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DIGITAL PRACTICES IN SUSTAINABLE AGRICULTURE

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Abstract – The concept of good agricultural practice has developed due to rapid changes and globalization in agriculture and the food industry. These changes occur as a result of the responsibility and work for the production of healthy and safe food, as well as the implementation of stable and safe sustainable agriculture, taking care to preserve the environment. The practices that are related to the quality of the soil include the maintenance and improvement of its organic ingredients, with the application of appropriate crop rotation and the application of the digital revolution. The digital revolution in agriculture represents the transformation of standard agriculture into digital agriculture through the installation and implementation of digital machines, sensors, systems, application of information and communication technologies. One of the most used technologies in the agricultural industry is the use of the Internet of Things (IoT). The Internet of Things (IoT) enables the automatic monitoring, control and management of devices that contain hardware, software and sensors, which can be controlled remotely using a smart device, and the data obtained from input devices such as sensors can be are recorded in a database for further processing, selection and generation of reports. By applying IoT, a sufficient level of protection of natural resources from pollution and damage is enabled, which, in addition to soil, includes water and air as resources, which will contribute to the reduction of global warming.

Keywords – IoT, Digital tools, Sustainable Agriculture, Soil

I. INTRODUCTION

The concept of sustainable agricultural production has developed due to rapid changes and globalization in agriculture and the food industry. These changes occur as a result of the responsibility and work of a number of entities for the production of healthy and safe food, as well as the implementation of stable and safe agriculture, taking care to preserve the environment. More broadly, sustainable agriculture applies available knowledge to solve problems related to the environmental, economic and social sustainability of agriculture and production processes to ensure safe and quality food and agricultural raw materials. By applying the measures listed below, farmers will guarantee a sufficient level of protection of natural resources from pollution and damage, including water, air and soil, and they will contribute to the reduction of global warming. Good practices related to soil quality include maintaining and improving soil organic matter through the use of "reserves" that refer to the use of appropriate crop rotation. On the other hand, the role of digital practices in agriculture is to use the power of digital technologies to accelerate and increase the volume of innovative ideas that will positively affect agriculture and food production. One of the innovative

technologies that finds great application in sustainable agriculture is the Internet of things. IoT refers to a network of physical objects that have built-in electronics, software, sensors, and connectivity that allow the objects to exchange data with operators or other devices. The purpose of these devices is to collect as much useful information as possible by integrating existing different technologies where the main goal is timely and accurate obtaining of data and information. The Internet of Things is expected to generate a large amount of reliable data that will enable correct and timely decision-making that will result in success in growing crops, increased productivity, and increased incomes.

II. Materials and Method

Timely and accurate information in sustainable agriculture contributes to the moderate consumption of non-renewable resources, taking into account the protection of nature and future generations. The concept of sustainable agriculture advocates stable and continuous production, with sufficient resources for both current and future generations. The use of good agricultural practice in sustainable production has several important goals: ensuring soil fertility and encouraging biodiversity, improving environmental conditions and preventing pollution, consuming less non-renewable resources, supporting rural economic development, improving the quality of health , farmers' rights and raising environmental awareness. Through the application of appropriate crop rotation as one of the most important measures for sustainable agricultural production, soil fertility is improved, humification is stabilized, water retention and nutrient efficiency are increased. Timely and accurate information contributes to making correct and timely decisions that result in success in the cultivation of agricultural crops, increased productivity and increased incomes. IoT refers to devices that are connected to the Internet in order to perform processes and services that support the needs of agriculture, the economy, the environment. An additional technology without which IoT cannot function is cloud technology. Cloud computing is a well-known and popular service that comes with many features and advantages. The principle of operation of cloud computing is to enable the user to perform tasks on the computer while using the services of the Internet. With this digital challenge, it is possible to increase the productivity and income of agricultural holdings, ensure sustainable food production systems and accelerate the digital transformation of the agricultural sector.

