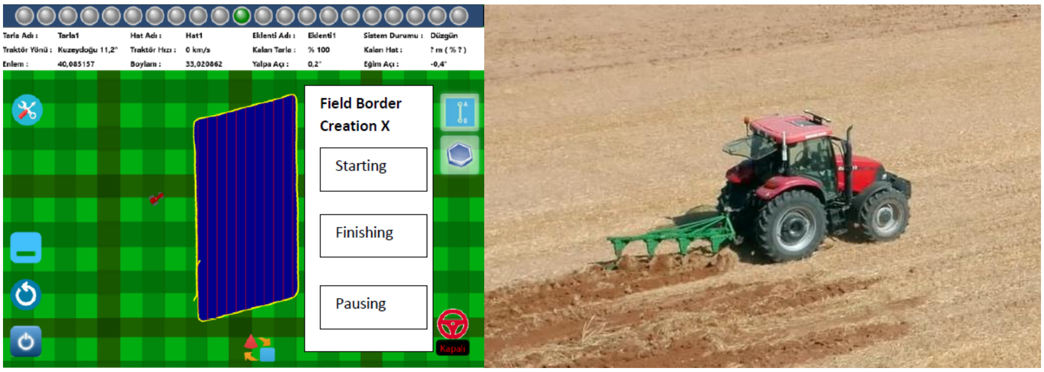

Figure 7. *Making rows and testing the system in the field*

1.5 Farm Management System

The IT sector in Türkiye hardly had any interest in agricultural applications for many years. In developed countries, agriculture is undergoing a serious evolution that is sensitive to humans, plants, animals and the environment and allows for an increase in production quality and yield with the development of information technologies. This has taken the agricultural business to a new level; thus, smart farming and machinery systems have emerged. In Türkiye, no domestic integrated system for precision agriculture sends map-based work packages to the tractor in the field via wireless communication from a control center on the farm and executes and reports on the work schedule with ISOBUS-compatible agricultural machines. A domestic farm management system was developed to meet this need with a project supported by the Ministry of Agriculture and Forestry and conducted by ASELSAN (Demirtürk et al., 2017). Within the scope of the project, a system that can work on the tractor in the field connected to a control center has been developed and integrated. The agricultural management system aims to enable the messages collected from an international ISO 11783 standard interface on agricultural vehicles to be transmitted over a long distance via a wireless communication link and to enable the collected data to be processed on the map, viewed and historically analyzed. With ISOBUS, it is possible to connect agricultural machines that will work with the tractor and thus, many functions such as variable-ratio applications and automatic steering can be performed via a single terminal. Thanks to this system, the farmer can monitor the operating parameters of the agricultural vehicle on the screen. Within the scope of this project, a system was developed where some of the system units are located on the tractor in the field and the others are located in the farm management center. The system communicates with the fertilizer equipment mounted on the back of the tractor in the field via ISOBUS.

This type of data communication technology does not work just between mobile phones and computers any longer; it also works between vehicles, places, production machines and wearable devices such as watches. Thus, each of them is turned into a communication tool. Data collection and communication with interconnected devices will also increase soon. Recent communication technologies such as 5G connectivity offer uninterrupted communication by almost eliminating the time difference between physical and cyber systems. The fastest and most cost-effective infrastructure investments that will provide data communication will enable the industry and service sectors to increase their current work efficiency, develop new products and services and thus maintain their global competitiveness.

1.6 E-Agriculture

E-Agriculture covers the entire agriculture and food system and supports the use of all kinds of communication tools in agriculture and food production. Within this context, under the coordination of the General Directorate of Agricultural Research and Policies and in cooperation with the United Nations Food and Agriculture Organization (FAO), a project titled "Support to Develop National E-Agriculture Strategy" was completed in 2022. In the project, the current state of digitalization in Türkiye has been determined and a national five-year E-Agriculture strategy has been developed. With this strategy paper, the concept of E-Agriculture, which deals with the concepts of smart agriculture, precision agriculture, agriculture 4.0 and digital agriculture, which has been frequently used in Türkiye in recent years, has been developed and country strategies for the use of information and communication technologies in all processes from soil to fork have been presented. As a result of this study, E-Agricultural solutions were listed and modified according to our country. The E-Solution priorities listed below have been determined and action plans have been developed by prioritizing them according to their contribution to the solution of problems (Türker et al., 2022).

a) Agricultural Marketing, Market and Logistics

This involves:

The creation of an online investor information system for agricultural investors

The establishment of a digital agriculture market

The creation of an environment for e-commerce

The development of a methodology for modeling agriculture and viewing livestock commodities.

b) Digitization in Farmer Education and Publications

This involves:

The development of e-learning contents

The establishment of a consultancy system on e-Agriculture

The development of electronic and mobile applications for publication, information and public services

The creation of digital agricultural libraries, virtual reality, augmented virtual reality technologies and simulated training models in agricultural publications.

c) Data and Monitoring

This involves:

Creating data control and validation contents

Building livestock record systems based on remote digital monitoring

Setting up a database of agricultural technology and mechanical tool manufacturers

The creation of a database of agricultural products storage facilities.

