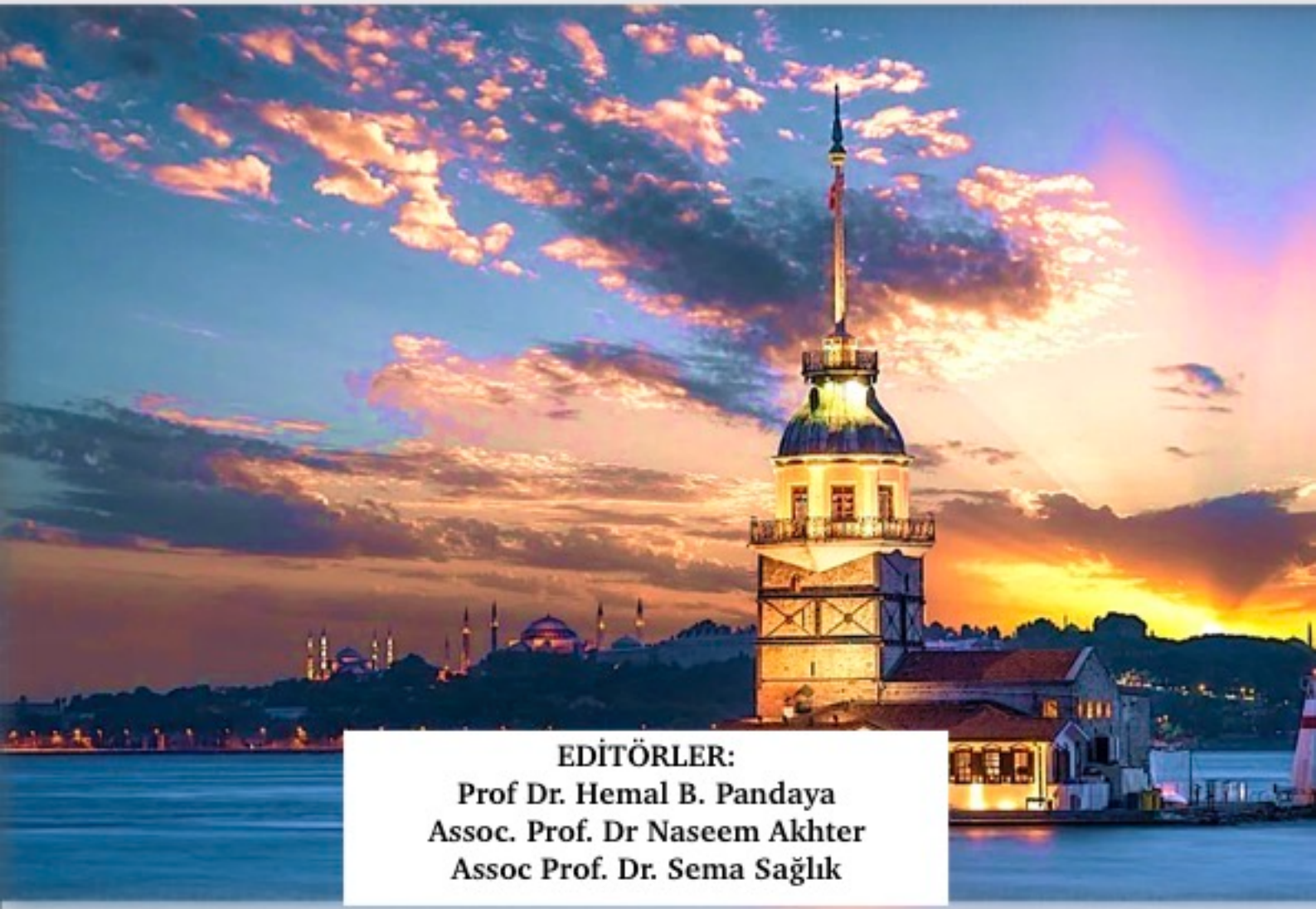
1.ULUSLARARASI ÜSKÜDAR BİLİMSEL ARAŞTIRMALAR KONGRESİ
19-20 TEMMUZ 2024
İSTANBUL



