INTERNATIONAL CONFERENCE AUTOMATICS'2020

Digital Agriculture Industry - Current Situation On The Basis of Existing Researches And Share Facts

MEng. Ilker Yahov, Assoc. Prof. Eng. Andrey Elenkov PhD

Abstract: *Despite the big and rapid growth of technologies during the 21st century, there is still an industry that is lagging behind with the optimization and launch of its digital transformation. In fact, this is the agricultural sector. Therefore, in recent years, many attempts have been made to develop and implement optimized processes and technologies, in order to increase production and reduce costs while maintaining product quality. The purpose of this publication is to summarize the current situation on the basis of existing researches and share facts.*
Key-words: *digital agriculture industry, smart production, automated systems, smart greenhouses, automated plant production, digital transformation, digitalization*

1. Introduction

Today, we are witnessing something which was thought to be imaginarily and extraordinary – the world is changing drastically! It firstly started long time ago with our personal data, such as documents, photos, music, etc. It didn't took much time until the next phase began - the business realized the true potential of the globalization and started adopting it, while changing its needs drastically, making the digital transformation irreversible. There is no more doubt whether the digital transformation is happening or not. It has already started and believe it or not - we are part of it.

The promise of digital transformation is to help companies, and even industries, to create new value, by adopting and implementing digital technologies, like artificial intelligence (AI), cloud computing, augmented reality (AR), virtual reality (VR), industrial internet of things (IIoT), Blockchain etc. The leading companies are already showing bright signs of improvements, thanks to the data-driven decisions. The main thing which they are doing is transforming their business models according the new trend, such as connecting their operations, gaining access to relevant data and digitizing processes.

Despite the many positive factors and signs, there is still an entire industry (with small exceptions) which was delaying the implementation of this new trend. The agricultural farmers and companies were keen on keeping the traditional way of working, which made them fall behind the business and economic evolution. This slow down led to multiple challenges in the industry. Because of the rapid urbanization and the global population growth rapidly (from 7.6 billion in 2018 to

over 9.6 billion in 2050), there will be a remarkable increase in the food demands. At the same time, there is a lack of natural resources as fresh water and arable land. This requires an urgent alteration of the whole agricultural system. Digital technologies are opening up an entire 'new world' regarding crop management. Producers' and agronomists' jobs are changing due to large amounts of data and tools they have at their disposal. However, how to incorporate these properly at a farm level, is still a learning process for most of them [1]. Digital transformation may be part of the solution. It is main part of the next industrial revolution, named the "Fourth Industrial Revolution" (or simply Industry 4.0).

2. Discreption of the problem

The efficiency of farming lies in a farmer's ability to predict natural conditions and react to them in the quickest way possible. A few decades ago, the precision of such forecasts wasn't so reliable — now, it's impressively high thanks to instant data gathering and distribution [14]. Despite its conservatism and stiffness, the agricultural industry realized that globalization without digitalization is impossible. Now a day's agriculture doesn't only limit to cultivate crops rather following convenient and efficient way to grow more crops. The demand & usefulness of greenhouse technology is increasing with increase in population and there is no alternative of it to cope with epicurean lifestyles of people. Not only that, it is not convenient to rely on natural climatic condition in agriculture [5].

In this paper we are going to do overview of the current situation and try to distinguish some working solutions to existing problems and blockers. Before deep-diving into the problem, firstly we will define the terms of digitalization and digital transformation. According to the market forecasts for the next decade, "the digital agricultural revolution will be the newest shift which could help ensure agriculture meets the needs of the global population into the future. Digitalization will change every part of the agri-food chain. Management of resources throughout the system can become highly optimized, individualized, intelligent and anticipatory. It will function in real time in a hyper-connected way, driven by data. Value chains will become traceable and coordinated at the most detailed level whilst different fields, crops and animals can be accurately managed to their own optimal prescriptions. Digital agriculture will create systems that are highly productive, anticipatory and adaptable to changes such as those caused by climate change. This, in turn, could lead to greater food security, profitability and sustainability [3]. The correlation between industrial revolutions and agricultural revolutions is clearly visible. There is only one thing left – the acceptance of the change. As Daniel Newman said "people in the industry—farmers, food producers—must embrace the digital transformation trends in agriculture. By using technology as a sustainable and scalable resource, we will be able to take agriculture to new heights, keeping farm to fork in our future [4].

So, what is this "digitalization" and what does the "digital transformation" mean?

According to Gartner's IT Glossary, "digitization is the process of changing from analog to digital form", while the "digitalization is the use of digital technolo-

gies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business". Also, from there we have the definition of digital transformation – it can refer to anything from IT modernization (for example, cloud computing), to digital optimization, to the invention of new digital business models. The term is widely used in public-sector organizations to refer to modest initiatives such as putting services online or legacy modernization. Thus, the term is more like "digitization" than "digital business transformation [2].

