FROM TRADITIONAL AGRICULTURE TO DIGITAL AGRICULTURE (AGRICULTURE 5.0) - TREND, CHANGES, IMPORTANCE

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Abstract. *The information that agricultural crops provide to farmers (production, degree of pest attack, soil water reserve, soil nutrient reserve pH, etc.) proves to be valuable information for farmers, the decisions that will be taken later analysis of this information being beneficial, advantageous and profitable for farmers. The implementation of new agricultural technologies and systematic data management have led to the emergence of the typology of "smart farm", a farm that will grow and become profitable as more data is collected, data that will be key elements in modern agriculture. Based on these data, agricultural producers (regardless of the branch of agriculture) will be able to make decisions so that the farm can make a profit. The advantages of obtaining large productions, of a high profit derive from the interpretation of the data obtained from the innovative technologies that more and more farmers implement in their farms, technologies such as sensors, drones, bet-bots, robots, etc. Data from agricultural crops obtained from the implementation of new, non-invasive technologies with the environment will increase crop efficiency, soil resources, reduce pollution of the environment and agricultural ecosystems and obtain healthy crops for humans and animals. The present paper aims to present a new type of farm, a technological farm, inside which any process will be monitored with the help of state-of-the-art technologies. The implementation and use of these new technologies on farms, data collection and interpretation is a crucial step for the farmer as well as a benefit by which farmers reduce farm costs, protect the environment, know exactly what parameters have crops and any disturbance of the agricultural ecosystem produced by pathogens, pedo-climatic factors, etc. The final aim of this paper is to present some of the technologies used by farmers to assess agricultural ecosystems, based on data obtained from crops, making decisions based on these data (after their interpretation), implementing a sustainable process of making of decisions and execution of tasks with the help of technological equipment available on the farm.*

Keywords*: emerging agricultural technologies, artificial intelligence, agricultural robotics, automated agricultural production systems*

INTRODUCTION

The agricultural field is in a continuous change, a change due to new agricultural technologies, transformations that prove to be promising for farmers because it will allow them to move to another level of agricultural productivity and profitability of agricultural production (AVITAL ET.AL., 2016). Precision agriculture has become an important factor for farmers because this concept has represented a revolution in agriculture to a modern, technology-assisted field. The implementation of new technologies in agriculture is the fifth wave, in contemporary society this field is being improved (constantly) with an increase in real-time data collection systems, tools for their interpretation and action technologies to restore affected agricultural ecosystems (BERGERMAN ET.AL., 2016).

The use of precision technologies in agriculture has led to an increase in the net yield of farms as well as their operational profits in order to maintain a sustainability of agricultural

production (COSSELL ET.AL, 2016). The use of these technologies will lead to an education, training of farmers in the agricultural field, a much easier and easier exchange of information, much faster availability of financial resources, saving funds and labor, obtaining increased production, reducing costs with minimal effort, farmers getting a maximized profit, they produce quality food through organic practices (RUNQUIST ET.AL., 2001). New technologies introduced in agriculture have facilitated the acceleration of processes within an agricultural farm, using data collection systems, systems of their interpretation in order to generate knowledge of the factors within the farm in order to facilitate certain decisions.

The first step in the implementation of new technologies in the agricultural field was the implementation of the Internet of Things (IoT) (ZAMBON ET.AL.,2019). This name refers to all the technologies that have been or will be implemented in an agricultural farm, from sensors to complex, intelligent systems, fertilization systems, plant protection to systems that have the ability to give back to farmers. data on the type of pests, the degree of attack as well as the solutions with which farmers to combat soil pollution, crops and even the environment (SAIZ-RUBIO, ROVIRA-MÁS, 2013). It has been proven that these new technologies have the potential to increase agricultural production by up to 70%. The main advantage of IoT implementation is high productivity that will involve lower and lower production costs (KÖKSAL ȘI TEKINERDOGAN, 2019).

MATERIAL AND METHODS

In order to increase and maximize agricultural production (regardless of crop), farmers are forced to adapt to new technologies of the future, technologies that have the role of regenerating the agricultural ecosystem, greening the soil and ensuring high production. For each field, the specialists have developed a series of emerging technologies that have the role of facilitating the work of farmers, to reduce costs as much as possible and to give a high production by implementing and using mechanisms. Because in the agricultural field of Romania these new technologies are very little encountered, as materials were identified technologies necessary for farmers, technologies that are already used in other countries. This paper did not use a series of working materials but only methods of using new state-of-the-art technologies, technologies used in agriculture. These methods have been described as succinctly as possible so that farmers are aware of the importance of new technologies in their own crops, as well as the benefits of these technologies in reducing costs, pollution and high production, high profit with minimal investment.

