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Smart Agriculture: Could IT Be the Future of Romanian Farmers?

Fertu Cristinel
cristi_fertu@yahoo.com
Dobrota Liviu Marian
liviudobrota82@gmail.com
Balasan Daniela Lavinia
balasan@ugal.ro
Stanciu Silvius
sstanciu@ugal.ro
Dunărea de Jos University of Galați, Romania

Domestication and cultivation of useful plants are correlated with the evolution and development of human civilization. The current evolution of agricultural technologies has allowed the development of new concepts of intelligent agriculture, based on ITC. In order to optimize crop production, pest control, soil and plant growth monitoring and better information collection for farmers, in the context of the world's growing population, smart agriculture will need to make more use of information technology. The future of agriculture in the coming years will be the result of the connection between satellites and intelligent technical means, both with monitoring and control of agricultural activity. The article presents the trends of smart agriculture and aspects related to the development of Romanian agriculture. The obtained results allow the development of more extensive analyzes, the presented study being part of the documentation related to the doctoral research.

Keyword: smart agriculture, drones, precision agriculture, sensors

JEL CODE: O13, Q16

1. Introduction

The evolution of human society is linked to the development of agriculture. Global population growth has led to higher food needs and the industrialization of agriculture. According to current estimates, agriculture is an economic sector worth over $ 5 trillion, and agricultural production uses large-scale information technologies based on artificial intelligence (Figure 1).

Major global food challenges will have an impact on the development of human society, requiring new technologies to use and protect our relationship with cultures in the future (Schaal, 2018).

Ehrlich, an analyst of the effects of population growth, believes that in the future the growth of the world's population should be limited and it is necessary to redistribute food resources to avoid a disaster for humanity. The optimum for which a decent living can be ensured would be about 1.5-2 billion people, but currently the population is about seven billion people, and is forecast to reach 9 billion by 2050 (Carrington, 2018).

Food production for this population is a difficult task, requiring innovative technological solutions in agriculture, food distribution and processing. Agriculture generally

requires large human and material resources, with significant costs related to planting, maintaining and harvesting crops.

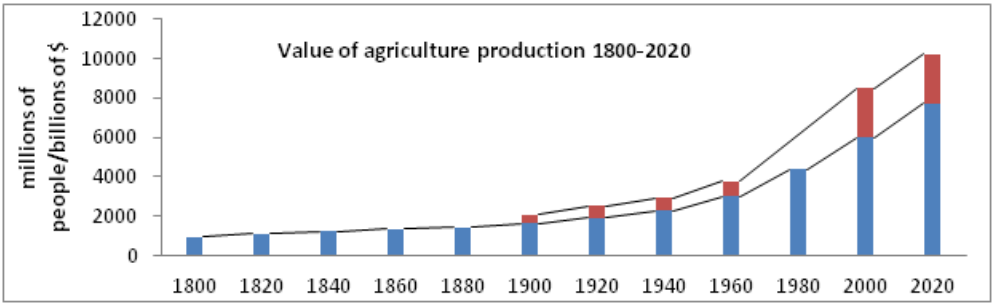

Fig 1. World population and agricultural production
Source: United Nations (2015)

Modern agricultural technologies, based on agricultural robotics, soil and crop monitoring and predictive analysis can replace some human activities and can guarantee increased economic efficiency (Figure 2).

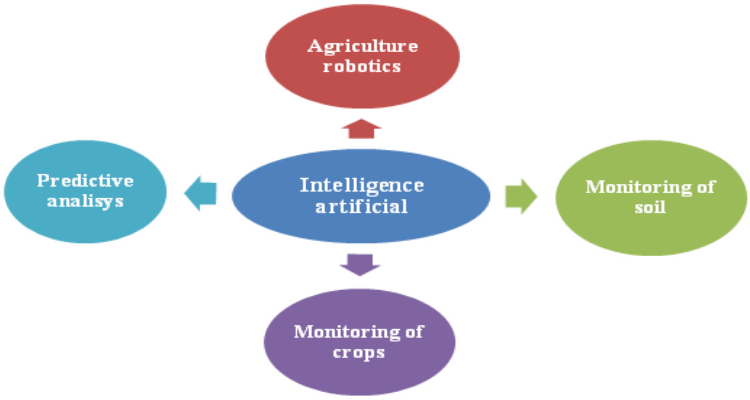

Fig 2. Activities of smart farming
Source: Authors, own contributions

Among Romanian farmers, technology is considered both a threat and an opportunity. Romania's agricultural sector brings only 4.5% of GDP, compared to 25% in IT, so there is an extraordinary opportunity for economic growth by coordinating both sectors. Small farms and fragmented land ownership, low levels of mechanization are barriers to the rapid computerization of the agricultural system. Domestic farms face the provision of labor resources, a challenge for which digitization and automation can be viable solutions. The concept of intelligent agriculture refers to the use of technologies such as the Internet of Things, sensors, satellite-based location systems, robots and artificial intelligence in organizing farm activity. The ultimate goal of modernizing agricultural technologies is to increase the quantity and quality of crops, optimizing the use of human labor and reducing the costs of agricultural holdings (Fertu et al., 2019).

