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DEVELOPING A EUROPE-WIDE LARGE-SCALE PILOT FOR IOT IN AGRICULTURE

Mahendra Singh*

*Department of Agricultural Sciences,
Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, INDIA
Email id: bhahuni.singh65@gmail.com

ABSTRACT

The Internet of Things technologies have a lot of promise for use in the food and agricultural sector, particularly given the social and environmental problems that this industry faces. IoT technologies have the potential to revolutionize the food industry from farm to fork, contributing to food safety, agricultural input reduction, and food waste reduction. The implementation of IoT-based large-scale pilots (LSPs) throughout the whole supply chain will be a significant step toward wider adoption of these technologies. The difficulties and limitations that an LSP implementation of IoT in this area must address are outlined in this paper. In order to establish a set of technical and agrifood needs, sectoral and technological problems are outlined. We quickly describe an architecture based on a system of systems approach, emphasize the significance of solving the sector's interoperability problems, and discuss needs for new business models, security, privacy, and data governance. Finally, a summary of the technology and solutions used in pilot design for four agrifood domains (dairy, fruit, arable, meat, and vegetable supply chains) is given. Finally, it should be emphasized that for IoT to succeed in this area, a major cultural shift is required.

KEYWORDS: *Agri-Food Sector, Iot, Precision Farming, Smart Farming, System-Of-System Architecture.*

1. INTRODUCTION

The Internet of Things (IoT) offers an once-in-a-lifetime chance for technology to revolutionize a variety of sectors, including food and agriculture. The agrifood industry has a low rate of adoption of information and communications technology (ICT) and a high data collection cost[1]. Sensors, actuators, drones, navigation systems, cloud-based data services, and analytics offer a range of decision support capabilities, and the IoT stack of technologies may substantially alter this industry[2]. The European Commission will finance large-scale deployments, or pilots (LSPs), of IoT throughout Europe as part of Horizon 2020 (H2020)[3]. This paper offers an overview of the possible role of IoT in the agrifood industry from the viewpoint of building and defining an IoT-based LSP, allowing readers to grasp the possibilities, limitations, and needs that IoT may solve in the sector.

IoT technology are referred to as "precision agriculture" or "smart farming" in the agrifood industry[4], [5]. The use of GPS to operate tractors (auto-guidance of equipment) to guarantee exact coverage of a field, whether plowing, planting, or engaged in another activity, is a good example. The increasing instrumentation of the agrifood industry results in a plethora of innovative data-driven services. These may tell a farmer when to spray or apply fertilizer, when to inseminate a dairy herd, and when to collect data needed by regulatory or certifying organizations. Data-driven services may benefit the logistics and supply chain by allowing for better route planning, easing recalls in food crisis situations, and enhancing stock taking and ordering procedures in general. Data from supermarket checkout counters and loyalty cards may be easily integrated into different IoT eco-system components. The bulk of these technologies and services exist, although they are only used in a few situations.

The European Research and Innovation agenda calls for the implementation of IoT by integrating these technologies throughout the value chain and deploying them on a wide scale to meet the requirements of governments, people, and businesses. Designing and implementing such LSPs would expose possible technology flaws while also promoting IoT in agriculture. The purpose of this paper is to describe the design of an LSP that seeks to solve many key problems in the agrifood industry via the use of IoT technologies and their adoption by all food supply chain stakeholders.

2. DISCUSSION

2.1. IoT Challenges and Constraints for the Agrifood Sector:

There are significant barriers to IoT adoption in agriculture, but there are also unique motivations. Large-scale industrial farming, particularly in North America, and supermarkets in most industrialized nations have adopted ICT and related data-driven services. Even in highly developed nations, there are numerous regions where IoT adoption is low or non-existent. The following sections go over the major problems impacting IoT adoption in the European agrifood industry.

2.1.1. Sectoral Issues:

- *Heterogeneity of the sector:*

In the food system, there are a wide range of various kinds of players, from the very big (supermarkets, seed and ingredient providers, commodities dealers) to the very tiny (artisanal cheese makers, microbreweries, roadside fruit and vegetable sellers). As a result, no one solution, whether technical, business model, or regulatory, can meet everyone's requirements. Vineyards in Hungary need quite different solutions than arable farmers in the United States. Precision agricultural techniques in arable farming, for example, have been extensively embraced by big farmers in Central and Northern Europe to boost output and improve quality in the EU. In Southern Europe, however, recent economic pressures in agriculture, high farm segmentation and dispersion, as well as growing water shortages, need the use of precision irrigation methods, primarily to reduce resource use.