RESULTS AND DISCUSSIONS

In order to obtain large quantities of seed material from agricultural crops and to maximize production per hectare, both for agricultural and viticultural crops, specialists have proposed a series of innovative technologies for agriculture, as follows:

1. The agricultural field of viticultural crops

1.1. Vinescout autonomous robot

This robot is based on artificial intelligence (AI), its main systems being the implementation of 3D software, with stereoscopic visualization, LiDAR system (light detection and amplification), ultra-sound sensors, the robot being equipped with solar panels on its surface. Vinescout can operate 24/24 hours, its role in wine crops is to measure soil surface temperature, soil moisture, plants, the amount of water in the soil, plants, fruits (grapes), the degree of attack of pests in agricultural crops as well as the type of pest (SARNI ET.AL., 2019). All these aspects are based on an infrared multispectral camera which, at the end of mapping the surface, the robot will provide the

farmer with data recorded as a map in both 2D and 3D format, a map that will provide all the data needed to make a decision by farmer on the situation of the crop (figure 2).

Figure 1. Vinescout autonomous robot

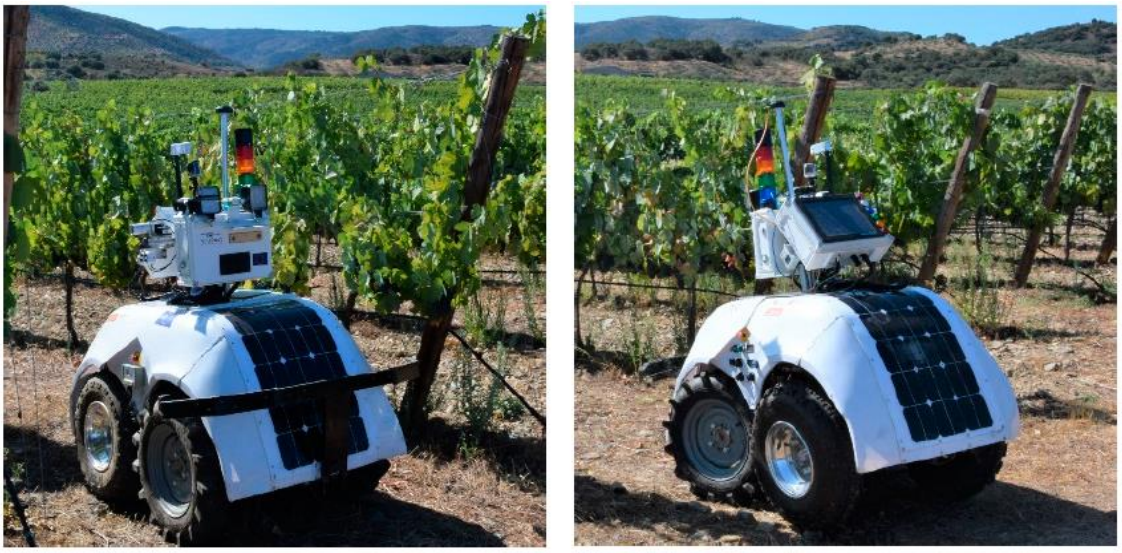
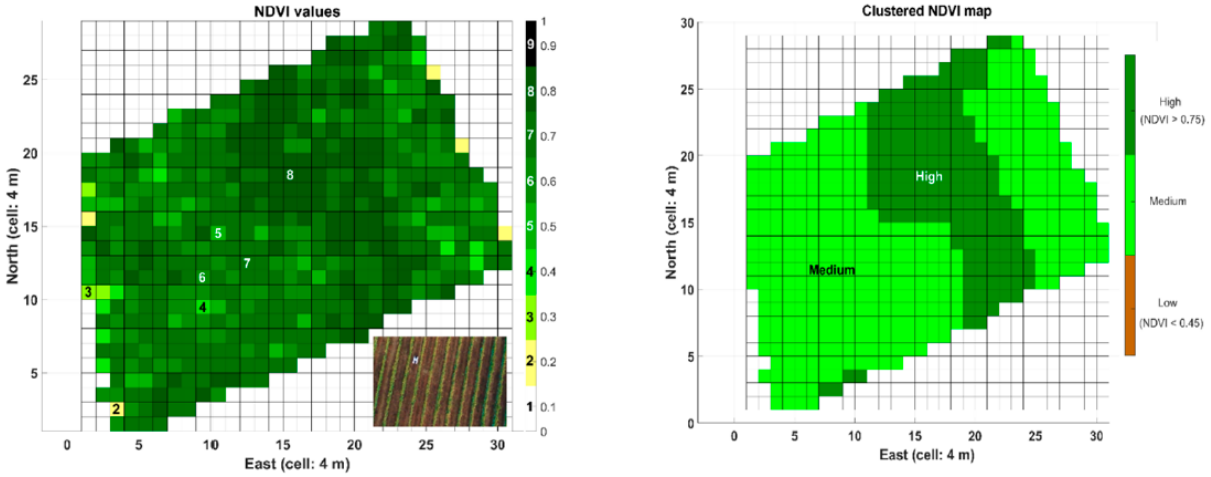