The establishment of farm mechanization information and services

Building ICT infrastructure for data collection, storage, analysis and sharing

The implementation of Big Data and data mining infrastructure

The development of agricultural workforce information systems and starting a farm-to-fork digital tracking system on the basis of the value chain.

d) R&D

This involves:

The creation of agricultural research databases

The development of online research training portals.

e) Environment, Bio-safety and Climate Change

This involves:

The setting up environmental impact monitoring and evaluation system for agricultural activities

The creation of a fertilizer history information system by land area

The establishment of a biosafety monitoring system

The development of policies for the improvement and dissemination of digital insect traps

The designing of systems for climate change modeling

The installation of a digital tracking system for agricultural wastes

The online tracking of soil and water budgets

The monitoring of irrigation water pollution via sensors and the establishment of a warning system

The monitoring of the use of pesticides specific to agricultural plots.

f) Early Warning Systems

This involves:

The installation of forecast and warning systems for diseases and pests

The setting up meteorological and agricultural early warning systems.

g) Smart/Precision Agricultural Systems

This involves:

The development of IoT-based soil analysis and irrigation monitoring systems

The development of a policy to expand the use of drones for agricultural purposes

The dissemination of computer-controlled air conditioning systems in greenhouses

The dissemination of digital harvest and post-harvest loss detection and prevention systems

The development and dissemination of herd and meadow management systems

The development and dissemination of wireless hive tracking systems

The development of a policy to promote the use of robots for agricultural purposes

The development of a policy to expand the use of autonomous tractors in agriculture

The development of a policy for the dissemination of smart irrigation technologies

The development of a policy for the dissemination of ISOBUS standards

The establishment of smart business systems remote monitoring and control

Providing farmers with low-cost wireless internet access

The development of a telecommunications policy for broadband internet access in rural areas.

1.7 Development of National Mobile Precision Agriculture Applications

Within the scope of the Precision Agriculture and Dissemination of Sustainable Practices Project in the GAP Region (GAP Precision Agriculture Project), carried out by TÜBİTAK Uzay and the GAP Regional Development Administration, the aim is to achieve 25% savings in fertilizer use by supporting agriculture with space technologies. R&D studies in space technologies have increased drastically and the domestically developed technologies are used in agricultural production to contribute to increase yield in this sector. Within the scope of the GAP Precision Agriculture Project, supported by the GAP Regional Development Administration of the Ministry of Industry and Technology, precision agriculture research has been carried out to achieve the best yield rates by applying the right amount of agricultural input, especially fertilizer, at the right time and the right rate.

In the first phase of the GAP Precision Agriculture Project, images of the region were collected in cooperation with TÜBİTAK Uzay and HAVELSAN via Göktürk-2 and numerous electro-optical and Synthetic Aperture Radar (SAR) satellites belonging to many European Union countries and NASA. In addition, aerial photographs were taken on different dates of the pilot area in the Harran Plain with a hyperspectral camera attached to an aircraft of the Defense Industry Agency. Aerial data collection was conducted simultaneously with ground data collection, by which spectral reflections of the different phases of wheat, corn and cotton crops were measured. Within the scope of the project, the first National Precision Agriculture Application Software was developed and made available. The crop patterns of cultivated wheat, corn and cotton in the Harran Plain were identified with an accuracy of 99 percent using satellite images and with an accuracy of 95 percent using aerial images. Analyses such as anomaly detection, crop classification, plant health and plant growth were performed. Soil survey and yield maps were integrated into the system by creating a farmer–consultant interface to deliver analyses to farmers through agricultural agents. In this way, local farmers have become able to monitor the status of the crop in their own fields in real-time via mobile platforms. In the second phase of the project, variable fertilization ratio applications were conducted and 25 percent savings were achieved in the use of fertilizer, which is the most expensive input. Soil maps, crop yield maps and unmanned aerial vehicle (UAV) images were analyzed and automatic variable fertilization ratios were applied in the fields of the GAP Agricultural Research Institute (GAPTAEM), part of the General Directorate of Agricultural Research and Policies of the Ministry of Agriculture and Forestry

Within the scope of the project, analysis and research were performed on subjects such as variable base and top fertilization ratios, crop pattern maps, crop yield estimation, weed detection, crop yield maps and soil nutrient maps using satellite and UAV images. It is expected that the results will make a significant contribution to the R&D and manufacturing processes of precision farming tools and equipment both in the region and throughout Türkiye. It is also expected that these studies will contribute to the national food security of Türkiye.

