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The international education program in the field of precision farming as an opportunity to raise the efficiency of agricultural farms manage by young agro-technicians

"PRECISION FARMING"

GUIDE FOR TEACHERS

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PRECISION AGRICULTURE

1.1 Definitions

In traditional agriculture, soil management is done by handling and operating the production environment in a uniform way. Although producers know that they sell different amounts of product from different parts of their fields or that those parts have different soil structures, they cannot evaluate this information in terms of production. For this reason, they always apply the same amount of inputs such as fertilizer and medicine needed by the plants grown in the field, which is traditionally considered as a whole regardless of its size.
This approach causes some parts of the field to receive more or less input than others.

Precision agriculture is a form of management that emerges when the grower accurately determines and understands the variability in his land using information technologies, and applies input appropriate to this variability in the lower parts of the land.
Precision agriculture presents an advanced system approach by combining control, electronics, computers, database and account information. Components of precision agriculture technology:

- ✓ Global Positioning System (GPS),
- ✓ Geographical Information Systems (GIS),
- ✓ Variable Rate Application (VRA) and Remote Sensing.

Today, the environmental impact of agricultural production inputs and the pressure to reduce input costs are increasing with the advancing technology. Precision agriculture envisages ensuring economy by using the inputs effectively (in the required amount) and thus reducing their environmental impact. This can also contribute to uniformity in the product quality.
Among the goals of precision agriculture

- ✓ Reducing chemical expenses on things such as fertilizer and medicine,
- ✓ Reducing environmental pollution,
- ✓ Providing high quantity and quality products,
- ✓ Ensuring a more effective flow of information for business and aquaculture decisions,
- ✓ Establishing a registration system in agriculture can be counted.

Precision agriculture is not a subject that can be realized with the effort of a single profession but a field that requires interdisciplinary work.

Precision Agriculture:

- **Production Pattern**
- **Change in the Amount of Plant Nutrients in the Soil**
- **Spatial and Temporal Change of Yield and Quality**
- **Differences in Topographic Structure over Long Years**
- **Geographic Information Systems**
- **Chemicals to be used against Diseases and Pests**
- **Mechanization Tools**
- **Mapping**
- **Meteorological Data**
- **Profitability**
- **Special Software**
- **Electronic Track Tracking**
- **Electrical Conductivity**
- **Image Processing**
- **Sensor Technology**
- **Classification Technology According to the Quality of the Product During Harvest**
- **GPS Technology**
- **Digital Data**
- **Electronic Measurements**
- **Remote Sensing**

It includes many areas such as the ones mentioned above. For this reason, it is not possible for a single occupational group to handle this work alone. This inclusive situation necessitates teamwork in precision agriculture in accordance with the requirements of the times. In addition, the main topics mentioned here have their own subtopics.

For example:

GPS's applications in agriculture:

- Automatic Steering (Driverless tractor)
- Variable Level Input Application (Fertilizer, Medicine, Water, etc.)

- Automatic Control Field Mapping (Yield, Quality, Topography etc.)
- Drainage
- Tracking
- Data Collection
- Controlled Field Traffic
- Product Tracking
- Irrigation
- Topographic Mapping
- Electrical Permeability Mapping

can be counted as fumigation.

Product yield in the Precision Farming method (harvest); It is increased by using agricultural inputs such as water, fertilizer and medicine in the most appropriate way. With the widespread use of drone and UAV systems, the use of remote sensing methods in precision agriculture is becoming widespread. Existing systems are mostly based on the NDVI (normalized differential vegetation index) methods that provide information about plant growth and health based on data obtained from multi-spectral sensors.

Using unmanned aerial vehicles connected to cloud-supported databases, one of the developing smart agricultural technologies, and with high-resolution cameras, monitoring the planted fields, controlling the values of air and soil such as humidity and temperature through digital sensors, prevents the waste of limited resources such as water and electricity. Some smart farming opportunities such as reducing water pollution have been seized.

The advanced information technology developed for agriculture provided the ability to analyse and remotely control undesirable substances such as some heavy metals and chemicals in the soil. Thanks to smart agriculture, an environmentally friendly study on things such as protection of natural resources and green energy has been carried out. A better quality and efficient agriculture is achieved by providing the opportunity to harvest the crops in the field without them rotting. With the widespread use of Internet of Things technology in the agricultural sector, the fertility of the soil will increase and the farmers will increase their gains. This type of agricultural production activities will significantly contribute to the rural development. As a result of the production of healthy products with agriculture, which is one of the important business lines of development, people will not have any problems with the agricultural products they buy. With this smart agriculture technology, harmful substances in the soil will be easily analysed and necessary interventions will be made. Thanks to artificial intelligence supported smart agriculture applications, which are being used effectively in our country, a significant contribution is made to rural development. With the developing technology, a more conscious and productive farmer portfolio has started to emerge.