EDİTÖRLER:
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KONGRE KİTABI

CONGRESS ID

CONGRESS TITLE

1. INTERNATIONAL ÜSKÜDAR SCIENTIFIC RESEARCH AND INNOVATION CONGRESS

DATE AND PLACE

19-20 JULY 2024, İSTANBUL ONLINE PRESENTATIONS

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Kübra Nur EVİN Assist. Prof. Dr. Yasin PARLATIR	Kırıkkale University	Evaluation Of Red Blood Cell Distribution Width In Acute Gastroenteritis Cases In Cats
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SMART AGRICULTURE (AGRICULTURE 4.0) APPLICATIONS IN ORGANIC FARMING

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ABSTRACT

It can be clearly seen that agriculture is one of the sectors that rapidly adapts to industrial developments. The use of the Internet in many areas and its widespread use with the expression "internet of things" has started to create the fourth industrial revolution and this revolution is called Industry 4.0. The main feature of the time period in which the first revolution, defined as Agriculture 1.0, took place, is that the mode of production with low productivity and labor predominance prevailed. Towards the end of the 1950s, synthetic pesticides, fertilizers and machines that provide greater effects brought production costs to lower levels, and thus the Agriculture 2.0 period called the "Green Revolution" emerged. There has been an increase in productivity in agriculture with lower costs and new practices. With GPS signals becoming available to everyone, the Agriculture 3.0 process in the 1990s was named with the concept of "Precision Agriculture" today. Along with GPS technology, manual guidance applications and VRA (Variable Rate Application) systems applied to harvesting machines, especially monitoring and monitoring the fertilization process, emerged as prominent technology systems applied in this period. Reasons such as the inadequacy of traditional agriculture to meet the needs of the increasing population, the increase in environmental pollution caused by agricultural production, the necessity of ensuring agricultural sustainability and food reliability have necessitated new approaches in agricultural production. For this reason, the use of smart technologies, which are on the rise, in agricultural production has come to the fore. Smart Agriculture is an agricultural management concept that uses modern technology to increase the yield and quality of agricultural products. With this compilation study, the interaction of smart agricultural techniques in terms of organic agriculture will be evaluated by emphasizing what is understood from the industrial revolution and the concept of agriculture 4.0 in our country, the areas of use of modern technology in agriculture and the point reached in our country.

Keywords: Smart Agriculture, Agriculture 4.0, Organic farming, Turkey

1. Introduction

Industry 4.0 or 4th Industrial Revolution is a collective term that includes many contemporary automation systems, data exchanges and production technologies (Lejon and Frankelius, 2015; Frankelius et al. 2017). This revolution is a set of values consisting of the internet of things, internet services and cyber-physical systems. At the same time, this structure plays a major role in the formation of a smart production system. Since this revolution will enable the collection of every data in the production environment and its good monitoring and analysis, it will create more efficient business models compared to the collection of data from the human eye and delayed decision processes (Ağızan et al. 2022).

The first industrial revolution (1.0) emerged with mechanical production systems using water and steam power. With the second industrial revolution (2.0), mass production was introduced with the help of electrical power. In the third industrial revolution (3.0), production was further automated with the digital revolution, the use of electronics and the development of IT (Information Technologies). The historical change until the fourth industrial revolution (4.0) is summarized as follows (Şahin, 2022; Anonimous, 2024).

Industry 4.0 generally consists of the following 3 structures:

► Internet of Things
► Internet of Services
► Cyber-Physical Systems

Within the scope of Industry 4.0 and modular smart factories, it is aimed to monitor physical processes with cyber-physical systems, create a virtual copy of the physical world and make decentralized decisions. With the Internet of Things, cyber-physical systems will be able to communicate and work collaboratively with each other and with people in real time. With the internet of services, both internal and cross-organizational services will be offered and evaluated by the users of the value chain (Wolfert et al., 2017).

Considering the increasing world population, there has been a necessity to keep up with the developments in the industry in the field of agriculture and in parallel; Development also continued in the field of agriculture. The use of the internet in many areas and its widespread use under the name "internet of things" has started to create the fourth industrial revolution, and this revolution is called Industry 4.0 (Lejon and Frankelius, 2015). The main feature of the time period in which the first revolution, defined as Agriculture 1.0, took place, is that the mode of production with low productivity and labor predominance prevailed. Towards the end of the 1950s, synthetic pesticides, fertilizers and machines that provide greater effects brought production costs to lower levels, and thus the Agriculture 2.0 period called the "Green

Revolution" emerged. There has been an increase in productivity in agriculture with lower costs and new practices. With GPS signals becoming available to everyone, the Agriculture 3.0 process in the 1990s was named today with the concept of "Precision Agriculture" (Rose and Chilvers, 2018). Along with GPS technology, manual guidance applications and VRA (Variable Rate Application) systems applied to harvesting machines, especially monitoring and monitoring the fertilization process, emerged as prominent technology systems applied in this period (Carolan, 2016).

