Annals of the University of Oradea, Fascicle: Ecotoxicology, Animal Husbandry and Food Science and Technology, Vol. XVI/A 2017

Analele Universitaţii din Oradea, Fascicula: Ecotoxicologie, Zootehnie si Tehnologii de Industrie Alimentara, Vol.XVI/A 2017

# ASPECTS OF WoT CONTRIBUTION TO SUSTAINABLE AGRICULTURAL PRODUCTION

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***Abstract***

*To feed the growing population, food production must increase with 70 percent by 2050. Sustainable development of agricultural production will be done using new data-driven business models based on data obtained using WoT (Web of Things). The Web of Things, which is a superset of the Internet of Things, represent the integration of digital technology in precision agriculture. Precision agriculture and digital technologies are the most influential trends affecting farming practices and structures through 2030. WoT will help precision agriculture to use satellite position data, remote sensing devices and proximal data gathering technologies. It enables an information based decision making approach to farm management, to optimize returns on inputs. Simply put, enabling more to be done with less. Unlike previous agriculture revolutions, which have focused on further intensification and standardization, this offers a new set of tools. It is not about drastically increasing yields, but tailoring the cultivation of each square foot: adopting a 'per plant' 'per animal' approach. This revolution in data available to the farmer, in contrast to those before, is an agricultural revolution.*

**Key words:** ICT, IoT, WoT, precision agriculture.

## INTRODUCTION

The Department of Economic and Social Affairs, Population Division, of the United Nations, (United Nations, 2015) has predicted that the global population will reach 8.5 billion people by 2030 and 9.7 billion people by 2050. In order to feed this growing population, food production must increase with 70 percent by 2050.

Agricultural investments have played an important role in the growth of the food supply through technological progress, and they will be crucial for achieving a sustainable food production in the future (Pardey et al., 2014).

"Promoting sustainable agriculture requires a renewed focus on innovation and investment in research, technology and capacity development", FAO Director General José Graziano da Silva said at a meeting of agriculture ministers of the G20 in China. He pointed out that "ICT (Information And Communication Technologies) helps in the monitoring of crop growth, utilization of new techniques, field management and harvests" (Da Silva, 2016).

In E-agriculture Strategy Guide (Food and Agriculture Organization,

2016) are set many roles of ICT in agriculture as presented in figure 1 (Food and Agriculture Organization of the United Nations and International Telecommunication Union, 2016).