Since approximately 83% of the agricultural enterprises in our country are small peasant enterprises under 10 hectares, it is not possible to accumulate the capital that could allow applying new technologies in these enterprises. Therefore, in recent years, small and medium sized enterprises have been in a difficult position in competition with large enterprises. With globalization, this problem will reach even more serious dimensions in a competition between countries. In all these circumstances, it has become necessary to provide precision farming technology to farmers in Turkey. However, since the costs of machinery and systems used in precision agriculture cannot be covered by production revenues, it is thought that the use of these systems will not develop at the desired speed.

1.2. The Importance of Maps in Precision Agriculture

The biggest problem that growers face is the reduction of crop yield or economic return due to various factors. Therefore, to be able to handle this in a competitive market, they must know everything about the product they are growing. In developed countries, farmers can monitor their lands by using information technologies and make use of very reliable information in making decisions according to changing conditions.

Since these technologies allow farmers to monitor their land in smaller sub-plots, they can provide information about crop yield as well as variability in soil characteristics. Electronic yield monitoring and recording systems have been developed for various products. Efficiency sensors also vary for the product range here. Some efficiency sensors used today and the products they are used in are listed below:

- Weight-based (impact plate) sensor (in grain products such as wheat, corn)
- Volumetric-based (optical) sensor in grain products such as wheat, corn)
- Conveyor-connected load sensor (in products such as potato, carrot, sugar beet)

- Agricultural truck load sensor (for products such as cotton, grapes, tomatoes)
- Moment converters (in tomato)

1.2.1. The Importance of Mapping in Data Acquisition in Precision Agricultural Technology:

a. The purpose of global positioning systems is to determine the latitude, longitude and altitude coordinates of the field and/or equipment according to spatial and temporal data. Variable amounts and doses of pesticides and fertilizers are applied to the field according to the mapping principle created by this system.

b. Crop yield monitoring and mapping systems are generally determined by instant yield measurement methods during harvest and after harvest. These measurement methods include sensors (such as product flow amount, product moisture, work width, harvest head) and a computer environment. In parallel with the development in image technology in recent years, sensitive and spectral cameras can be installed on UAVs to determine parameters such as the distribution of the plant in the field, plant health and frequency. Thus, mapping is carried out by making predictions about the yield before harvest and even during the plant development period without waiting for the harvest or afterwards.

c. Soil characterization and mapping systems are particularly important for variable level fertilizer applications. In this system, soil fertility (plant nutrients), soil physical (soil type, compactness, organic matter content, etc.) and chemical (soil pH level, cation exchange capacity) characteristics, and irrigation and drainage properties are taken into consideration. For the analysis of soil properties in the agricultural field, soil samples were collected and taken to the laboratories. Later, automatic soil sampling tools started to be used. However, in recent years, thanks to the special cameras and sensors mounted on the UAV, time of the mapping operations has been shortened.

d. In the crop and field conditions monitoring systems, it is aimed to monitor the plant and field situation on the land on foot or by vehicle and to obtain border maps. Although vehicle applications are faster than pedestrian, technological developments show that UAVs can also be used in this area. Data obtained in areas limited to pedestrians or off-road vehicles or monitored over a long period of time are then uploaded to the computer and evaluated. The impressions of the applications made with the UAVs are displayed with the help of the software. The use of UAVs not only saves time with higher resolution images at low altitudes but also offers the opportunity to monitor larger areas in a short time and take precise measurements by scanning the entire field surface.

e. The purpose of remote sensing systems is to measure and monitor from a certain height and distance without contact with the field and/or plant. Measurement and viewing heights can vary from a pole planted in the field to a satellite in space. Measurement and imaging from the pole can be fixed or mounted on an off-road vehicle. Measurement and viewing from the satellite can be monthly, weekly or daily. However, with UAVs, it is possible to take measurements and images at desired altitudes and at any desired time – day and hour. UAVs can be used as an alternative to satellite images used in soil survey mapping studies, maps obtained by taking up-to-date images at the desired time and area can assist in fertilization, land reclamation, urban planning, land use and planning studies at the next stage.

1.3 Using GPS in Precision Agriculture

Global Positioning Systems

Global positioning systems are a satellite measurement system that determines the position of a user anywhere in the world at any time and is based on measurement from at least 4 satellites.

Global positioning systems were first used by the US Department of Defense for navigational expedition purposes, and are now available to many industries, including agriculture.

In agricultural use, these systems provide convenience, speed and economy in collecting data on issues such as yield monitoring, soil and plant sampling.

Positioning with GPS (global positioning system), wireless communication and information technologies are changing the relations of farmers with the land. Farmers are now able to manage each operation on their land – from planting to fertilizing and from harvesting to spraying, reducing declares to meters, increasing efficiency and productivity.

