CHALLENGES IN THE TRANSITION TOWARD AGRICULTURE 4.0

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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 and digital technologies. Precision agriculture and digital technologies are the most influential trends affecting farming practices and structures through 2030. 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. This revolution carries different names, Digital Farming, Farming 4.0, Agriculture 4.0, Smart farming, but its essence is the same, being supported by the industrial revolution Industry 4.0.

Key words: agriculture 4.0, precision agriculture, ICT, IoT, hands-free farm.

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 8.55 billion people by 2030 and 9.77 billion people by 2050. In order to feed this growing population, according to FAO (Food and Agriculture Organization of the United Nations, 2016), food production must increase with 70 percent by 2050 and a 60 percent increase in demand for high quality protein such as milk, meat, and eggs.

In E-agriculture Strategy Guide (Food and Agriculture Organization, 2016) are set many roles of ICT in agriculture. Enabled ICT environment can unleash the real potential of agriculture being the first step towards Digital Farming. Because agriculture is regard as an industry, most analyst's transposes industry forecast in agriculture. In the manufacturing industry, after the term Digital Revolution, the Industry 4.0 concept appears. In agriculture, appear initially the term "Digital Farming" and after that Agriculture 4.0 and Farming 4.0. Unfortunately, there are two major issues affecting agriculture, the evolution of the weather and the environment protection in the long term, which complicates achieving optimal solutions.

MATERIAL AND METHOD

This study analyzes the state of the current and future challenges in the evolution toward the Agriculture 4.0.

Efficiency in agriculture is not only about yield, profit and money but also about time and environmental impact.

The first big challenge is to reduce the technological gap from different regions of the world because:

- 15% of the world (about 1.2 billion) has not yet reached the 2nd Revolution (no electricity and mechanization without combustion engines);
- 50% has not yet reached the 3rd Revolution (no internet neither precision farming).

One of the institutions that is involved in reducing the technological differences in the world's agriculture is the FAO. In the Transforming Food and Agriculture to achieve the SDGs (FAO, 2018), starting with five general principles, need of 20 actions are recommended to modernize agriculture

Farming 4.0 utilizes ultra-modern technologies as:

 Global Positioning Systems (GPS), which provides a navigation system to establish a position of a tractor or combine anywhere in a land within less than 2 centimeters on a latitude-longitude grid overlay.

 Geographic Information Systems (GIS) – GIS Computers capture, manage and analyze spatial data related to crop productivity and field inputs.

 Variable Rate Technology (VRT), which provides “on-the-fly” control of field inputs.

 Optical satellite imagery – provides real-time monitoring of crop development and anomalies due to variation in soil potential, physical or climatic variables, pest and diseases, or nutrient deficiencies.

 Satellite Imagery and Aerial Imagery – can also include drone imaging.

 Near Infra Red (NIR) Ortho rectified Imagery. This is becoming a very important technology – initially with timber and wine farmers but spreading to all farmers.

 Internet of Things (IoT) technologies.

 embedded Artificial Intelligence technologies.

 Big Data and predictive analytics technologies.

New technologies of Agriculture 4.0 help to establish a flexible and optimized value chain. In Digital Agriculture (Capgemini Consulting, 2017) some relevant aspects of new technologies are presents for the agro-food chain (Fig.1.).

These technologies can help farmers to meet modern requirements and optimize their processes at the same time. But there are a number of obstacles to overcome before these opportunities can be exploited.

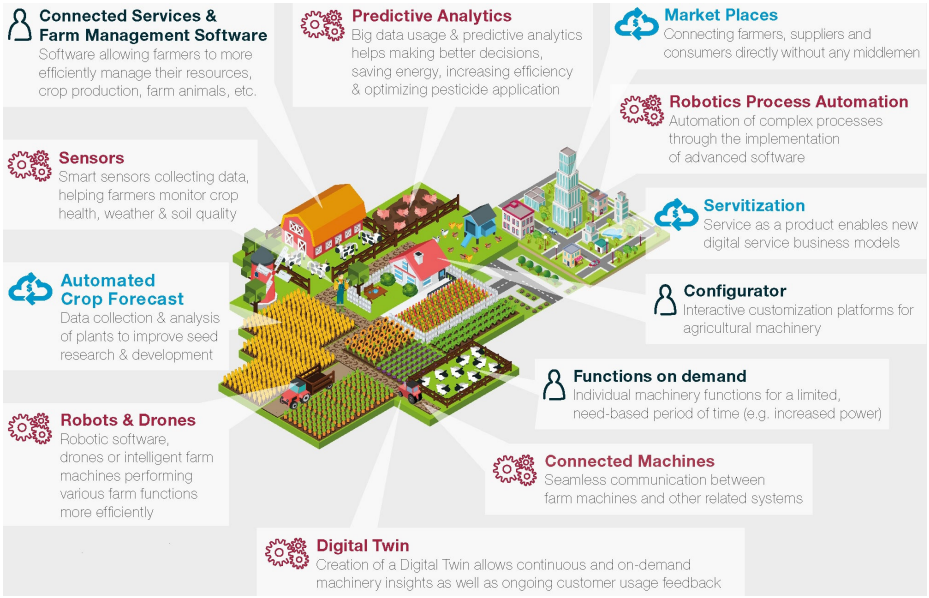

Fig. 1. New technologies to agro-food chain (Capgemini Consulting, 2017)

Key challenges facing farmers wanting to modernize their processes:

• Because of its age, the overwhelming majority of agricultural equipment currently in use is analogue, i.e. not equipped with digital technology and not networked.