2.Trends in smart agriculture

Identification of diseases and pests

Common agricultural practices for diagnosing crop diseases are mainly based on visual inspection, as in most cases the disease shows a number of visual signs, such as colored spots and general changes in leaf color (Figure 3). Direct observation of disease symptoms in agricultural crops is costly, requiring time and specialized human resources, especially for diversified agricultural crops (Stanciu et al., 2018).

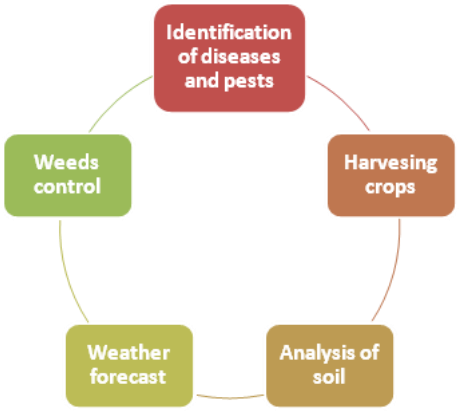

Fig.3. Trends in smart agriculture
Source: Authors, own contributions

Machine learning helps to detect diseases early, specialized software processes images captured by drone cameras, analyzes and compares photos with an archive of images in the cloud, providing a quick and accurate diagnosis (Fertu, Dobrota and Stanciu, 2019). Computer programs allow a faster predictions and a better management of diseases that could affect crops. At the same time, automatic data processing and the development of variable-rate prescription maps allow rapid isolation of disease outbreaks over large agricultural areas and cost savings due to the use of smaller quantities of plant protection products. An accurate location of pests and an early diagnosis allows the application of herbicides only where interventions are needed (Ghise, 2020).

Weeds control

Weeds can be effectively controlled by various activities, one of the most effective methods of weed control is crop rotation, which requires lower costs. This prevents the spread of diseases and pests, and the stock of weeds in the soil is also reduced. By using technologies based on drone analysis, pest and weed control helps farmers reduce financial efforts and better protect crops. Precise identification of weed-infested areas allows the application of herbicides to be optimized, thus reducing the consumption of the active substance and the allocated resources.

Harvest the crops

Traditional methods of crop analysis take a long time and are affected by errors. With the help of precision agricultural drones, farmers obtain accurate data on the state of the crop, being able to take early measures to improve the yield of the entire farm. With the help of drones, the analysis of plants in a certain area is feasible and fast, simpler and more accurate

than traditional estimates. The assessment of the health of plants can be done based on the technology of "image recognition" and thus reduces, using a mathematical algorithm, the number of plants analyzed. Thus, it is possible to quickly highlight areas with losses, allowing immediate replanting. Large area harvesting can be also done depending on when the crop reaches maturity.

Analysis of soil

The application gives farmers the opportunity to apply so-called precision agriculture, where each agricultural area is optimized. If a lack of nutrients is found in a certain area, apply a fertilizer or agricultural treatment locally, so as to obtain a good production. The application can also identify plant diseases and can provide a diagnosis of plant health, based on artificial intelligence and machine learning.

Weather forecast

Artificial intelligence also helps the farmer to be informed about the weather forecast. Estimates of soil water requirements help farmers take action early so that plants are not severely affected by drought or too much water. These applications for fall and estimated short- and medium-term rainfall lead to higher yields for farmers and lower risks of drought losses. Technology is evolving rapidly, moving from software and hardware technologies to systems capable of interpreting all the data collected (for example, data collection in the management system, data transmitted by weather stations, sensors or drones). In addition, there is knowledge passed down from previous generations, information that may be unique to each farm and which is related to the geology and microclimate of the area concerned. All these, put together and properly interpreted, can form the basis of a "recipe" for the efficiency of agriculture, the optimal use of resources for maximum results. The data collected is used to make forecasts and to "predict the future". As with weather forecasts, the farmer can make decisions to reduce the risks - what treatments are needed and when they should be applied or when they are harvested to get the best harvests (Murariu et al, 2019).

3. The impact of smart agriculture and its role for Romanian agriculture

Farmers' incomes can be affected by the evolution of the agricultural market, based on consumer demand or due to unfavorable production conditions. Extensive supply chains and global distribution networks cause farmers to produce more for lower prices. Farmers need to identify ways to finance cutting-edge technologies and minimize operating costs, while maintaining effective profit margins to be competitive. Ensuring access to technology can be done through own funds or by resorting to national or regional financing programs for farmers, intended to promote, harvest, or other various investments that include smart solutions for agriculture (Rafoi A, 2019). Although not very clearly provided for in the Common Agricultural Policy, the European Commission considers that certain aspects, in particular subsidies, are directly involved in increasing farmers' incomes (Figure 4).