Different measurement methods are used according to the type of the measured points in GPS, the desired sensitivity and the purpose. The resulting coordinates vary according to the receiver type, observation time, location and number of satellites and the measurement type. If a point's position on the earth (latitude, longitude, altitude, etc.) can be determined directly, it is called **absolute positioning.**

Determining the positions of more than one point relative to each other is called **relative positioning.**

If the point to be located is stationary (triangulation, polygon, detail, soil sampling point, etc.), it is mentioned as **static positioning, if it is** moving (tractor, harvester, spraying plane, etc.), **kinematic positioning** is mentioned. In addition, **real-time location determination** can be made for the **journey of** agricultural vehicles and machinery.

In order to obtain more precise results, it is also possible to post-process the obtained data in the office after the measurements in the field are made. GPS applications include drawing land borders, crop monitoring and evaluation, yield monitoring and soil sampling.

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1.4. The Use of GIS in Precision Agriculture

GIS is a set of systems in which all kinds of data belonging to objects and events on the earth are entered into the computer according to real coordinates and displayed in the form of maps, tables and graphs by subjecting them to analysis.

CBS is a system consisting of software, hardware and a user that enables geographical data to be collected, verified, stored, updated, modified, analysed and brought to the visual environment.

The data used in GIS are divided into two groups as graphic and non-graphic (verbal) data.

Graphic data: They include information such as the location, shape and boundaries of the data. Coordinate information of their locations are indicated by points that make up a line or a polygon. Thus, it is possible to present scale and area information. For example, in cadastral information, parcel boundaries, roads or waterways, if any, are graphic data.

Non-graphic data: Text-specific attribute descriptions that should be associated with graphic information constitute non-graphic information. Generally, it complements graphic information and is used in data analysis and query studies. Depending on their association with geographic data, they provide graphic data as a result of querying or data analysis.

GIS has five basic components.

These are:

a) Hardware

b) Software

c) Data

d) People

e) Listed as methods.

GIS is also effective in agricultural improvement, detecting diseased areas of vegetation and in agricultural taxation by detecting the agricultural areas with satellite images. In cases such as unauthorized use of planting areas, agricultural control can be easily performed with satellite images obtained by the Remote Sensing method. In addition, thanks to satellite images, the tax that the farmers will pay depending on the type of agriculture can be directly calculated and the tax can be collected automatically from the taxpayer.

As in every field of agriculture, many studies can be done with the help of GIS technology in the field of agricultural economics.

These issues; of a region

- ✓ Determination of the land structure
- ✓ Detection of the product pattern
- ✓ Determination of what type of fertilizer or pesticide will be used to grow the crops
- ✓ Determining the most suitable location for any investment
- ✓ Determination of the most suitable alternative investment
- ✓ Determining the sensitivity of the producers to environmental problems
- ✓ Determining the demographic structure of the household
- ✓ Determination of producer and consumer profile
- ✓ Determination of rural tourism potential
- ✓ Determination of market opportunities of existing factories
- ✓ Determining the distribution of potential customers for the product

- ✓ Determining the socio-economic structure in order to develop marketing strategies for a new product
- ✓ Determination of the most appropriate and effective distribution network systems for factory, warehouse and wholesale customers
- ✓ Identifying the areas that will be affected by the decisions of the manager on any matter
- ✓ Determining the distribution of the available data (Akça and Esengün 2003)
- ✓ Value determination of immovables
- ✓ Determination of factors affecting the value of immovables and their degree of influence
- ✓ Determination of areas and products covered by agricultural insurance can be carried out.

1.5. The Relationship between GPS and GIS Methods in Precision Agriculture

Precision Agriculture refers to the whole of smart agricultural practices that are used together with Global Positioning (GPS), Geographic Information Systems (GIS), remote sensing, yield monitoring and variable rate application technologies, aimed to achieve more efficiency with less input. Precision agriculture technologies offer many opportunities to increase the performance of agricultural activities and to make fast and optimal decisions within different agricultural processes.

Precision agriculture focuses on environmental data that vary, such as soil structure, weather, water and humidity, and the impact of these data on agricultural activity and product quality. In this direction, precision agriculture is a set of processes to analyse farm and field-specific conditions in the best way using the most advanced technologies and to determine the optimal input use at the right time and in the right place.

1.6. Using GPS/GIS in Other Industries

The rapid increase of the human population living in the world, the interaction of people with each other, the creation of living spaces at demographic and geographic levels, the increase in their needs and technological and scientific developments that can meet their needs are factors that have jumpstarted the use of new, instant, fast, accurate, applicable, inquiry and traceable, reliable, and data exchange information systems in many sectors such as agriculture, defence industry, health systems.

The use of GPS/GIS systems, which are one of the scientific and advanced technologies, has revealed that the information systems should be used by 5N 1K, why, when, how and by whom.
In this regard: – ISP (International Photogrammetry Association) was established in 1910, and in 1980 ISPRS (International Society for Photogrammetry and Remote Sensing) was expanded as the International Photogrammetry and Remote Sensing Association. When it comes to Photogrammetry and Remote Sensing; it includes obtaining reliable information about physical objects as a result of measurement and interpretation of data compiled photographically or digitally by means of sensor systems.