2. Agriculture 4.0 Development Course

It has been announced that after 2011, for the first time in Germany, we will enter an industrial turning point called Industry 4.0, where information technologies and industry will work together, production will be implemented with maximum efficiency with integrated computer systems, and artificial intelligence will come to the fore. With Industry 4.0, a similar parallel process to the revolution in industry has begun to occur in the agricultural sector (Anonymous, 2023). Reasons such as the inadequacy of traditional agriculture to meet the needs of the increasing population, the increase in environmental pollution caused by agricultural production, the necessity of ensuring agricultural sustainability and food reliability have necessitated new approaches in agricultural production. For this reason, the use of smart technologies, which are on the rise, in agricultural production has come to the fore. Smart Agriculture is an agricultural management concept that uses modern technology to increase the efficiency and quality of agricultural products (Dağ, & Akbay, 2022). In particular, knowledge and capital are very important for smart agricultural technologies. Smart agriculture is knowledge-based agricultural production whose philosophy is to produce by managing the heterogeneity of nature. While 80% of farmers in the USA use smart agricultural technologies, this rate is approximately 24% in Europe. The strong growth in the US market is due to the high rate of adoption of technologies by farmers in the US (Kaya, 2019).

Recent research by the McKinsey Global Institute shows that the agricultural sector has the lowest digital penetration rate of any industrial sector. Although the agricultural sector is far behind in productivity and the addition of new services, it reveals the necessity of accelerating digital transformation in agriculture without wasting time. According to the IBM Food and Agriculture Organization's previous report, we have to produce 70% more food since 2006 to meet the food needs of the growing world population in 2050. Naturally, the necessity to produce better quality, lower cost and more food has emerged. In order to meet this demand, states, farmers and agricultural companies are forced to turn to Industry 4.0 solutions, especially

the Internet of Things, in order to produce more and more efficiently, and the formation of AGRICULTURE 4.0 is taking place (Şahin, 2022; Anonimous, 2024).

Technological innovation is not a new concept for agriculture. Portable tools became the standard hundreds of years ago. With the industrial revolutions, chemical fertilizers, tractors and even satellite images began to be used in agriculture. The transition of agriculture to the next level is realized with the internet of things. High-tech agriculture is rapidly increasing thanks to drones and sensors in smart agriculture, which has become widespread among farmers. It is a great reality that internet of things (IoT) applications in agriculture will help farmers meet world food demands in the coming years (Anonymous, 2024).

With precision and smart farming practices, farmers have started using some high-tech farming techniques and technologies to increase the efficiency of their daily work. For example; Sensors placed in agricultural fields allow farmers to obtain detailed information about the topography and resources in the region, as well as variables such as soil acidity and temperature. They can also access climate forecasts to predict weather conditions over the coming days and weeks (Pakdemirli et al. 2021; Anonimous, 2023).

Farmers can use their smartphones to remotely monitor their plants and livestock, as well as plan for the future by compiling statistics on feeding and producing their animals. By monitoring the temperature values of the soil instantly, more efficient decisions can be made about the planting, irrigation and harvesting of agricultural products. In a study conducted by OnFarm, it was determined that with Industry 4.0 solutions, the efficiency for an average farm increased by 1.75%, energy costs decreased by $7-$13 per acre, and water use for irrigation decreased by 8% (Pakdemirli et al. 2021; Anonimous, 2023).

3. Expectations from Agriculture 4.0

Collecting and analyzing big data in agriculture has become a great need to maximize productivity in agriculture. After industrial areas such as mechanization, chemistry and biotechnology, there is also a big change in the field of agriculture and agriculture 4.0 is emerging. With Agriculture 4.0, it can help farmers, consultants and researchers develop more flexible and unique agricultural strategies by making them less dependent on external inputs and more economical (by reducing costs) (Ercan et al. 2019; Pakdemirli et al. 2021).

Agriculture 4.0 can combine various applications to meet different needs. Smart farming mostly uses internet technology. Various sensors placed on equipment or in the field provide data to a platform (cloud-based) that allows the creation of an information system for users (agricultural supply specialists, farmers, consultants, researchers, etc.). Examples include sensors embedded

in machines that use artificial intelligence to detect weeds to be targeted for local destruction (Anonymous, 2024).