1.8 Developing a System for Monitoring and Tracking Grain Losses in Wheat Harvest

The Ministry of Agriculture and Forestry developed a system that can transmit data to a remote monitoring center via a GSM/GPRS system connected to a central module, with sensors mounted on the combine harvester and using a GPS system under the title Development of a System for Monitoring and Tracking Grain Loss in the Wheat Harvest. This system has been designed in a way that data communication and database application are executed from an internet-based and integrated control center. After this project, a further continuation project: the Cloud-Based Yield Monitoring, Mapping and Tracking System Development Project (for combined harvesters using Türkiye), was initiated (Anonymous, 2018).

1.9 Development of Variable Fertilizer Ratio Application Technology in Precision Agriculture

It is possible to use less agricultural inputs by making a heterogeneous application in the field using fertilization and spraying – and even irrigation recipes – prepared by considering the current weather conditions and soil parameters and the yield map of the field from the previous season (by giving as much fertilizer as it needs in the region), thus making more profitable farming and causing less contamination. Only 200 to 400 kilograms of each ton of fertilizer in traditional agriculture can be used by the plant and the remainder is unused, causing negative effects on the environment. This leads to both disruption of the structure of the soil and increased input costs. This ratio can be improved with precision agriculture. Considering the measurements made with a simple sensor in grain in France, an average of 70 € per hectare gain was achieved, with a protein increase in the crop, an increase in the yield and less fertilizer use (Türker, 2018). Map-based application technologies are applied by georeference mapping of the nutrients in the soil with GPS and then developing the application maps as a result of evaluating them in combination with the yield maps before applying fertilizer with GPS and smart machines in the field. In Türkiye, this technology has been developed by university, industry and private sector initiatives (Fig. 8). This domestic system has been patented. Images from the tests of these systems in Adana are given in Figure 8 below. The system can apply the fertilizer distribution map to the land by georeferencing through the machines.

Figure 8. *The first domestic smart machine was developed for map-based application in Türkiye (Türker, 2015)*

1.9 Other New Technologies in Agriculture that the National Technology Initiative Will Bring

In addition to the agricultural technologies developed in combination with the National Technologie Initiative discussed above, significant developments are expected from technological advancements. The use of internet-based applications in agriculture, the ability of different devices, sensors and machines to communicate with each other over internet networks, their use in decision support systems by producing huge amounts of data and their transformation into meaningful and usable information for farmers, can be seen as important areas of progress in Türkiye. Blockchain technology has the potential to be a game-changer in the agri-food business because it offers complete transparency over who adds value or changes prices at different stages of the value chain (Anonymous, 2020).

These technological advances could theoretically one day even eliminate the need for retailers. There is great potential for these and other technologies to transform agriculture. It could make agriculture more productive, safer, less labor-intensive, more attractive to young people with ICT skills and perhaps more suitable for older people who are less active.

The other fields where technological developments are expected in our country are given below:

a) 5G and beyond connection technologies
b) Artificial intelligence and machine learning
c) Robotics and autonomy
d) Internet of Things
e) Big Data and Data Analytics

Conclusions

The development of national technologies in agriculture can provide important contributions to the national economy, as the defense industry has done. National technologies help reduce costs and increase production efficiency by combining science and technology in the best way. In this way, it is possible to support the agricultural enterprises in terms of achieving their future goals, protecting the environment and being cost-friendly. More agricultural production will be needed in the future. This will be possible by increasing the yield from a unit area. Globally, since the early 1990s, with the development of information technologies, there has been a process of change that is sensitive to humans, plants, animals and the environment and that prioritizes the quality and productivity factors in production. It is necessary to keep up with this change by developing our own technologies with National Technology Initiatives and making them available to our farmers. The National Technology Initiative is the key for Türkiye's producers to protect their data and to develop and produce strategically valuable technology products through their own capabilities. In sectors such as food, agriculture and livestock, it is expected to contribute more to sector roadmaps that are prepared to increase the efficiency of sectors and reduce foreign dependency with alternative sources using technological products based on national technologies.

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