A balance must be found between what is often termed precision (arable and livestock) farming, capable of correctively determining the correct, limited scale of intervention at the right time and in the right place, and a preventive, systemic approach enabling a cultivated ecosystem to produce without the need for curative treatments [7]. There are many circumstances which cannot be neglected when talking about digital transformation. Some constraints are the required technology, including availability, connectivity, affordability etc. Also, there are some basic conditions, which has to be fulfilled, like infrastructure and connectivity (mobile subscriptions, network coverage, internet access, and electricity supply), affordability, educational attainment (literacy, ICT education) and institutional support. Most of the developing countries have seen the gap in this industry and started many initiatives in the context of creating a good environment for development of new processes and methodologies.

Digital agriculture is the use of new and advanced technologies, integrated into one system, to enable farmers and other stakeholders within the agriculture value chain to improve food production. But less than 20 percent of acreage today is managed using digital agriculture technologies (e.g., variable-rate spraying) due to the high cost of gathering precise field data. The fourth agricultural revolution is associated with many innovations in sustainable agriculture, some emerging and some more established, which are interacting and co-evolving in a wider "ecology of innovation"; Such an ecology of innovation includes "big" emerging smart technologies (e.g., AI, Internet of Things, Cloud Computing, robotics), as well as "smaller" farmer and/or community-led innovations. When it comes to technology and data available within the agricultural industry, there's a large amount of choices these days. It's important that retailers understand and are able to provide guidance for growers about what works and what doesn't work as well. Understanding the technologies and datasets are important and how to best use them is even more crucial. Precision agriculture is a term widely used in the industry today. Precision agriculture is an approach to farming that employs data sensors, connected devices, remote control tools, and other advanced technologies to give farmers more control over the field and the team [14]. It helps growers better respond to variability within a field or series of fields to improve overall crop health and increase yields. Digital agriculture tools include the variety of technology and software systems that provide data to enhance decision making in precision farming, and if used properly, can help reduce waste, increase profits and protect the environment. Using technology for farm management increases data accessibility. With precision agriculture, the team members are no longer bound to the office space. Thanks to cloud-based technologies, all the necessary data is free for access any time from any device.

4. Problem solution

With the help of smart sensing elements, growers can predict best conditions for plant growth and what nutrients their crops need. At the moment our ability to collect vast amounts of data easily outstrips our ability to convert it into usable information. Predictive analytics can play a critical role for decision makers who need to interpolate and forecast from a current situation to an alternative state. There are many technological solutions to implement this. One way is by placing sensors throughout the fields to record rainfall and soil conditions in these different areas. There are a variety of computer applications, software programs and other digital ag tools that can be used along with agricultural equipment or can be used manually to record soil sample results, fertilizer inputs, rainfall and other conditions. When a farmer uses sensing elements in the field, it will help him with continuous monitoring of predefined parameters and offer real-time data, to help the grower make informed decisions while planting, through the growing season and during harvest. Including If a grower is using sensor technology in their operations, soil and plant species can be automatically optimized through these sensors and taken from a Decision Support System, which can help determine the best timing to water and fertilize the particular crops [12]. It's estimated that more than half the growers currently engage in some form of agricultural technology and this number is expected to continue to grow as agronomists and growers see the improved benefits of digital ag tools and how they can improve their results within their overall precision agriculture strategies. Precision farmers are finding that the ordinary day to day farm processes are becoming easier to manage and this is as a direct result of technology implementation and streamlining procedures. Implementing better growing processes is providing produce that is of a higher quality. This is done in many ways such as actively monitoring the nutrients in soil, strip tilling and irrigating plants correctly and when irrigation is needed. Again; this not only boosts yields, but it also boosts profit margins further as when it comes to taking the crop to market, precision farmers are able to negotiate a higher price for the improved quality in the produce.

Precision agriculture, in combination with more productive crop varieties/livestock and the use of decision support systems to foster evidence-based decision-making can lead to the smarter use of inputs with greater rewards [11]. Agriculture and food are ideal domains to exploit the potential of distributed ledgers or blockchain. This emerging technology is most commonly associated with Bitcoin and other cryptocurrencies. But it can be used equally well in agriculture for decentralized and transactional data-sharing across a large network of untested participants. It enables new forms of distributed systems and agreements and captures transactions permanently, without relying on a trusted central authority. Blockchain will open up ways for farmers to put their products into differentiated markets by allowing verification of provenance and other attributes. It will meet the demand by consumers for better quality assurance of their food and fibre [13].

Other system that is being very widely used is Unmanned aerial vehicle (known to the public as drone). Equipped with hyperspectral and multispectral sensors, these instruments help farmers determine the health of plant leaves and measure water stress

levels from a distance. Other than that, UAVs also contribute to disaster management and risk reduction.

