Review on Agriculture and Rural Development 2021 vol. 10 (1-2) ISSN 2677-0792
DOI: 10.14232/rard.2021.1-2.3-8

THE IMPACT OF A PRECISION MONITORING SYSTEM ON VEGETABLE CULTIVATION IN RURAL AREAS

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ABSTRACT
The modern development of recent years has not left agriculture untouched either. The advent and introduction of precision technology have accelerated events further. Slowly, even the smallest farms are trying to move from the methods they have become accustomed to as much as possible, using precision technology to make their operations more efficient and profitable, as those who lag behind will lag behind and will not be sufficiently competitive with other producers. Precision development covers all areas, we have the opportunity to apply new knowledge and technologies in sowing, irrigation, plant protection, harvesting, and last but not least, nutrient replenishment and even other areas. This development is a major task and very topical for smaller producers in rural areas, as they need to develop and create the necessary financial resources, which in many cases can only be achieved in the form of subsidies from different locations. This is all the more true for horticultural crops, since, for example, in contrast to the arable crop production, producers have much higher energy and capital requirements to achieve the same level of profit. In the course of the study, we examined the opinion of the producers supported by the Southern Horticultural Cooperatives – Délalföldi Kertészek Szövetkezete (DélKerTÉSZ) - whether the Agro Sense decision support precision tool placed to them had improved their production conditions and made their production more profitable due to the use of the tool.

Keywords: precision agriculture, vegetable growing, rural development, rural area

INTRODUCTION

GÁL ET AL. (2013) state that the goal of precision farming is to produce the best possible quality and safe food so that resources are utilized in the most efficient way possible, yet sufficient raw material remains for our offsprings as well. At first glance, this may not differ any way from the principles of traditional farming, but the main difference is that the efficiency of information acquisition using digital technologies gives producers a much greater development perspective and increases their competitiveness, resulting in better results compared to the traditional production, while placing a strong emphasis on sustainability. Precision farming, as the word implies, helps make farming more accurate and disciplined. It helps the farmer to plan production meticulously, takes the burden of making a decision off their shoulders, for example with the help of analyzed data collected by various monitoring / decision support tools. All this even so that the producer may have the opportunity to set up the optimal values per square meter or per crop, instead of a uniform stock management.
The above described things sound good, but in many countries, including Hungary, there is a great deal of financial differences between the regions, due to which the developments are not proportionate to each other. At the domestic level, small and medium-sized farms do not have enough technical knowledge and financial background to introduce modern technologies, so there is a need for easy-to-use and cheaper equipments, otherwise the difference in production levels between small and large farms will increase (JÓRI, 2019).

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Typically, younger, higher-educated, and capital-intensive producers are those who are more open to new technologies, but most producers belong to the middle and older age groups (BERNARDI AND INAMASU, 2014; FOUNTAS ET AL., 2005; ANTOLINI ET AL. (2015); DEFRA (2013). In addition to the financial conditions, there is a need to ensure professional knowledge so that producers can process the data efficiently. According to HADÁSZI (2018), only 20 percent of the highly valuable data from precision instruments are used. In June 2016, the European Parliament decided that barriers to the spread of precision agriculture should be removed and producers should be encouraged to adopt new technologies (HUSTI, 2018). Farmers' cooperatives, and special bank loans and a part or all of the reimbursable subsidies also have an incentive effect on certain producers, as well as high-quality advisory services to help them learn how to use valuable data in production (NAK, 2019). Lots of modern technological elements have already emerged in all areas of agriculture, both in animal husbandry and crop production. In animal husbandry, it can be said that there is no significant difference in the development of certain sectors, but this is no longer true for crop production. The repertoire of precision tools that can be used in the cultivation of field crops is much wider and more mechanizable than in fruit production or by horticultural crops, where in many cases it is difficult or impossible to replace live labor with machines. In the latter two sectors, perhaps the greatest assistance of precision tools to the producer are currently in forecasting and monitoring systems. Areas that can be automated (e.g. irrigation, nutrient replenishment, ventilation, etc.) do not require a special human presence. There are many types of monitoring systems on the market today, such as: Autogrow / IntelliDose; IntelliClimate; MultiGrow / [1], Sensaphone [2] [3] [4] [5], RESORT AGRO - MONITOR [6] [7] [8], BDPA Automation Kft. [9] and Agro Sense [10].

