Annals of the University of Oradea, Fascicle: Ecotoxicology, Animal Husbandry and Food Science and Technology, Vol. XVI/A 2017
Analele Universităţii din Oradea, Fascicula: Ecotoxicologie, Zootehnie si Tehnologii de Industrie Alimentara, Vol.XVI/A 2017

IoT APPLICATION TO SUSTAINABLE ANIMAL PRODUCTION

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Abstract

To feed the growing population, food production must increase by 70 percent by 2050. Sustainable development of animal production will be done using new data-driven business models, generated by WoT (Web of Things), and based on data obtained using IoT (Internet of Things). The Web of Things, which is a superset of the Internet of Things, represent the integration of digital technology in precision livestock farming. Precision livestock farming and digital technologies are the most influential trends affecting farming practices and structures through 2030. WoT will help precision livestock farming 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 is about enabling to be done more with less. Unlike previous revolutions, which have focused on further intensification and standardization, this offers a new set of tools. It is not about drastically increasing yields, but adopting a 'per animal' approach. This evolution, in data available to the farmer, in contrast to those before, is a revolution.

Key words: IoT, smart farming, precision livestock farming, WoT.

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 and a 60% increase in demand for high quality protein such as milk, meat, and eggs (FAO, 2011).

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 (Pardey et al., 2014) and food security (Balş, 2010) in the future.

"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 (Da Silva, 2016).

Because is increasingly regarded as an industry, analyst's transposes industry forecast in animal production.

Internet of Things is not just about the "things", but moreover about connecting people to the right data, automating processes for cost reduction at the same time with enabling inter-dependencies between the operational

level and the business level of the organization. Specifically, IoT becomes a tool for predictive maintenance (Donca, 2016) or an intelligence assurance policy aimed at improving products and services quality through optimizing processes.

The IoT movement transcends nowadays the limits of M2M (machine to machine) 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).

The Web of Things (WoT) 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. 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.

MATERIAL AND METHOD

This study analyzes IoT contribution to sustainable animal production starting from documents produced by Animal Task Force, an European Public-Private Platform. They promote a sustainable and competitive livestock sector and representing key stakeholders from industry, farmers and research from across Europe.

In the 1st Addendum to the Animal Task Force White Paper (Animal Task Force, 2013), was presented the key areas and priority-topics to support the livestock production sector by science and innovation, identified by the organization. These are show in Figure 1 (Animal Task Force, 2014) and have already been included in the Horizon 2020 calls and other recent European research programs. From the 13 topics, of this document, which is considered important for action in the next round of H2020, IoT will have an important contribution at:

- Priority C: Robust and resilient animal production,
- Priority D: Big Data; Phenotyping and precision livestock farming (PLF),
- Priority F: On farm animal welfare performance indicators,
- Priority G: Integrated farming performance,
- Priority H: Agro-Ecology based livestock production systems,
- Priority I: Fortify animal disease prevention and control.

Most large companies are involved in developments in this area.

Precision Livestock Farming (PLF) promoted by ATF and CEMA is key to achieve more efficient use of resources, combined with better animal production/reproduction health, and welfare through animal individual and (automated or not) real-time monitoring, management and care.

Fig. 1. Key areas and specified priorities that ATF suggest to support the livestock production sector by science and innovation (Animal Task Force, 2014)

For example, SCR Dairy has "HealthyCow24" a solution based on the Internet of Things that uses Windows Embedded software and Microsoft Azure cloud technology. This cow-monitoring system gives farmers insights that can boost milk production, smooth the calving process and ensure healthier cows — all while saving time (Heikell, 2016). SCR Dairy now has about 4 million tags connected to cows around the world, monitoring their activity and wellbeing 24 hours a day. The data generated from the tags is transferred to management solutions that help farmers make better

decisions, as well as providing alerts.

Another big company, Intel, is engaged in development, by Keenan manufacturers of „InTouch" IoT-enabled system, which provide guidance throughout the mixing process to ensure an optimal feed mix and help make on-farm decisions about ration formulation, weight gains, yield, and costs (Intel, 2015). Solution structure is presented in Figure 2 (Intel, 2015). Vodafone M2M SIMs and network connectivity established built-in, direct, wireless contact ensuring that the precise feed specification was achieved each and every time, unlocking a range of benefits for farmers (Vodafone, 2014).