Figure 2. Infrared mapping of vine culture



This technology allows the farmer (by accumulating data) to know exactly what the condition of the crops is, with what treatments to act on the plants and / or fruits so that the yield of the respective crop is maximum.

2. Drones

Another technology encountered in viticulture is represented by drone technology (figure 3). After interpreting the data obtained from the problem area, farmers can use drones to treat pests in viticulture, as well as to spray water on surfaces where the data indicated a water deficit. Thus, drones offer a variable rate of accuracy in the application of fertilizers and plant protection products

in vineyards (WANG *ET.ALL*., 2017). At the same time, the endowment of drones with multispectral and hyperspectral systems will help to obtain aerial images that will help create the vegetation index in the crop, can identify the stress of plants and fruits depending on crops and stages of vine cultivation (TOBE ET.AL, 2017).

Figure 3. Drones in the field-spraying plant protection product

Drones can also be used in the process of growing and tracking the formation of fruits, seedlings (cuttings) and in the process of growth and development of both the crop itself and plants. Equipping drones with infrared systems, hyperspectral sensors and other technologies will address another issue, namely the precise identification of the health of plants, fruits and soil . Moreover, the installation of a Canopy-Chlorophyll (CCCI) type software in the agricultural mapping of vines and not only, will provide information about the amount of chlorophyll in the leaves (figure 3), about plant stressors, these systems differentiating the non-plant plant (vine from weeds) as well as a healthy plant from a diseased plant. All these data managed by farmers will lead to a maximization of agricultural production as well as a large reduction in production costs per hectare of crop (TZOUNIS ET.AL., 2017).

Agricultural field-large crops

In order to maximize agricultural production, farmers use in addition to chemical fertilizers (in increasing quantities) a number of new technologies, emerging technologies that have the role of reducing costs in agriculture, to restore the soil and to obtain a large agricultural production. Thus, changes in agriculture in the context of climate change, soil degradation, acidification, obtaining lower and lower yields, extreme drought, etc., have led farmers to new technologies, emerging in order to obtain quantities of much larger seed material, in the most environmentally friendly / ecological conditions possible (Veroustraete, 2015). Thus, farmers have turned to a number of technologies, as follows:

3. Soil disinfection device

The "Microsoil" device is an innovative device (figure 4) for the agricultural field, it works on the basis of microwave heating technologies, in parallel with the beneficial action of ultraviolet radiation. This device is friendly with the environment and the beneficial fauna of the soil, the disinfection of the soil being on a depth of 20-25 cm. the process of disinfecting the soil with waves generated by the magnetron, in parallel with the ultraviolet radiation will reduce by about 90% the

degree of infestation with soil pests (Institutul de Cercetare-Dezvoltare pentru Industrializarea și Marketingul Produselor Horticole-Horting. Oferta ASAS 2019).

Figure 4. Soil disinfection device „ Microsoil

4. Drones

The use of drones for the application of spray treatments is already widespread in Europe, about 30% of the spraying of fertilizers and pesticides is done with their help. Drones have the ability to navigate in areas very difficult to access by agricultural equipment, steep places. These have the role of exempting farmers from entering the field with heavy machinery, which compact the soil and have a negative impact on crops and the environment. The drones use a LiDAR navigation system, GPS system (figure 5) as well as other sensors and a tank of about 5 liters for spraying pesticides. The map and the guide is made by the farmer with the help of a high-performance software in which he will enter the data of the respective culture .