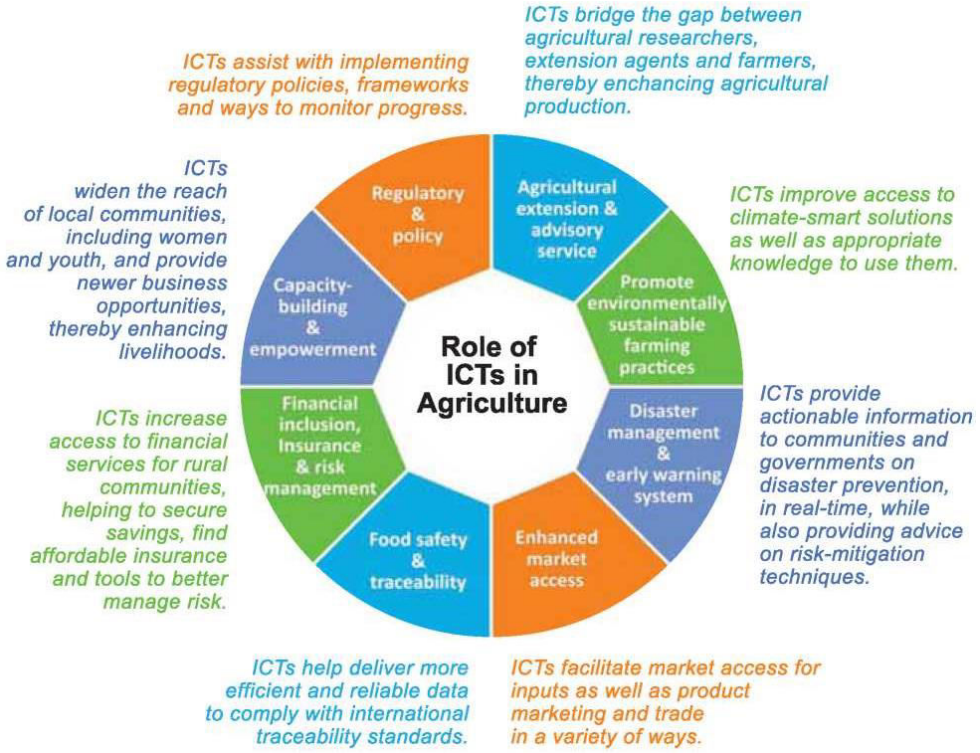


Fig.1. Roles of ICT in agriculture

In ICT, one of the main buzzword in last years is IoT (Internet of Things) alongside Big Data. This, as a matter of fact, is an evolution of the Machine to Machine (M2M) concept and describe a universe of connected physical devices and data.

Enabled ICT environment can unleash the real potential of agriculture as presented in figure 2 (Food and Agriculture Organization of the United Nations, 2016).

Internet of Things is not just about the “things”, but moreover about connecting people to the right data, automating processes for cost reduction and enabling inter-dependencies between the operational level and the business level of the organization. Specifically, IoT becomes a tool for predictive maintenance or an intelligence assurance policy aimed at improving products and services quality through optimizing processes.

The IoT movement transcends nowadays the limits of M2M communication, enabling even devices that do not include the respective electronics to connect to the Internet by using an intermediary non-intrusive device. According to Cisco, this technology is poised to generate $4.6

trillion by 2024, through the efficient management of resources, improving employees' productivity, new business models and increasing the benefits for end users (Nedeltchev, 2015).


Fig. 2. Enabled ICT environment in agriculture

The Web of Things is a superset of the Internet of Things where everyday devices and objects, which contain an embedded intelligent device or computer, are connected by fully integrating them to the Web.

## MATERIAL AND METHOD

This study analyzes WoT contribution to sustainable agricultural production on three different levels:

- expectations and forecasts of analyst's area,
- trends of the agricultural machinery manufacturers,
- the level of existing achievements in the field.

Because agriculture is increasingly regarded as an industry, analyst's transposes industry forecast in agriculture. Unfortunately, there are two major issues impacting agriculture, the evolution of the weather and the environment protection in the long term (especially soil) which complicates achieving optimal solutions.

On the other hand, due to the inherent mobility of the basic components of IoT, the advantages that bring them in agricultural technology will be higher than in industry.

WoT system will need to combine information from IoT system with data obtained from various sources and external services to provide proposals for action, including risk analysis, so that the farmer to get maximum profit in terms of enforcing laws and protecting the environment.

The basic elements on which is built smart and precision agriculture today are WoT and IoT.

Among companies based in the US who have significant achievements in this area we highlight Deere & Company, Trimble Navigation Ltd., Raven Industries, AgJunction Inc., Monsanto and DuPont.

DuPont launched its Encirca farm services, which have a powerful analytics models (Poston, 2016,). These models integrate decades of agronomy research with new technologies like wireless data transfer and cloud computing to allow for the seamless transfer of data from the field to the farmer's fingertips. Encirca$^{SM}$ services can even provide farmers with advanced 3-D views into the composition of the soils on their farms, including valuable information on soil depth, texture, organic matter content, and water holding capacity, to help inform decisions on input management. DuPont's Evalio® AgroSystems monitors pest populations and their movements to give real-time warnings to farmers, resulting in crop protection measures that are targeted for maximum benefit. Against conventional growing techniques, Evalio® AgroSystems can help improve yield and crop quality, increase economic returns for farmers, and reduce water consumption and greenhouse gas emissions.