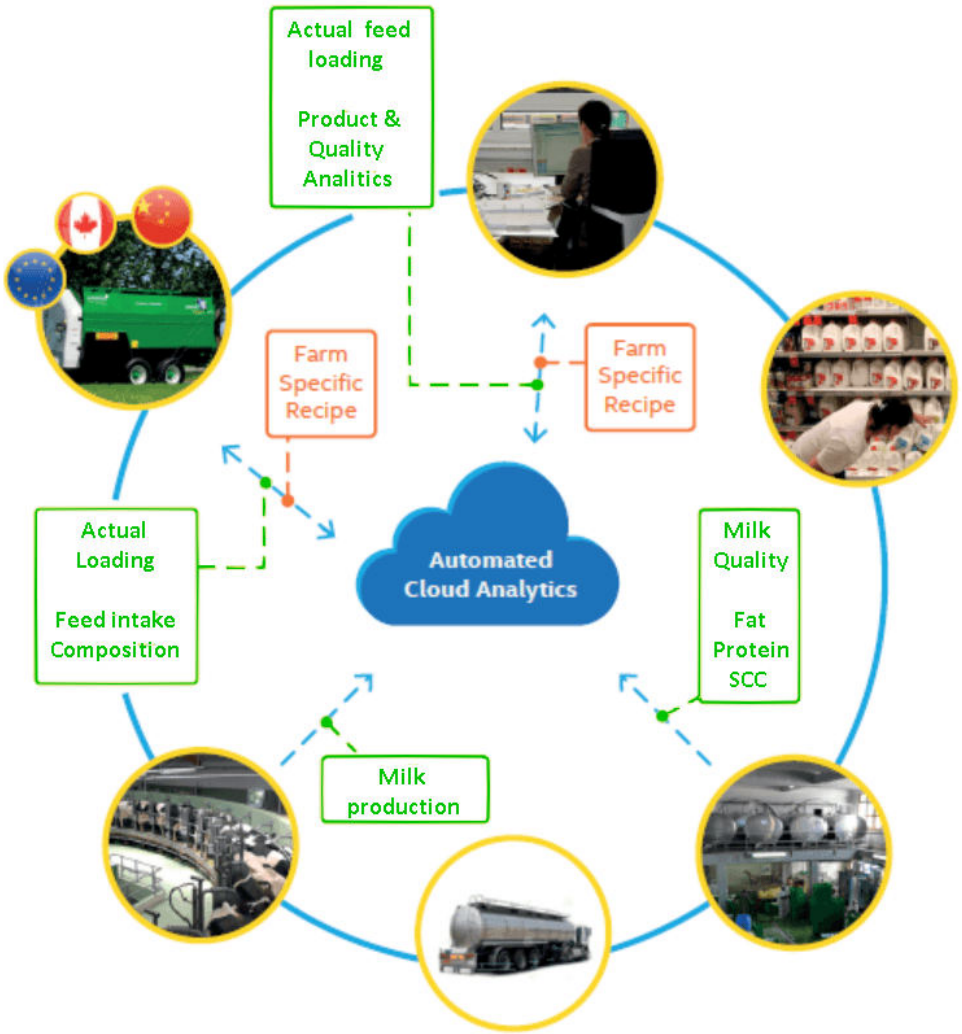

Fig. 2. IoT gateways collect data from the mixer wagon and operations to send it to the cloud and provide guidance on optimal feed mix (Intel, 2015)

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). 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).

The Internet of Food & Farm 2020 (IoF2020) is a European consortium whose goal is to foster the large-scale adoption of Internet of Things (IoT) technologies in the European farming and food value chain. The project, launched on January 1st 2017, emerges from the "Alliance of Internet of Things Innovation (AIOTI)" (Alliance for Internet of Things Innovation, 2015) initiative, which was established by the European Commission and will run for the next four years. IoF2020 brings together 71 partners from 16 countries and is coordinated by Wageningen University & Research Centre (Netherlands). Aligned with the Horizon 2020 strategy, this 30 million euro project, co-funded by the European Union, has the objective of investigating the implementation and the use of IoT in European food and farming (Wolfert Sjaak, 2016).

The theme of smart and connected objects is of growing interest, take-up, however, remains relatively low in Europe. The role of IoF2020 is to highlight the challenges facing the agricultural sector and to look for solutions which can facilitate its expansion. To this end, the project will focus on 19 use cases throughout Europe and will seek to provide solutions for five agri-food areas: arable farming, dairy, meat, vegetables and fruits by taking into account their specific requirements and challenges. The IoT technologies will be evaluated, as well as their societal impact to better understand the adoption of such technologies.