The Union has 81 country members and 7 commissions:

1. Obtaining basic data.
2. Data processing and analytical systems
3. Mathematical data analysis
4. Database applications in cartography and photogrammetry and remote sensing
5. Near field photogrammetry and Computer vision
6. Economic, vocational and educational status of photogrammetry and remote sensing
7. Remote sensing data and interpretation of photographic images,

Common interests of the commissions are as follows:

a. Optical sensors: Geometric parameters of lenses; They are constantly being developed in the direction of increasing the degree of separation, reducing distortion and light loss, and research is continuing to increase the radiometric characteristics of optical sensors for cosmic currents and air image acquisition. In addition, calibration methods, standard development issues in the definition of separation degrees are emphasized.

b. Digital image recording: Studies have focused on the optics of electronic sensors, lenses, filters, rotating mirrors, and CCD-rows and matrices. Other research topics are optimization of geometric and radiometric characteristics and standard development of these systems.

c. Remote sensing systems with the microwave technique: Efficiency and possible applications of microwave sensors to be installed on aircrafts, drone devices and spacecraft for topographic and thematic data collection, quality standards, and increasing the information systems on the ground are the studied subjects.

d. Sensor orientation and navigation: For the navigation of sensors in aircraft and spaceships, research is carried out on models, techniques and mechanisms, especially related to GPS.

e. Analytical instruments: Studies on hardware and software standards in these instruments, standardization of accuracy tests, technical specifications of instruments and preparation of relevant catalogues of computer software for mechatronics, mechanical and electronic devices.

f. Integrated photogrammetric systems, algorithmic and structural status of digital photogrammetric systems, digital image processing techniques: Software and computers, standardization of devices that digitize photographic and graphic images and vice versa, communication between different systems, price-benefit analysis, and research on technology. (Geographic Information System) provided important information on the issues of data exchange, GIS and communications for human-tool relations, real-time and on-line processing, mono-, stereo-, multi-, display and we are working on evaluation of opportunities such as making transactions.

g. Systems for acceptance, recording pre-processing, archiving and distribution of remote sensing data. Development of systems needed by the archiving and data storage systems.

h. Instrument technique and systems for processing SAR (Synthetic Aperture Radar) data: pre-processing data and improved decision and movement systems.

i. Obtaining and using space photographs in map production and integrations: In recent years, it has contributed to the integration of satellite photographs of large-scale maps and to the development of the created data on geographic systems.

In the 6th Five-Year Special Expertise Commission Report in our country established a Cadastre Information System (KBS) which made and finalized the legal, technical and structural requirements and regulations during this plan's period regarding the following:

- ✓ Making use of GPS (Global Positioning System) in position determination and making it widespread,

- ✓ Accelerating map production and using photogrammetry technique extensively in digital data collection,
- ✓ The need for renewal in the cadastre due to various reasons.

It is possible to see photogrammetry, remote sensing, geodesy and cartography data in GIS, GPS applications. The rapid transformation process taking place in scientific institutions and industry increases the importance of reliable information systems in practice.

Determining the coordinates of satellite systems as point locations by using signals is called GPS (Global Positioning System), and GIS is called geographic information system.

These two , the GPS and the GIS system, have started to be used in the transportation sector, for the use of multiple vehicles, the use of all kinds of logistics systems, due to traffic density that increases the need for information systems in sea, air, land and rail transportation.

Today, newly developing technology and computer software systems, artificial intelligence theory, finding tools that work with mechanical and electronic materials and providing data exchange, transfer and storage of data, using information systems will form the basis for the creation of more perfect systems in the future.

SOIL AND PLANT MANAGEMENT
TO SAVE FOOD AND INCREASE FOOD SAFETY

What is Sustainability?

Today's social order and living standards; It is the definition and implementation of resources that exist in nature in a way that enables them to be used without damaging the possibilities of meeting the needs of future generations.

2.1. Sustainable Soil and Plant Management

Ensuring the continuity of growing healthy, quality and productive plants by protecting the diversity of healthy and fertile soils.

All methods of improving soil functions and ecosystem services in order to eliminate the causes of degradation of soil resources are evaluated within "SUSTAINABLE SOIL MANAGEMENT". In fact, a "productive" and "healthy" soil means sustainable food supply. In other words, healthy food supply takes place in a healthy soil.

"Soil management is sustainable if the supporting, productive, regulatory and cultural services provided by the land can be maintained or developed without significantly damaging the soil functions or biodiversity that make these services possible. The balance between the supportive and productive services used for plant production and the regulatory services provided by the soil for water quality and water availability and atmospheric greenhouse gas composition is also a special consideration".