Based on the same technology, climate-smart agriculture strives to enable more sustainable agriculture, taking into account the challenges of climate change. Its three main goals are: "increasing agricultural productivity to support increased incomes, food security and development; second, increasing adaptive capacity at multiple levels (from farm to nation); and third, reducing greenhouse gas emissions and increasing carbon sinks" (Atasoy, 2019).

Geographic information systems (GIS) are another form of agriculture 4.0 characterized by the significant use of GPS technology. The latter allows mapping of terrains for increased precision during technical operations. For example, mapping the nitrogen requirements of a plot allows inputs to be tailored not only at the plot level, but also for different regions defined by the satellite (Anonymous, 2024).

Another interesting area is cooperative farming or mutual agricultural assistance. The term was developed by companies using digital platforms to help farmers connect for commercial relationships (equipment rental, feed sales, etc.) or share knowledge and experience without intermediaries. In these few examples, agriculture 4.0 appears to meet the needs of efficiency, sustainability, sufficiency or socio-economic issues (Kaya, 2019; Şahin, 2022).

In the future with the advanced technology smart agriculture (agriculture 4.0) systems implemented today; We will have the opportunity to view our farm with the help of a cloud-connected and camera-equipped drone, to control elements such as humidity, temperature and pH with digital sensors, to prevent waste of our inputs such as water and electricity, and to reduce pollution in other water bodies, especially groundwater. In addition, with Agriculture 4.0, farmers will be able to analyze their resources in detail by evaluating productivity in real time. With Agriculture 4.0, cheap and easy soil analysis, viewing and managing the farm via mobile phone, unmanned tractors, green energy, harvesting products in the desired quality, taste and aroma are or must be among the main goals of all companies in the agricultural sector. Thanks to technology developing day by day, better quality and more efficient agriculture will be possible (Pakdemirli et al. 2021). In the field of animal husbandry, fully automated "monitoring and control systems" developed based on the latest developments in the world of technology have contributed to the development of animal husbandry. It has emerged as a livestock management system that constantly monitors the reproduction of animals, animal production, the health and welfare of animals and their interaction with the environment, predicts important events such as birth or disease before they occur by using different modeling methods, and ensures that the necessary precautions are taken in this context. . In addition, in

recent years, the process of applying robotics, automatic control and artificial intelligence techniques in dairy cattle farming has begun, and automation applications and robotic milking methods have further developed. By using smart agricultural techniques, farmers have become able to better monitor the needs of individual animals and adjust their nutrition accordingly, prevent disease and improve herd health (Şahin, 2022; Sevli, 2023).

4. Topics and Concepts Related to Agriculture 4.0

Smart agriculture, in addition to plant production, also at every stage of animal production processes; It is an application that can be managed not only at the production site but also remotely, via satellite, in internal or external agricultural activity areas. When evaluated from this perspective, it is possible to list the following applications as the main Agriculture 4.0 areas (Demirel Atasoy, 2019).

4.1. Precision Agriculture

-Image Detection and Phytobiological Information

-Remote Sensing via Satellite and Aerial Vehicles

-Talking Plant/Talking Fruit Approaches

-Machine Vision in Agriculture

-Control of Fertilizer Applications

-Detection and Information Management in Plant Protection

-Drug Application Techniques in Plant Protection

-Information Technology Applications in Greenhouse Agriculture

-Precision Animal Production

-Information Technologies in Fish Farms

-Advanced Life Support Systems in Space

4.2. Management and Decision Support Systems

-Farm and Product Management Systems

-Information Technologies in the Design of Animal Shelters

-Imaging, Estimation and Control of the micro-environment

-Information Technologies in Water Management

-Geographic Information Systems

-3D Animation and Virtual Reality

4.3. Communication Issues and Internet Usage

-Special Communication Systems and Standards for Agricultural Applications

-Remote Service and Maintenance: E-Commerce, E-Business, E-Consultancy, E-Support

-Storage and Processing of Food and Raw Materials

-Quality Problems in the Agricultural Production Chain

-Low Cost Information Technologies for Developing Countries

5. Developments in Agriculture 4.0 in Turkey

In Turkey, the Ministry of Agriculture and Forestry plays an important role in implementing many technologies and informatics infrastructures such as information technologies, decision support systems, technological agricultural applications, agricultural information systems, recording and database systems, both in its strategic plans and legislative regulations and in the fields of activity of the main service units (Kılavuz and Erdem, 2019).