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). This platform can do: livestock tracking and geofencing, stats on livestock feeding and produce, predictive analytics for livestock, remote equipment monitoring and more.

RESULTS AND DISCUSSIONS

In this battle came not only traditional producers for agriculture but

also those from ICT. Reasons are given in official documents such as E-Agriculture Strategy Guide (Food and Agriculture Organization of the United Nations and International Telecommunication Union, 2016) but also studies of economic journals, such as The Economist (The Economist, 2013).

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. It 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 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 completely process.

To ensure predictable sustainability, performance farms will need to take all technical updates, future farms will be showing as in Figure 3 (Norris and Bland, 2015).

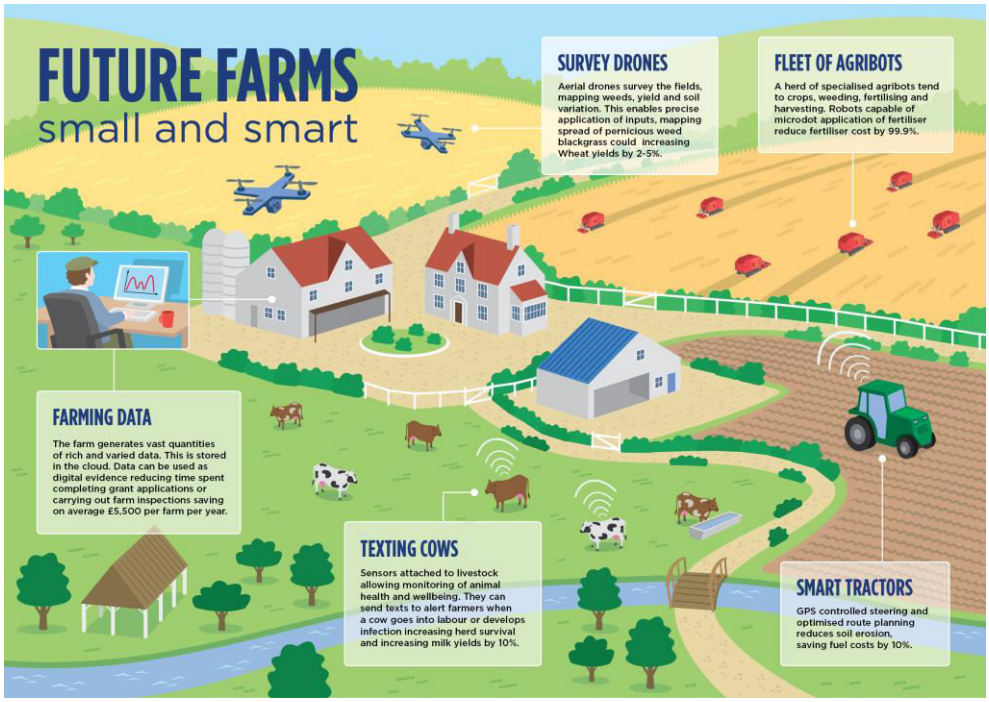

Fig. 3. Future of farms (Norris and Bland, 2015)

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, 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 animal production is about to be disrupted and will transform into a high-tech industry and IoT 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.

REFERENCES

1. Alliance for Internet of Things Innovation (AIOTI), 2015, Smart Farming and Food Safety Internet of Things Applications – Challenges for Large Scale Implementations, http://ec.europa.eu/eip/agriculture/en/content/open-day-internet-things-large-scale-pilot-smart-farming-and-food-security-new-date