The types of ecosystem services and the land functions mentioned in the definition can be detailed as follows:

- ✓ Supporting services include primary production, nutrient cycling and soil formation;
- ✓ Supply of food, fibre, fuel, timber and water within the scope of production services; raw soil material; surface stability; those are habitat and genetic resources;
- ✓ Regulatory services mean regulating formations such as water supply and quality, carbon sequestration, climate regulation, erosion and flood control;
- ✓ Cultural services refer to the aesthetic and cultural benefits derived from land use.

Sustainable Land Management is associated with the following features:

1. Soil erosion from water and wind is minimal;

2. The soil structure does not deteriorate (e.g. due to soil compaction) and provides a stable physical environment for root growth as well as the movement of air, water and heat;

3. There is sufficient surface cover (e.g. growing plants, plant residues, etc.) to protect the soil;

4. The organic matter storage in the soil is stable or increasing and ideally close to the ideal level for the local environment;

5. The presence and flow of nutrients are suitable for maintaining or improving soil fertility and productivity, and reducing losses to the environment;

6. The rate of salinization, sodification and alkalinity of the soil is minimal;

7. Water from additional water sources such as rainfall and irrigation is effectively filtered and stored to meet the needs of the plants and drain excess water;

8. Pollutants below toxic levels; that is, below levels that could harm plants, animals, humans and the environment;

9. Biodiversity in soil enables the realization of a wide variety of biological functions;

10. Soil management systems used for food, feed, fuel, timber and fibre production are based on the optimized and safe use of inputs; and

11. Thanks to responsible land use planning, losses in soil permeability are minimized.

The ever-increasing population is fed by the soil. Climate change, drought, desertification, improper agricultural practices (such as excessive fertilizer use, excessive pesticide use) reduce soil fertility on the earth and negatively affect cultivation. In addition, agricultural areas are gradually decreasing due to erosion, landslides, industrialization, and urbanization. The United Nations Global Compact on Sustainable Soil Management has been prepared in order to eliminate poverty and hunger and to promote the sustainable use of terrestrial ecosystems. The aim is to raise awareness of soil protection and strengthen existing soil conservation policies with long-term programs. For this, 6 basic principles have been determined, also called Soil Principles, and these principles include strategies for the protection of soils in agricultural ecosystems.

Sustainable Soil Management Principles

The basic principles that need to be applied in order to restore the characteristics of the degraded soils from their healthy periods when they were not touched by human hands, and then to protect and maintain these characteristics can be listed as follows.

Principle 1.
Preservation of physical, chemical and biological characteristics of soils

- ✓ Keeping the soil surface covered with continuous vegetation or plant residues.
- ✓ Avoiding agriculture with continuous deep tillage that disrupts soil integrity, using conserved farming, no-tillage farming methods and improving soil drainage.
- ✓ Using plant and crop growing systems suitable for the geography and ecology of the region, to place the appropriate crop rotation systems.
- ✓ Applying all kinds of methods to keep erosion under control.
- ✓ Minimizing the possibility of soil pollution from all sources.
- ✓ Keeping forest and agricultural ecosystems in balance. To prevent deforestation and to allow trees to retain carbon.
- ✓ Not using physically marginal lands in agricultural practices
- ✓ Keeping animals without harming nature, preventing urbanization in agricultural areas.

Principle 2.
Restoration of degraded soil and marginal areas

- ✓ Determining the degradation levels of the soils, preparing the process for the applications needed to restore the soils to their former fertility conditions.
- ✓ Re-establishing the soil structure in a balanced way, actively increasing and protecting the soil carbon and organic matter and restoring the plant nutrient content balance.
- ✓ If the soil has eroded and its depth has decreased, restoring the initial soil depth.

- ✓ Implementing sustainable soil management systems not only on the field but also on the regional, country and global scale.

Principle 3.

Preservation of ecosystem services – water availability and quality provided by the soil

- ✓ Sustainable soil absorbs water quickly, stores it in its structure and drains it to prevent ponding.
- ✓ Managing soil and water in a balanced way.
- ✓ Fertilization only in the required amount and time in a balanced way and to protect ecologically sensitive areas from the effects of fertilization.
- ✓ Preserving beneficial microbiological and biochemical activities in the soil.
- ✓ Sheltering soils from the impact of the global climate change.
- ✓ Establishing pollution absorbing buffer areas in between to protect surface water resources and wetlands against the pollution of agricultural activities.
- ✓ Choosing and applying sustainable irrigation systems suitable for geographical conditions.
- ✓ Especially in changes in space usage; field conservation value assessment, environmental impact assessment and product stability assessment.

Principle 4.

Increasing soil productivity to its natural capacity

- ✓ Intensive application of sustainable agriculture systems.
- ✓ Using an integrated approach to soil fertility management and replenishing nutrients removed from the field through crop harvesting.
- ✓ Maximizing the organic matter cycle in soils, using mineral fertilization for reinforcement in a way to balance organic fertilization.
- ✓ Growing plants or products suitable for the climate and soil type.
- ✓ Leaving harvest residues on the soil surface.
- ✓ Integrating livestock farming into vegetative production as a source of plant nutrients. Encouraging the use of all kinds of compost and barn manure.