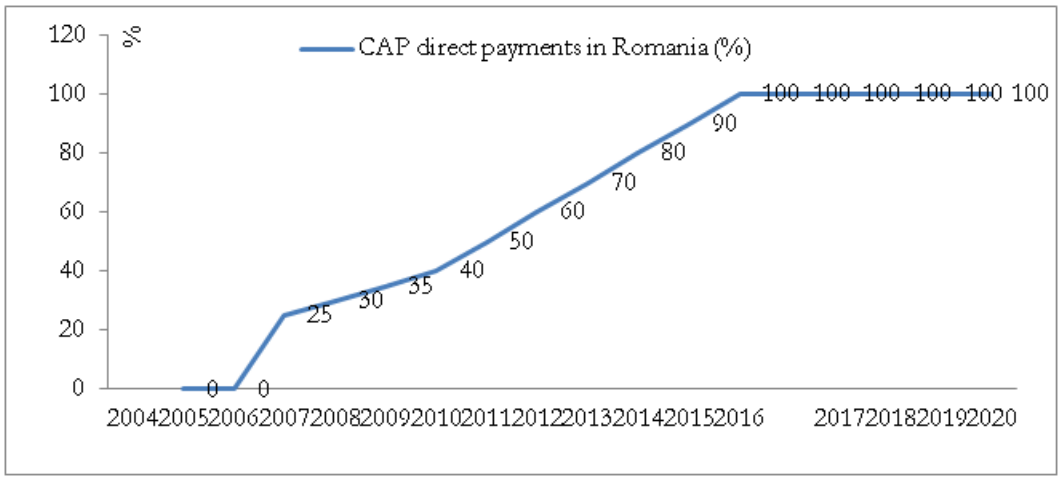

Fig. 4. CAP direct payments in Romania (%)
Source: EC (2001-2003)

A priority of European agricultural policies is the development of agriculture by supporting and stabilizing farmers' incomes, thus ensuring their long-term economic viability and reducing their vulnerability to market fluctuations. The payment system based on the cross-compliance and greening mechanism should contribute to the sustainable development of agriculture. A recommended way is to associate farmers with pooling resources, reducing costs and individual contribution. Many agricultural activities, especially repetitive ones, which require precision, high physical effort or risk to the worker, can be taken over by robots in the near future. Agriculture is assimilating more and more technical advances, being a major difference between the traditional methods used a few decades ago and modern technologies. In the future, a better level of skills and new skills are needed for the agricultural workforce. After the introduction of new technologies, it is estimated that by 2030 traditional jobs in agriculture, forestry and fishing will decrease by 13%, requiring new skills for employees, such as drone operators, programmers, specialists in robotic surveillance of crops. (Hagi, 2019).
There are digital applications for weather, water or soil prediction, sensor-based systems that can detect crop health and insect attack. Romanian farmers can also benefit from state-of-the-art technologies due to the impact of the area payment schemes managed by the European Union. After Romania's accession to the European Union, eligible local farmers became beneficiaries of European subsidies granted under the European Agricultural Guarantee Fund, although Romania is one of the few European countries with the lowest minimum eligible area for subsidy (0.33 ha).

In other European countries, the minimum area for accessing subsidies is 2 ha in Spain, Austria, Slovakia, 4 ha in Luxembourg and Sweden) or even 5 ha in the Czech Republic and Denmark (Figure 5).

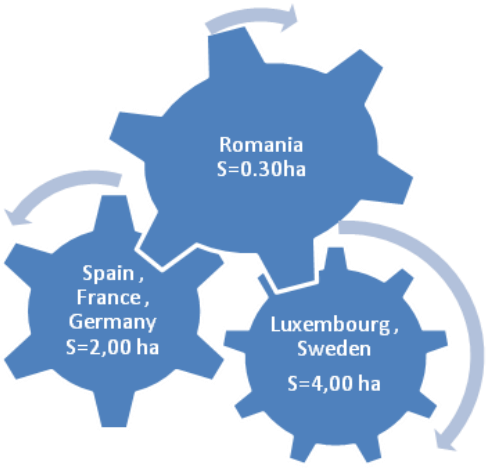

Fig.5. The minimum eligible area of farm for subsidies in European Union
Source: Authors, By using

A Romanian farmer can receive European subsidies if he owns even 0.33 ha. The amount of the subsidy is 200 euros for Romania, Ireland, Portugal, Slovakia, while for Spain, France, Germany it is 300 euros, 400 euros in Italy, Greece, Belgium and even 500 euros in the Netherlands. The amount of the subsidy and the minimum eligible area favor the Romanian farmer (Sahlean, 2019).

4. Conclusions

Romania is one of the European countries with the highest risks related to the labor force in the agricultural sector. Many rural employees perceive the lack of opportunities in agriculture and will continue to leave the sector, looking for employment opportunities in other fields of activity. A potential solution for Romanian farms is based on the application of intelligent agricultural technologies. European programs should focus more on technology transfer in agriculture. Easy-to-use applications for small farmers should be targeted, ensuring that agricultural products have easier access to the market, providing agri-climate forecasts or information on subsidies and support measures.

Agricultural high schools and agronomic universities should modernize their curricula to include digitization-oriented specializations and the development of new skills adapted to modern agricultural production.

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