In the EU, the Future Internet Accelerator Programme for Internet-based innovation in the food and agribusiness have three projects domains, FInish, SmartAgriFood and Fractals to give 14 million euros in grants for application developments (Verdouw et al., 2014). One of them, QUHOMA (QUalitative HOrticulture Marketplace) is an example of Future Intelligence's farm services (Geissler, 2015). Hardware (FINoT equipment) is provided for free to farmers and access to relevant data is provided upon subscription to agronomists/mentors and Quality Certification bodies. In Italy, AgriAware is a traceability project that follows the transformation of olives and other fruits from the tree to the packed product (AIOTI, 2015).

The European Innovation Partnership 'Agricultural Productivity and Sustainability' presented at a seminar (EIP-AGRI, 2016), how agricultural and rural development policy can support the data revolution for an enhanced productivity and sustainability in the wide agri-food chain, covering different sectors, farm types and production systems. These data, generated by components of networks IOT will determine in many cases the implementation of data-driven business (Poppe, 2016).

We should mention the Kaa open-source IoT Platform (Popović et al., 2016) which is a crucial middleware technology that allows walking safely

into the agriculture IoT field (http://www.kaaproject.org/agriculture).

**RESULTS AND DISCUSSIONS**

In this battle came not only traditional producers for agriculture but also those from ICT. In 2015, Fujitsu and Microsoft announced an offer for a solution that blends Fujitsu's Eco-Management Dashboard, an IoT service for the agricultural sector, and Microsoft's Azure database services (Microsoft News Center, 2015). This solution is based on the innovative work Fujitsu performed in Aizu-Wakamatsu, Japan. Fujitsu converted its semiconductor manufacturing operations into its Akisai Plant Factory, figure 3 (Fujitsu, 2013) – the largest low-potassium vegetables "Plant Factory".

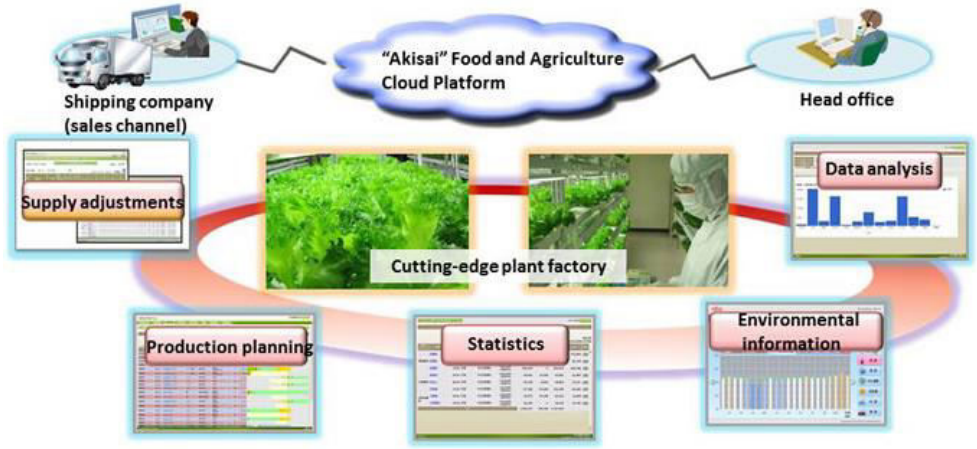


Fig. 3. Akisai Plant Factory

Horizon 2020, the EU's framework program for research and innovation, is investing nearly €77 billion over seven years (from 2014 to 2020) in research and innovation projects to support Europe's economic competitiveness and extend the frontiers of human knowledge, have a Work Programme called Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy (European Commission, 2016). One of the call topic is Robotics Advances for Precision Farming and will help attain high levels of precision in modern farming through the smart use of robotics. Research and Innovation Actions will focus on the design, development and testing of robotics systems for precision farming, including autonomous or semi-autonomous farm vehicles or sophisticated sensors and intervention mechanisms. The actions will prioritize technologies such as selective harvesting, more targeted weed reduction or environment friendly fertilization, and / or livestock management, based on better planning and targeted intervention, using

sensors (local and aerial, even maybe earth observation satellite). This will also allow the tagging of agricultural produce or livestock for better traceability and subsequent big data processing, optimizing the whole agricultural process.