III. Results

The research done in this paper refers to digital practices - ICT opportunities in sustainable agriculture, as an example soil moisture reading is taken, so the technologies that are used are the integration of IoT and Cloud technology. AWS IoT was used as a service provider. Through this service, it is possible to connect to a device that can work independently, process data and forward it in real time from any place using a smart device, through an appropriate connection, i.e. use of the Internet. As a hardware part, two Arduino boards are used, one of which represents the base, and the other allows connecting to the Internet and reading the data from a suitable humidity sensor that transmits information about soil humidity. As for the software part, i.e. presentation of the data, the AWS IoT platform is used, where for its use it is necessary to make an appropriate registration and log in to an appropriate panel. In the process of connecting our user profile with the appropriate device, we need to go through several configuration steps that contain the connection of appropriate public and private keys that relate only to the appropriate user and the appropriate device, through which communication is enabled. The code that enables connection to the Arduino board, along with the sensor and using AWS are shown in figure 1.

Figure 1 – Parameter binding code.

Calling and executing the code is done in such a way that first we call the folder in which the corresponding file is via the command line, we write the name of the port to which the board is connected and its connection is made, the connection is opened and the presentation of the results begins .
The presentation of the loading results is shown in figure 2.

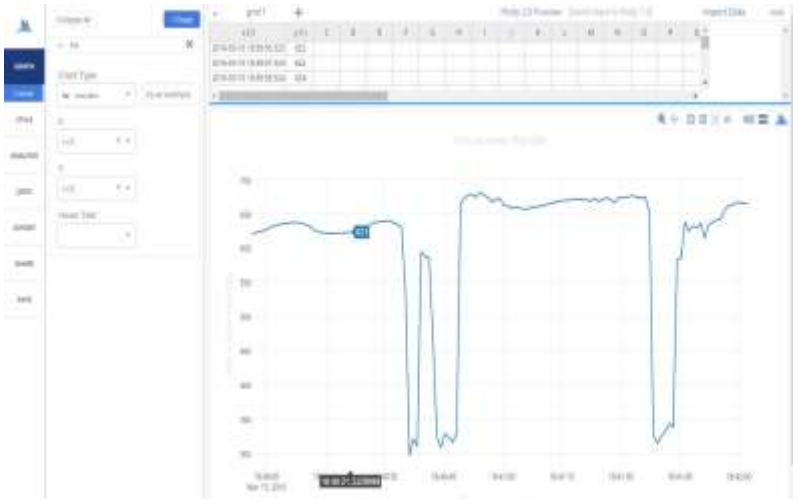

Figure 2 – Presentation of the results of loading the humidity sensor.

Picture number 2 shows the presentation of the results of the soil moisture measurement sensor. The review of the results can be done from any place where the condition that should be fulfilled is to enable an Internet connection and a smart device. According to figure two, the parameters that can be configured on the platform depend on the work that the input device is supposed to do – in our case, the humidity sensor. The more moisture the soil has, the more the line oscillates, that is, it holds an upper limit, while if there is no moisture or there is reduced moisture in the soil, then the oscillation is in a downward line.

IV. CONCLUSION

Sustainable agricultural production represents the need to find different ways of agricultural production that do not degrade natural resources, and at the same time bring high yields and income to agricultural producers. Preserved natural resources and improved quality of life in sustainable production systems are very important not only for the present, but also for future generations. In the development of sustainable agriculture, more and more emphasis is placed on positive activities in the field of agriculture, and one such activity is the application of crop rotation. Its application increases yield, soil quality and reduces the use of protective agents. In addition to the use of good agricultural practices in sustainable agriculture, IoT technology is gaining momentum in agriculture, which can change and modernize traditional agricultural practices. By connecting physical devices, various sensors and sophisticated software to the internet, IoT solutions enable detailed real-time data insights, analytics and remote monitoring. With the information derived from these IoT solutions, farmers could make decisions and solutions for increased efficiency, sustainability and productivity. IoT solutions in R.S. Macedonia, especially in agriculture, are still in the early stages of adoption. Although there is a growing interest in utilizing IoT technologies to improve agricultural practices, the implementation of such solutions is not yet widespread. By demonstrating the benefits of IoT solutions through various projects and pilot programs, the awareness and adoption of these new technologies among Macedonian farmers is increasing. Thus, in the future, farmers in our country are expected to adopt IoT solutions, thus improving productivity, sustainability and competitiveness in the agricultural sector.

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