5. Conclusion

While traditional ICTs were the weak ties for diffusion of innovation, modern day ICTs are bringing vast amount of information to rural communities [9]. Precision agriculture is the key to farming that employs data sensors, connected devices, remote control tools, and other advanced technologies to give farmers more control over the field and the team. Increasing the productivity is an age-old ultimatum for the agricultural industry. The digital transformation of this industry will definitely help large and small scale farms improve processes, boost their yield, and increase profitability, helping to meet the growing global food demand and lowering the overall environmental impact of farming. Despite the fact that much work is needed in the area of digitalization in agriculture and rural areas, the potential environmental, economic and social benefits are significant. Only introducing technologies is not enough to

generate good results. To be able to use the full potential of digitized agriculture, both literacy and education levels has to be increased. A lack of e-literacy and digital skills in rural areas means these populations will fall behind in the modern labour market. Identifying the barriers to Internet adoption is a critical step to formulating effective solutions. The global Internet landscape is constantly evolving. The last years, we are noting that the number of farmers with university degrees and specializations is increasing. These people are often being neglected, but their innovative thinking and skills is shaping the future of this industry and the global food supply chain. What is more, during the next several years, it could be noted that developing countries will be transformed as new population segments will gain access to the Internet. This will reduce the disparities in the adoption of digital agriculture technologies between developed and developing countries and between global companies and those at a local, community or family scale.

As digital agriculture develops, it will be critical to make the technology available to as many farmers as possible and to implement it in ways that minimizes negative impacts on those who work in the sector [8]. This will vastly increase efficiency as well as create new markets and opportunities.

ACKNOWLEDGEMENTS

The scientific researches and results presented in this publication are funded by the Internal Competitive Bidding at TU-Sofia-2020

REFERENCES

[1] Daniel Azevedo, “Digital agronomists the link between data and crops”, https://www.futurefarming.com/Smart-farmers/Articles/2019/10/Digital-agronomists-the-link-between-data-and-crops-488987E/

[2] Gartner Glossary, Information Technology, https://www.gartner.com/en/information-technology/glossary/digitalization

[3] Trendov, N. M., Varas, S. & Zeng, M. 2019. “Digital technologies in agriculture and rural areas” – Statusreport. Rome. Licence: cc by-nc-sa 3.0 igo.
[4] Daniel Newman, “Top six digital transformation trends in agriculture” https://www.forbes.com/sites/danielnewman/2018/05/14/top-six-digital-transformation-trends-in-agriculture/
[5] Saha T., M. K. H. Jewel, M. N. Mostakim, N. H. Bhuiyan, M. S. Ali, M. K. Rahman, H. K. Ghosh, Md. Khalid Hossain, “Construction and development of an automated greenhouse system using Arduino Uno”, International journal of information engineering and electronic business(IJIEEB) - Vol.9, No.3, pp.1-8, 2017. DOI: 10.5815/ijieeb.2017.03.01
[6] Atul, “Smart Greenhouse: The future of agriculture” - https://www.hackster.io/synergy-flynn-9ffb33/smart-greenhouse-the-future-of-agriculture-5d0e68
[7] Jean-Marie Séronie, “The digital revolution, precision agriculture and conservation farming” - - https://www.willagri.com/2020/01/20/the-digital-revolution-precision-agriculture-and-conservation-farming/?lang=en
[8] Disruptive technologies – “Digital Agriculture - Feeding the future” - http://breakthrough.unglobalcompact.org/disruptive-technologies/digital-agriculture/
[9] Suchiradipta Bhattacharjee, Saravanan Raj, “Shaping the future of agricultural extension and advisory services”, GFRAS Interest Group on ICT4RAS 2016
[10] Laurens Klerkxa, , Emma Jakkub, Pierre Labarthec, “A review of social science on digital agriculture, smart farming andagriculture 4.0”: New contributions and a future research agenda, open access article underthe CC BY license (http://creativecommons.org/licenses/BY/4.0/).
[11] Rose DC and Chilvers J (2018) “Agriculture 4.0: Broadening Responsible Innovation in an Era of Smart Farming. Front. Sustain. Food Syst. 2:87. doi: 10.3389/fsufs.2018.00087
[12] 4 Benefits of Digital Agriculture Tools - https://inthefurrow.com/2018/01/29/benefits-precision-agriculture/
[13] Dr Michael Robertson, Dr Andrew Moore, Dr Dave Henry, Dr Simon Barry, “Digital agriculture: what’s all the fuss about?”, AGRICULTURE AND FOOD, csiro.au
[14] Digiteum Team, “Precision Agriculture Technology: The Future of Precision Farming with IoT” www.digiteum.com

Authors:

Ilker Yahov, MEng, Technical University of Sofia, PhD student - Faculty of Automatics, iyahov@tu-sofia.bg
Assoc. Prof. Eng. Andrey Elenkov PhD, Technical University of Sofia, aelenkov@tu-sofia.bg