To ensure predictable sustainability, performance farms will need to take all technical updates, future farms will be showing as in figure 4 (Norris and Bland, 2015).

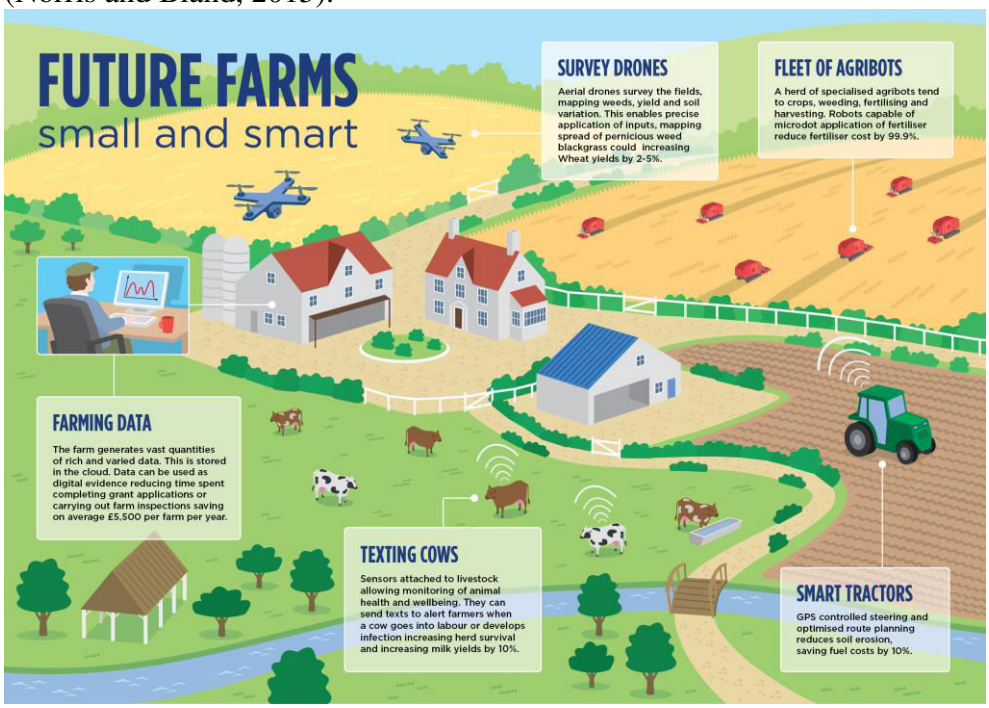


Fig. 4. Future of farms

**CONCLUSIONS**

The European Innovation Partnership 'Agricultural Productivity and Sustainability' was highlighted the importance of developing an EU ICT Architecture Strategy for AGRI-FOOD. In the current H2020 call for proposals there is a call to submit a proposal for a multi-actor project on business models (not necessarily data-driven) in agriculture (Boot, 2016). If this call leads to insufficient attention for data-driven business models, a follow-up call specifically oriented at data-driven business models might be interesting.

In short, we can conclude that the agricultural industry is about to be disrupted and will transform into a high-tech industry and WoT will be one of the main tools. At the same conclusion reached by several experts (Laugerette and Stöckel, 2016). It is important that all farmers to make future plans based on those technologies that will generate the necessary

changes to ensure sustainable development of the business.

**Acknowledgement**

This paper was supported by the project - Increasing the competivity of the didactic station of University of Oradea, project code CNFIS - FDI - 2016 - 0036, project founded in the frame of the call Institutional Development Found - FDI 2016.

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