• Farmers wanting to use new technologies need to extend their knowledge and technical skills.

• Telecommunications and data communications infrastructures are inadequate in rural areas.

• Data protection and data sovereignty must be ensured.

• Once collected, data has to be organized and analyzed as “big data”.

• Standalone solutions should be avoided.

Due to the challenges presented, but not only of them (financial reasons and necessary expenses are important), many farmers with small-scale agricultural businesses are reluctant to use this farming technologies. However, it is important to embrace the continuous progress made in this field. That is why we must start with the technical education of farmers and the attraction of young people in rural areas. Taking into account the results of Farm Structure Survey 2016 (Eurostat, 2018) only 11% of farm managers are under 40 years old and 57% are over 55 years old.

Including cutting-edge technologies, training is needed for farmers to understand technical principles and adopt their methods and can make farmers more efficient in maximizing their production. It has been found that the diffusion of sustainable practices is facilitated by educational programs and is positively influenced by extension services to farmers.

The communication infrastructure problem in rural areas are being solved because of both political pressures and technological advances in the field (5G technology and TV white band transmission) (Chandra, 2018).

The International Data Corporation (IDC) estimates that by 2021, enterprise spending on artificial intelligence (AI) and machine learning will more than triple that of 2017 (IDC, 2018).

The implementation of new farm-level technologies requires new players specialized in these technologies as presented in figure 2 (Adam, 2017).

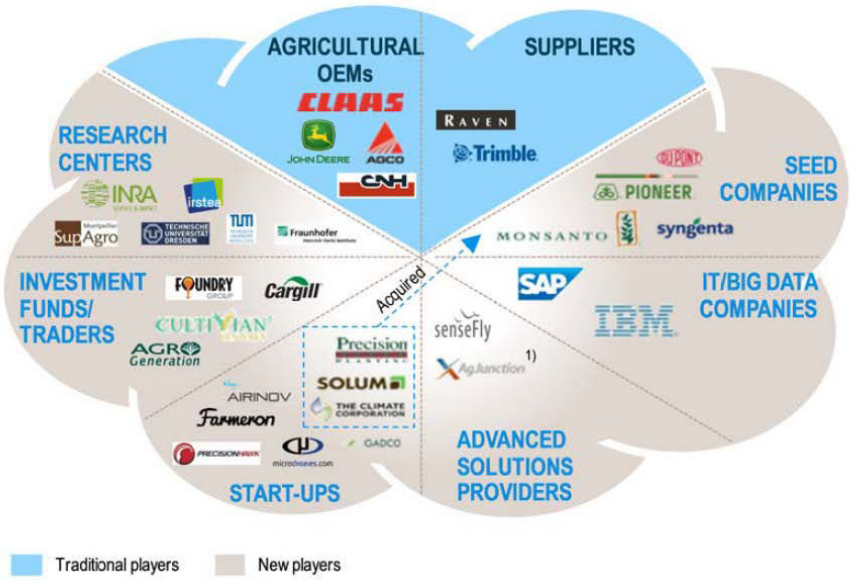

Fig. 2. New Mix of Players in Agriculture 4.0 (Adam, 2017)

Data protection and sovereignty over them, together with access to shared and open data, must be ensured for all farmers. These challenges are solved by a coalition of associations from the EU agri-food chain launched a joint through EU Code of conduct on agricultural data sharing by contractual agreement (COPA and COGECA et al., 2018).

Farmers must have seamless access to exchange of data and managing complexity in the farm data ecosystem. IOF2020 reference architecture for interoperability, replicability and reuse (IOF2020, 2017) is an example of EU-funded research to harmonize data used in agriculture.

RESULTS AND DISCUSSION

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. A Work Programme of Horizon 2020 called "Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy" (European Commission, 2016) will fund "Robotics Advances for Precision Farming" which 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).

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 in agriculture (Boot, 2016).

CONCLUSIONS

Markwell R., President of CEMA, the European trade association of the agricultural machinery industry said, at CEMA Summit 2017, "To reap the full benefits of digital farming, the EU needs to devise supportive, coherent and forward-looking policies which encourage those who push the boundaries of innovative digital farming technologies further, such as the farm machinery industry, and help those who can make a real difference on the ground by using them: farmers and agricultural contractors".

The environmental concerns and global warming are the most important issues at present and in the future agricultural crop production and farming operations since they directly affect agricultural productivity. The changes in climate are expected to be more dynamic in the future and this will limit and reduce the food production in our planet. The technology and the capacity of the farm machinery should be available in order to carry out field operations on time since the yield or the quality of food depends upon how fast and how accurately these operations are achieved. The intelligent farm machineries equipped with computers and sensors will be in use in the future. The use of these technologies already started in some part of the world while some still carry out field operations by animals.

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