- ✓ Taking precautions against soil salinization and keeping the pH of the soil between 6-7.5, which are suitable values.
- ✓ Using combustion product formed as a result of pyrolysis combustion as a biomarker and a soil organic matter enhancer.

Principle 5.
Promotion of publication services, information systems and innovative practices

- ✓ Implementation of mass information and publication services.
- ✓ Especially selecting women and young people in information and publication services.
- ✓ Realization of applied publication services.
- ✓ Implementing ecologically sustainable, innovative service techniques and technologies such as product, plant variety, agricultural application, fertilizer, and plant protection.
- ✓ Preparation of maps of soil classes, making recommendations for sustainable agricultural products and soil for each product and soil class.
- ✓ Encouraging good agricultural practices, recording soil data and creating information sharing platforms to ensure their accessibility. Developing long-term soil monitoring systems.
- ✓ Implementing soil cultivation tools and equipment and methods to prevent soil compaction.

Principle 6.
Keeping the importance of soils on the agenda

- ✓ Keeping the importance of the lands in economic, social and environmental terms constantly on the agenda.
- ✓ Building a consensus and sharing information on land conservation among the government, business, academia and civil society.
- ✓ Providing applied information environments to decision-makers, ensuring that they prepare the right policies within their knowledge.

- ✓ Preparing a curriculum that will include agriculture in schools, to enable young people to develop advanced agricultural education and career.
- ✓ Ensuring that waste reduction measures are implemented from consumers to farmers to reduce the pressure on the agricultural land for food production.

The most sensitive issue in the context of **sustainable soil and plant management** should be the organic farming method.

Organic farming; It includes human and environmentally friendly production systems aimed to restore the natural balance lost as a result of faulty applications in the ecological system, and recommends using organic and green fertilizing, alternation, soil conservation, increasing plant resistance, parasites and predators instead of using synthetic chemical pesticides and fertilizers. It is a type of production that adopts the principle of increasing the quality of the product, not the increase in the production. As can be understood from the definition, it should be the goal to use organic agriculture as the main method in sustainable soil and plant management, and healthy, quality plants that have their needs met and, therefore, food could be provided to future generations.

We can list the main objectives of organic agriculture as follows:

1. Planning resource use to protect and develop natural (soil, water and plant) resources in agricultural production, and establishing continuous information and monitoring system for this. Development of training programs for soil conservation and improvement for farmers.
2. Making efforts to conserve and use plant genetic resources more effectively for sustainable agriculture.
3. Striving for the effective conservation and use of animal genetic resources for sustainable agriculture.
4. Making pest control methods in agriculture more environmentally friendly.
5. Developing and promoting more environmentally friendly plant nutrition methods in crop production.

6. Developing education and dissemination projects of production technologies developed and applied for this purpose by disseminating organic agriculture programs and practices.

2.2 Technological Advances in Agriculture

Today's rapid technological development has brought agricultural business to a new level. In particular, developments in information and communication technologies have also affected agriculture and agricultural technologies and created smarter agriculture and machinery systems.

Precision farming technologies (HTT), which is widely spoken of today, has emerged as an innovative agricultural system that improves agricultural operation and management by bringing information and technology together to agriculture.

In the agricultural sector, it provides technological support to the producers in the processes of producing herbal and animal products with services based on the GSM technology, increasing their quality and productivity, preserving the products under appropriate conditions, processing, evaluating and marketing.

Through this technology, all manufacturers and farmer organizations operating in the agricultural sector in Turkey and in the world are connected with each other.While large-scale production technologies in developed countries in world agriculture engage in mass production with an advantage of scale, the production of large communities in developing countries has gained importance. The smaller the agricultural area, the greater the need for more products that can be put on the market. We need to reduce production costs without reducing productivity.

Technological Applications for Agricultural Production

Studies on Smart Agriculture solutions in the agricultural sector are integrated with services based on the GSM technology, allowing farmers and producers to closely follow their activities in the agricultural sector.

The control of the temperature monitoring and warning system provides early measures that will allow taking early precautions against the changing weather conditions and diseases.

In the cases where the humidity values cannot be controlled, negative consequences such as disease and harm are prevented.

Intelligent Irrigation Systems

By preventing unnecessary irrigation systems with smart irrigation systems, water resources are preserved and deformation that may occur in products with excessive irrigation is prevented. Since the water requirement of each crop grown in the field is different, water is given to the product when the percentage of soil moisture is lower than air humidity. The irrigation programmed with mobile devices has seasonal, monthly, weekly, daily and hourly programming possibilities and saves time for the producer.