In this context; Systems such as Geographic Information Systems, Integrated Administration and Control System, Agricultural Information System and Farm Accounting Data Network have been put into operation. Thanks to these systems, a village database, digitization of agricultural plots, processing of satellite images, agricultural production and registration system have been created. In addition, projects on "Determination of Variations Affecting Yield in Grain Growing Areas Using Precision Agriculture Techniques" and "Planning, Development and Dissemination of Precision Agriculture Applications in Crop Production" on "Precision Agriculture Technologies" were carried out at research institutes affiliated to the Ministry of Agriculture and Forestry, and new developments were made in these subjects. Thanks to this and similar application projects, for the first time in Turkey, applications that can deliver the amount of fertilizer according to the needs of the crop in the field with domestically developed machines have been made. These practices have produced environment friendly products that save approximately 30% in fertilizer use (Demirel Atasoy, 2019).

In Turkey, studies are carried out to support Smart Agriculture not only in agricultural practices but also in R&D Studies. It enabled ASELSAN to transfer its knowledge gained in unmanned systems, communication projects, traffic and automation systems to the field of national agricultural automation applications. Additionally, regarding Smart agriculture; Domestic Automatic Tractor Steering and Control (OTAK) System Development Project, Farm Management System Development Project, Unmanned Aerial Vehicle Image Processing Based Precision Agriculture Applications Project, Development of the System for Monitoring and Tracking Grain Losses in Wheat Harvest, Smart Measurement Platform Prototype for Sheep Breeding with its development and project outputs such as the ARI-1 Rotary Wing Unmanned Flying System; Infrastructure will be established for soil, drought, fertilizer status, harvest forecast, yield calculation and creation of a library for different products. After the infrastructure is established, studies are being carried out for use in damage assessment studies for agricultural insurance (Anonymous, 2023).

As a result, with Agriculture 4.0 applications that include precision agriculture techniques;

• Obtaining precision agriculture data temporally and spatially based on location,

• Reducing production costs and environmental pollution by preventing excessive and ineffective use of agricultural inputs,

• Determining adaptation strategies according to the region for widespread use by farmers,

• Establishing a database where all data is kept and where farmers can monitor the status of their lands on a web-based basis,

• Capacity development to produce consultancy information for farmers about high-tech products,

• Providing virtual consolidation solution to increase efficiency in agriculture,

• Implementation of precision agriculture technologies that have been developed or will be developed,

• Providing precision agriculture production solutions for our country,

• Traditional agriculture and precision agriculture practices will be compared on a product basis and precision agriculture will be disseminated,

By revealing the practical implications of all these applications, we will have the opportunity to make faster progress in providing food to the increasing human population.

6. Conclusion

Data analysis and reporting, which will be essential for planning, can be made with the databases created in all components of agricultural production in smart agricultural systems. Natural and climatic factors aside; Turkish Ministry of Agriculture and Forestry is trying to benefit from the opportunities of the rapidly transforming technological and digital process in line with Turkish agricultural sector, which is shaped by many economic, sociological and industrial parameters.

Agriculture 4.0 reduces the amount of inputs needed (fertilizers and phytosanitary products) and at the same time optimizes movement to reduce mechanization loads. These technologies help reduce farm costs by making farms more economical at a time.

The farmer also gains decision-making ability through tools that allow field research and access to some of the data on specialized platforms. Like any new technology, agriculture 4.0 raises many questions among its users. This promotes the exchange and sharing of information between farmers in groups operated by different networks: chambers of agriculture, agricultural credit cooperatives, provincial and district agricultural and forestry directorates, associations, unions, producer cooperatives, etc. In short, new technologies are not intended to replace agricultural consultancy but to provide new tools. Although there are some challenges, such as

short-term concerns about the interoperability of various platforms or the ownership of collected data, agriculture 4.0 is a promising tool. It can improve the analysis and precision of the technological solution provided by farmers, consultants, technical and research organizations in order to achieve a more sustainable and resilient agriculture.

By increasing the technology level of smart agricultural applications, it is aimed to develop organic agriculture in Turkey, optimize agricultural inputs and increase the profitability rate. It is also seen that all these studies are compatible with the practices defined as Smart Farming in the world.

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