Drone technology as agricultural spraying equipment must be associated and synchronized with imaging, processing and automatic analysis of data obtained in culture, the drone acquiring capabilities to accurately address the affected areas or plants. The use of drones will lead to improved crops in the affected areas, a reduction in the overall use of chemicals in that crop. Such an approach would not only improve doses in the affected areas, but also reduce the overall use of chemicals in the area. Mapping and imaging capabilities of drone platforms with a wide range of sensors throughout the entire production process can be used to better plan production (Sonka et.al., 2014).

Figure 5. Drone technology as a tool for improving agricultural productivity

At the vine crops, it have undergone a series of research on plant health before and after the application of fertilizers and plant protection products. Nutrient mapping and identification flights were performed using sensors and recognition systems (Figure 6).

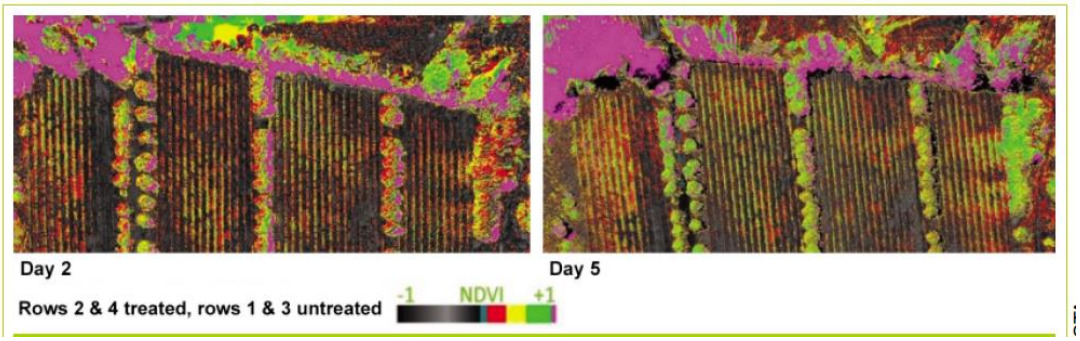


Figure 6. Situation of treated rows compared to untreated rows.

CONCLUSIONS

The use of emerging technologies in agricultural crops (new types of fertilizers, robots, drones, sensors, etc.) have the role of developing a sustainable agriculture, a sustainable agriculture whose role is to reduce chemical pollution of soil and environment, to reduce costs in agriculture as well as to maximize agricultural production and crop yields. The use of these technologies has led to:

1. Precision agriculture (autonomous monitoring of soil respiration, activity of photosynthesis, amount of chlorophyll, degree of pest attack and biological soil factors,

2. Monitoring of soil pollution (measurement of carbon dioxide emissions per hectare, nitrogen emissions, amount of nitrates in the soil in order to reduce the environmental footprint of pollution),

3. Monitoring of soil biotic factors (amount of water in the soil, number of bacterial colonies, soil texture and humidity, light, etc.),

4. Weed and pest control (autobots navigate agricultural crops and spray herbicides, insecticides, fungicides in order to eliminate weeds and pests identified in crops, helping to prevent and increase weeds and reduce pest attack),

5. Obtaining a high quality seed material in the shade of using these innovative technologies in agriculture.

New emerging technologies in agriculture have the potential to reduce farmers 'work, reduce the impact of farmers' intervention on crops, and provide farmers with all the information they need so that decision-making is firm and transparent. The technologies implemented in agriculture have the role of monitoring soil factors, plants and agricultural production so that the farmer is aware of each parameter, its situation and non-invasive intervention on crops with a certain degree of discomfort (thermal, water, pest attack etc). The use of these technologies has a role in balancing the electrolytic processes of the soil, ensuring basic nutrients for plants, ensuring good growth, development and maximizing agricultural production.

The role of agricultural management systems is to manage the company's data so that the results obtained within the farm will address customized solutions depending on the type of each farm. This help comes to farmers in the form of digital solutions that combine software systems with robotics and artificial intelligence in order to create the idea of Agriculture 5.0. In order to be successful on farms, specialists in the field of Agriculture 5.0 must train end users

(farmers) so that they learn the concepts, processes and results obtained from the implementation of these concepts.

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