Sensor Based Technological Applications

Today, systems made with smart agricultural technologies that can instantly adjust the amount of pesticides automatically according to the condition of the products grown in the spraying area have been developed. These systems take into account the condition of the product grown; and the amount of dispersed medicine is also related to the development status of the product. Thus, it allows saving a great deal of disposed drugs.

In the detection method, after the calculation and measurement of the plant, which condition is measured during the movement, fertilization is carried out in a single operation. The instant fertilizer amount is calculated and transmitted to the fertilizer distributor and the required amount of fertilizer specific to the area is distributed.

Robot Applications and Driverless Technologies

Specially designed robots, which are used effectively in harvesting fruits and vegetables in agricultural operations, are with prototype studies preferrable to human labour. These robots, which have cameras and GPS equipment, have processing appendages that automatically perform the harvest. In this context, open field robots are classified as a GPS-assisted steering system, pasture and silage robot, spraying robots, planting robots and pruning robots. Robots used indoors are harvest robots, milking robots, barn robots.

2.3 The Use of Technology in the Animal Husbandry Sector

Developed by taking advantage of the latest developments in technology and working in real time, continuously monitoring the reproduction, production, health and welfare and environmental effects of animals with fully automated monitoring and control systems, using different modelling techniques to predict important events such as birth and disease before they occur and a livestock management system that ensures the necessary precautions are taken is known as sensitive animal husbandry.

Studies show that livestock precision agriculture (HHT) systems increase milk yield and improve animal welfare. With automatic HHT techniques, operators can spend more time with animals and manage larger herds by creating more free time for them, as they reduce the time they spend on routine work. In this way, an increase in productivity and a more docile behaviour profile can be seen in animals.

As a result, today's machines are now equipped with smarter technologies. For example, a machine equipped with advanced technology not only harvests but also collects data. Thanks to these data, the efficiency of agricultural operations can be further increased. Agricultural tractors, tools and machines are equipped with GPS, mobile computers, wireless technologies, spectrometers, and infrared cameras, so instant product monitoring and instant applications are made possible. Automatic guidance systems that reduce the workload and stress of the operator and ensure the ease of operation are increasingly used by manufacturers due to the availability of low-cost system options on the market. At the same time, it has direct cost-reducing benefits such as using optimal input and reducing operator errors and extending uptime.

2.4 Water Resources Management and The Use of Technology in Fisheries

2.4.1. Water Resources Management

Water today it is a vital need for the life and health of people and ecosystems as well as a fundamental need for the development of countries. Social and environmental benefits of systematically expressing the use of **water resources management** has revealed the concept. This management should ensure that water is used for multiple purposes as well as continuously.

When we look at a satellite photo taken from space, our world looks like a water world. The vast majority of the earth's surface is covered by oceans. This situation may lead to the misconception that water is an inexhaustible resource. It is found mostly in oceans and seas on earth as salt water that people cannot use in a healthy and economical way.

This corresponds to 96.5% of the total amount of water. Water resources that people can safely consume for domestic, agricultural and industrial purposes are only a small portion of the total water resources in the world, such as 2.5%. On the other hand, if it is remembered that water resources are not evenly distributed for all people and countries in the world, it is an undeniable fact that how much water there is and how much is used will affect the policies of countries. With the increasing world population, people's demand for water increases the pressure on existing resources, while water supply may be insufficient to meet this demand.

Countries are classified as follows in terms of water resources:

Water poverty: the amount of usable water per person per year 1.000 m^3 'and less.

Water starvation: the amount of usable water per person per year 2.000 m^3 'and less.

Water Wealth: The amount of water available per person per year 8000-10000 m^3

Our country, with the amount of available water per capita in the amount of 1500 m^3 is located in the category of countries with water restrictions.

Water scarcity is becoming an increasingly obvious and widespread problem, and water quality is deteriorating rapidly in almost every country. This problem also causes many social and economic problems. Adjusting the conservation-use balance according to the socio-economic conditions of our country is a very important and difficult task in terms of protecting our natural resources and ensuring sustainable development. All these elements can only be evaluated within the scope of sustainable water management.

The current approach in terms of water resources management is the realization of resource management on the river basin basis and in an "integrated" manner with other natural resources. Environmentally compatible and integrated management of water resources, which is a driving force for the main sectors of socio-economic development such as energy, agriculture, health and environment, is one of the basic components of sustainable development. It is of great importance to consider the needs of future generations based on the natural renewal process as well as the efficient use of water resources.

Groundwater and soil are always at risk of contamination from human activities and natural resources. Especially unconscious and unplanned water use and above ground activities directly affect both soil quality and groundwater quality and quantity. It is very difficult, expensive and in some cases impossible to clean the pollution that may occur after such activities from soil and groundwater and to bring water back to the economy. Planning in the sustainable management of water and soil resources, taking these resources into consideration, ensures a more efficient and long-term use of these resources.