Agro Sense decision support monitoring system:
The Agro Sense distributed by Sys-Control Ltd. stands out from the precision monitoring systems prevalent in the domestic market, which is in partnership with companies such as KITE Ltd., Syngenta and DélkerTÉSZ in Szentes. During the past 7 years, this precision instrument has been installed in 6 countries and in more than 70 locations. Its field of application is very wide: in orchards, greenhouses, arable lands and in field vegetable production. The system itself consists of wireless mini meteorological stations, Agro Sense Bases, which measure precipitation, wind direction, wind speed, air temperature, air humidity, air pressure, incident solar radiation, photosynthetically active solar radiation, and ground temperature. They consist of different sensors, Agro Sense Nodes, which measure soil or agent moisture, conductivity (EC), leaf moisture, air temperature, humidity, but it is important that the sensors have to be placed right next to the plants. It is quick and easy to install and manage, and provides users with accurate and precise data on which they can base their cultivation decisions. It collects and stores data, allowing users to access them anytime and anywhere if they have an internet connection. To achieve a better effect, distributors recommend growers the Agro Sense Trap, a pheromone insect trap that takes a picture of the insects caught and counts the pests caught daily and transmits the collected data to the Base unit. When the parameters measured in the system, reach the set limits, it sends a notification to the producer in the form of a message. [10]

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MATERIALS AND METHODS

The main aim of the survey was to examine the impact of the Agro Sense decision support system on producers and their decisions, how they see what positive and negative experiences they have using the system. We also asked the users about what expansion opportunities they think Agro Sense has and wether they want to develop their own tools further. We tried to assess this with the help of a detailed questionnaire and we made personal interviews with the producers. In 2016, DélKerTÉSZ deployed the Agro Sense measuring network at its Szentes-Szentlászló foil plantation for the first time at its three producers for experimental purposes. At that time, they had one base station and three substations and the corresponding measuring sensors. Farmers usually produce white conical peppers on rockwool or on coconut fiber substrate in soilless culture, in plastic tunnels heated with thermal water, or in some cases unheated, with several years of experience. Later, another 10 producers joined the experiment, so currently the system has been installed at 13 producers in the last 5 years. The precision device is based on providing almost realtime information about growing conditions with the help of sensors: substrate temperature, water capacity, EC, air humidity, air temperature. In addition, the meteorological data of the base station are immediately received by the producers: outdoor temperature, humidity, irradiation, air movement data and precipitation. Each grower can track the data generated by the system with an individual code, edit it for a specified period, display it graphically, and compare the individual factors. The consultants of DélKerTÉSZ also have access to all data sets.
The survey was conducted by using an online, anonymous questionnaire consisting of 24 questions in early February, 2021. The questionnaire was sent to all 13 producers, 10 of whom contributed to the completion and provision of data. The composition of the questions was varied. The first part was used to gather general, more personal information (gender, age). In addition, the respondents answered questions about their way of production and how long they had been using Agro Sense. There were questions to which their answers could be determined on a scale of 1 to 5. The questions focused on how much the producers are satisfied with the system, whether they find it reliable, and whether they think it is easy to manage, if it can positively influence their production decisions. Most of the other questions were multiple-choice, where they could choose the ones that corresponded to them from the given values and answers.

RESULTS

The soilless technology is becoming more and more widespread in the Hungarian indoor vegetable production. The producers in TÉSZ mainly use rockwool and coconut fiber substrate. The greenhouses are covered with a double-layer plastic film, vegetables are grown under partly regulated climatic conditions. The greenhouses are heated by thermal water. The technical equipment of greenhouses would need to be improved, since most of them have been in production more than 15 years, so their replacement would be justified. Soilless cultivation is characterized by a more efficient water and nutrient utilization, which also means an improvement in cost-effectiveness.[11] The producers asked in this study have limited possibilities to install for example, certain control units (climate control) in their greenhouse. The evaluation is based on a comparison of the responses provided by the 10 producers. During the comparisons, we tried to get the opinion of the majority, but the evaluation was also done on an individual basis. During the evaluation, it

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is worth considering the useful information, criticisms and suggestions obtained from the producers' responses, in order to improve the quality of the service, to raise its standard, and to introduce new developments. A similar survey has already been carried out among producers in 2018, the results of which are as follows:

"There was a consensus among the producers involved in the testing that the use of sensors was beneficial. It keeps track of temperature changes in the plastic tunnel, and soil moisture data informs and helps with irrigation planning. The values of EC and substrate humidity, and their daily and weekly changing tendency provide good feedback in the evaluation of nutrient solution. The web interface is very good, you can keep track of the values, you can look back at the data of certain periods, it also allows for later analyzes. Cultivation becomes safer, the amount of nutrients and irrigation water applied can be adjusted more confidently. The possibility of continuous monitoring of water capacity during the summer was particularly a big step forward. Irrigation shortage caused by a possible technical fault can be controlled almost immediately."[12]

The growers' opinions have not changed over the years, so most of them find the AgroSense useful and enjoy using it. Over the years, they have drawn even more experience and ideas from the possibilities offered by the system. Now, during the survey, we had the opportunity to ask what is good and what should be changed by the system developers. Parameters monitored regularly has not changed by now. The temperature of the substrate and the soil, the humidity of the air and the water capacity are in the first place. What was surprising, however, is that parameter EC was monitored rarely, which was still regularly monitored during the post-deployment survey. This may be related to the insufficient and fast maintenance work, which means that they cannot make decisions based on these values, but have to rely on their own experience in production. So, the position of the growers is that there would be a great need to speed up the maintenance and repair processes, make them smoother and maintain the software on a regular basis. In the first survey, they found it useful to have access to their data on the web interface, which has not changed since then, as where there is an internet connection, they can access their own user interface and retrieve the data by any means. One of the biggest benefits is the fast information service, which gives the producer great security about their daily tasks. This significantly shortens the "reaction time" and can quickly correct any problems that may arise. As the system stores the data collected in the given periods, it can serve as a useful basis for planning and optimizing the production processes in the next growing season. It can provide not only estimation but also figures, so with the help of simpler or even more complex calculations it is possible to reduce and plan expenses. This was also confirmed during the survey, although not all producers made calculations, but they were unanimous in their opinion that the system reduced their costs and the amount of raw materials used. So, summing up the above, the lives of producers have become easier and more predictable in the recent period. The DélKerTÉSZ helped the producers participating in the experiment both professionally and financially, as they did not have to invest in the system from their own resources, but the system was outsourced to them with the support of the TÉSZ.

DISCUSSION

In many cases, the system has proven to be useful in making production decisions. The farmers' lives have been greatly facilitated and a part of their daily tasks has been taken over by AgroSense, which collects them data every hour of the day, saves time, energy and money for them as they can make their decisions based on these data. The shortcomings of

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AgroSense also became clear during the survey. To the producers' opinion they would only extend the monitoring tool, if the maintenance process were carry out quickly and smoothly.

In several cases, it took months to replace a defective part. Also, there would be a need for periodic recalibrations, which would give even more certainty to producers in their decision-making. The other direction of development suggested by farmers is not only to have remote monitoring of the system, but also to provide opportunity to perform the necessary interventions. In soilless pepper production beside fractional climate control development of pepper plants under plastic greenhouses might be regulate by nutriant and water dosage based on the producers' experiences. Using sensor based DS tools growers, for instance, could judge whether the variation of daily water capacity in the substrate or soil would have been sufficient for reliable plant development. However, in modern greenhouses irrigation is controlled by automated climate computers based on solar radiation, while small growers could not afford to buy these automated tools. Consequently, small farmers producing in low-tech greenhouses can establish their technology implementing DS tools (like AgroSense) and decrease the risk of their growing. Investment of these sensorbased tools is more affordable to the automated climate control computers in high-tech greenhouses.

Our proposal for AgroSense operators would be to place more emphasis on the farmers' opinion in the future and to monitor their feedback. The survey also made it clear that at the moment the main problem has occured with the sensors accuracy and the maintenance processes. This makes everyday life difficult for producers and they cannot facilitate their decisions with the help of the system. We believe that if these problems were solved, producers would be even more satisfied and more likely to expand more devices into their greenhouses or even they would recommend the AgroSense tools to their fellow producers. On the other hand, DélKerTÉSZ would also have a better chance of expanding and continuing its cooperation with AgroSense if it could really deliver the best quality service to its producers. According to the survey, there would be a need for expansions on the part of producers, so I recommend DélKerTÉSZ to pay more attention to the monitoring system and encourage the system operator to perform regular maintenance work. So, in that way DélKerTÉSZ can promote and support the interests of producers with even greater security than they have done so far. An exemplary support system could be developed that could be adapted to other parts of the country to start catching up and reduce extremism among producers and allow everyone to produce on an equal footing with a similar level of technology.

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Review on Agriculture and Rural Development 2021 vol. 10 (1-2) ISSN 2677-0792
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