2. Animal Task Force, 2013, Research & innovation for a sustainable livestock sector in Europe, Suggested priorities for support under Horizon 2020 to enhance innovation and sustainability in the animal production sector of Europe's food supply chains, http://www.animaltaskforce.eu/Portals/0/ATF/documents%20for%20scare/ATF%20white%20paper%20Research%20priorities%20for%20a%20sustainable%20livestock%20sector%20in%20Europe.pdf
3. Animal Task Force, 2014, Research & innovation for a competitive and sustainable animal production sector in Europe, 1st Addendum to the Animal Task Force White Paper, http://www.animaltaskforce.eu/Portals/0/ATF/horizon2020/1st%20Addendum%20ATF%20White%20Paper_final(2014)%20.pdf
4. Balş C., 2010, Traceability in agri-food chain, Scientific Papers, Animal Science Series, University of Agricultural Sciences and Veterinary Medicine, Iasi", vol 53
5. Boot I., 2016, Emerging new business models in the AGRI Food sector, Sofia, EIP-AGRI seminar, https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/field_event_attachments/ws-datarevolution-20160622-pres01-iman_boot.pdf
6. Da Silva, J. G., 2016, Investment in agricultural innovation needed to fight poverty and hunger, G20 Summit, Xi'an, China, http://www.fao.org/news/story/en/item/417344/icode
7. Donca Gh., 2016, Aspects of the maintenance employee's crisis and solutions for manage in Romania, Proceedings of the 5th Review of Management and Economic Engineering International Management Conference, "From Management of Crisis to Management in a Time of Crisis", 22th – 24th of September 2016, Technical University of Cluj-Napoca, România, pp. 26-31, Todesco Publishing House
8. EIP-AGRI, 2016, Data revolution: emerging new data-driven business models in the agri-food sector, https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/eip-agri_seminar_data_revolution_final_report_2016_en.pdf
9. European Commission, 2016, HORIZON 2020 - Work Programme 2016 – 2017, Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy, http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-food_en.pdf
10. FAO, 2011, World Livestock 2011: Livestock in Food Security, Rome
11. FAO and International Telecommunication Union, 2016, E-Agriculture Strategy Guide, Bangkok, http://www. fao.org/3/a-i5564e.pdf
12. Heikell L., 2015, Connected cows help farms keep up with the herd, https://news.microsoft.com/features/connected-cows-help-farms-keep-up-with-the-herd/#ra6AqTHbC7icJTe2.99
13. Intel, 2015, Keenan and the IoT create a new kind of data farm, http://www.intel.com/content/dam/www/public/us/en/documents/case-studies/iot-gateway-keenan-case-study.pdf
14. Laugerette T., Stöckel F., 2016, From Agriculture to AgTech, An industry transformed beyond molecules and chemicals, Monitor Delloite, issue 8 / 2016, https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-industrial-products/Deloitte-Tranformation -from-Agriculture-to-AgTech-2016.pdf
15. Nedeltchev P., 2015, The Internet of Everything Is the New Economy, http://www.cisco.com/c/en/us/solutions/collateral/enterprise/cisco-on-cisco/Cisco_IT_Trends_IoE_Is_the_New_Economy.pdf
16. Norris J., Bland J., 2015, Precision Agriculture: almost 20% increase in income possible from smart farming, http://www.nesta.org.uk/blog/precision-agriculture-almost-20-increase-income-possible-smart-farming
17. Pardey P. G., Chan-Kang C., Dehmer, S., Beddow J. M., Hurley T. M., Rao X., Alston

J., 2014, Investments in and the Economic Returns to Agricultural and Food R&D Worldwide, book chapter in Encyclopedia of Agriculture and Food Systems, pp. 78-97, Academic Press, New York
18. Poppe K., 2016, Data Innovations in the Agri-Sector: in search of data-driven business models, Sofia, EIP-AGRI seminar, http://ec.europa.eu/eip/agriculture/sites/agri-eip/files/field_event_attachments/ws-datarevolution-20160622-pres02-krijn_poppe.pdf
19. Popović T., Radonjić M., Zečević Ž., Krstajić B., 2016, An IoT cloud solution based on open source tools, XXI International Scientific-Professional Conference Information Technology 2016, Žabljak, Montenegro https://www.researchgate.net/profile/Tomo_Popovic/publication/298303336_An_IoT_Cloud_Solution_based_on_Open_Source_Tools/links/57736f8d08ae07e45db24df8.pdf?origin=publication_detail
20. Sjaak W., 2016, How IoT is changing the agribusiness landscape, IoT Event, Eindhoven, http://www.slideshare.net/SjaakWolfert/how-iot-is-changing-the-agribusiness-landscape.
21. The Economist, Intelligence Unit, 2013, The Internet of Things business index: A quiet revolution gathers pace, London, http://www.arm.com/files/pdf/eiu_internet_business_index_web.pdf
22. United Nations, Department of Economic and Social Affairs, Population Division, 2015, World Population Prospects, The 2015 Revision, Key Findings and Advance Tables, NY, https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf
23. Verdouw C., Kruize J. W., Wolfert S., 2014, Accelerating Internet-based Innovation in Agriculture and Food, http://www.finish-project.eu/wp-content/files/Poster_Accelerating_Internet-based_Innovation_in_Agriculture_and_Food_Session_C6_update.pdf
24. Vodafone, 2014, Keenan case study, http://www.vodafone.com/business/iot/case-study/vodafone-m2m-adds-the-final-piece-to-keenans-world-class-service-for-farmers