2.4.2. The Use of Technology in Fisheries

Aquaculture is one of the fastest growing sectors in the world, and in parallel with these developments, the aquaculture sector in our country continues to grow with the increasing amount of production every year. As in the world, it is an approach accepted by scientists that the limit point is reached in the production by hunting in our country and that the continuity of the existing production should be maintained rather than increased. It is considered that the increasing demand for seafood can be satisfied by aquaculture.

Some of the studies conducted in our country to increase aquaculture are as follows:

New potential aquaculture areas are determined and these areas are offered for the use of entrepreneurs. Establishment of Europe's first agriculture-based Aquaculture Organized Industrial Zone (OIZ) continues in Adana .

On the other hand, innovative practices and use of modern technology in aquaculture are encouraged. Studies are carried out to increase the number of species cultivated and the variety of products on the market. Various support is provided in order to encourage production in aquaculture enterprises.

Fisheries Law No.1380 and the regulation published based on this law.

The harvesting of fisheries with the notification an place, time and method of hunting, fishing gear and fish hunt.

Regulations such as the one above are introduced Studies are carried out by MFAL to reduce and prevent nitrate pollution of surface and underground waters caused by the unconscious use of animal and chemical fertilizers. In order to effectively monitor and control agricultural nitrate pollution in water, vehicles equipped with a mobile laboratory are used. Monitoring is carried out by MFAL Provincial Directorates in receiving environments and wastewater in order to protect water resources and ensure the sustainability of fisheries.

In order to monitor the receiving environment in 81 provinces, 14 water parameters are monitored by taking samples from 858 stations registered in the **Agricultural Information System** for four periods a year. On the other hand, with the "Integrated Pollution Monitoring Program in the Seas" conducted by the Ministry of Environment and Urbanization, all our seas are monitored, and the chemical and ecological status of our seas is determined, the effectiveness of the measures taken to prevent pollution is evaluated for compliance with national and international legislation.

2.5. The Use of Technology in the Food Industry

Considering that there are 7.5 billion people in the world and the world population continues to increase day by day, this means that there is more demand for food every year. Unfortunately, it does not seem possible to respond to this demand with traditional methods. For this reason, it is inevitable to benefit from technology in order to improve processing, packaging, shelf life and food safety.

The use of machines in the food industry brings many advantages. The machines not only reduce the production time but also increase the production amount. This also provides an advantage in terms of quality and price. Technological formulas that reduce costs with the ability to keep food fresh also increase efficiency.

The rise of robotics in the food industry is shown as an important step in food technology. In addition to Germany, as the prominent country in this field, it is seen that the use of robots is quite high in Sweden, Denmark, the Netherlands and Italy.

The use of robots in the food industry is also considered as an important development in preventing occupational accidents that cause significant losses every year, robot machines can help eliminate safety problems by undertaking hazardous work in the food industry. For this reason, it is aimed for the industry to benefit more from robot technologies.

3D printing, which is among the rising trends of recent years, seems to have found a place for itself in the food industry. 3D printing, which does many things we could not do before, opens the doors of innovation and helps the sustainability of foods. NASA's use of 3D printed food applications to produce soft foods for those who cannot chew hard foods is a prime example of the rise of 3D.

The concepts of "drone and farming" are considered together, these two very different notations have entered into cooperation with new technologies. GPS tracking systems and satellite images are used to monitor crop productivity, soil levels and weather patterns on the farm. Drones are one of the technologies used to obtain these images. Not only can drones see what is happening in the fields, they can also use an analysis from the findings to test the soil and the health of crops.

Drone technologies that can identify and detect diseases or damaged crops also enable farmers to be more productive. Robot technologies also help create a faster environment to produce more goods than normal labour.

As can be seen, a new era is beginning for food technologies. It is difficult to predict what kind of place the future will be, but we can easily say that the way we obtain and consume food will change with the developing technology.

In this context, considering its economic importance, the expectations and the major developments in agriculture and food in the coming years could be listed as:

- ✓ Application of nanotechnologies and the use of robots in production,
- ✓ Privatization of countries on the basis of products, widespread quality and brand awareness,
- ✓ Spreading environmental awareness and protecting natural resources, developing methods that transform wastes into new products, accelerating publication and training activities,
- ✓ Inevitably maintaining intensive production to feed the increasing population,
- ✓ Increasing the demand and consumption of functional foods with product diversity,
- ✓ Using environmentally friendly technologies that destroy food elements less than traditional technologies such as heat treatment in the food industry,
- ✓ Working on the ability to produce agricultural products and, therefore, food in less volume with higher nutritional value,
- ✓ Developing concentrated products in industrial production,
- ✓ Making a widespread use of smart kitchen equipment and monitoring its impact on the way food is prepared,
- ✓ Making use of biosensors and multi-purpose enzymes widely and effectively in the hygienic quality, processing, classification and packaging of foods,
- ✓ Can be listed as the increase in monopolization tendencies.