- *Farm sizes and capital investment costs:*

Larger, more capital-intensive farms are considerably more open to IoT technology adoption, and they are also receivers of such technology as part of ongoing equipment investment (e.g., tractors and farm equipment). Existing smart farming industrial solutions are either intended for big farms, such as JohnDeere™, or function in restricted geographic areas, such as FieldViewand Encirca, which primarily serve the United States and Canada[6]. 365FarmNet is tailoring the price and kind of services it offers to the size of the farm, but its reach is currently restricted to Central Europe[7]. The issue is to make IoT solutions appealing to small-scale farmers with limited resources for new technologies and substantial concerns about data abuse.

- *Business models and business confidentiality:*

Appropriate business models are required, enabling farms and other agrifood operators to monetize the data they produce while maintaining the required degree of confidentiality and control over data. This is a point of controversy, with big companies like John Deere attempting to profit from the data collected by the equipment they sell, while farmers view it as another loss of control and value. The Agricultural Data Coalition was recently formed by the American Farm Bureau Federation, which has been spearheading a battle for farmers to maintain control and ownership of their data.

- *User and societal acceptance:*

End users must be educated and trained in order to comprehend the usage and application of these new technologies. Until recently, 71% of EU farm managers were still working on the basis of practical experience, thinking that such improvements were unnecessary for their everyday duties and that they did not have time to learn. Adoption of smart technology will certainly be difficult for those who are not digitally savvy. However, there are currently education and training programs in place throughout Europe to spread IoT culture among young people and other food chain players.

2.1.2. Technological Issues:

- *Lack of interoperability:*

For billions of devices to communicate, common building blocks, data protocols, and standards are required, and there are many suitable standards in the agrifood sector in an effort to achieve an overall agreement in this field. There are standards for semantics and data modeling (e.g., AgroRDF, AgroVOC, and agroXML), agri-machinery (e.g., ISOBUS), weather data (e.g., SWEET), the supply chain (e.g., EPCIS from GS1), e-commerce retail stores (e.g., Good Relations and Schema.org), and numerous initiatives e.g., IEEE Standards Association's Standards like ISOBUS, on the other hand, have not kept up with the rapid rate of development, and most new equipment has proprietary connection with other machinery from the same company[8]. This results in "vendor lock-in" and increased farmer opposition. Both the Agricultural Electronics Foundation and AgGateway are working hard to break down interoperability obstacles. The issue here isn't a lack of standards, but rather an overabundance of them.

- *Lack of connectivity:*

The absence of connection, or inadequate third/fourth generation (3G/4G) coverage, is a major barrier to the continued growth of IoT in agriculture in many places (in spite of the much trumpeted wish to move to 5G). Low-power wide-area (LPWA) technologies like as LoRa and SIGFOX provide a viable solution to these issues, however they are not capable of handling huge datasets (e.g., originating from satellite imagery)[9].

- *Data processing power:*

This may come as a surprise, but for small to medium farmers, accessing large-scale computing capacity at a reasonable cost to perform complicated computations (e.g., traveling salesman type field traversal planning) remains a problem. IoT is severely hampered by the lack of data processing services.

- *Lack of clear data governance:*

Regulators and legal frameworks are just now beginning to catch up with contemporary technology realities. The ownership and control of agricultural data is still a point of contention (as noted above). Large corporations may wish to think of themselves as "data businesses" and oppose efforts that would give farmers and other main players ownership of data.

- *Data security and privacy:*

Security and data privacy concerns are distinct from governance concerns. The top five worries among respondents directly or indirectly relate to security or privacy, according to a

European Commission/International Data Corporation (EC/IDC) study of EU demand for cloud computing services and obstacles to adoption. This demonstrates the significance of such issues for IoT adoption in smart agriculture.

Despite these challenges, there is a growing community of technically savvy young farmers, as well as hi-tech professionals and tech-enthusiasts with a significant interest in the agrifood sector. This has resulted in an influx of companies, hackathons, and other efforts, all of which are helping to make the use of data science, sensors, and technology in general to agrifood a more appealing and exciting possibility. The Food + Tech Connect website in the United States is a great place to start, but there are many of similar efforts in Europe and East Asia.

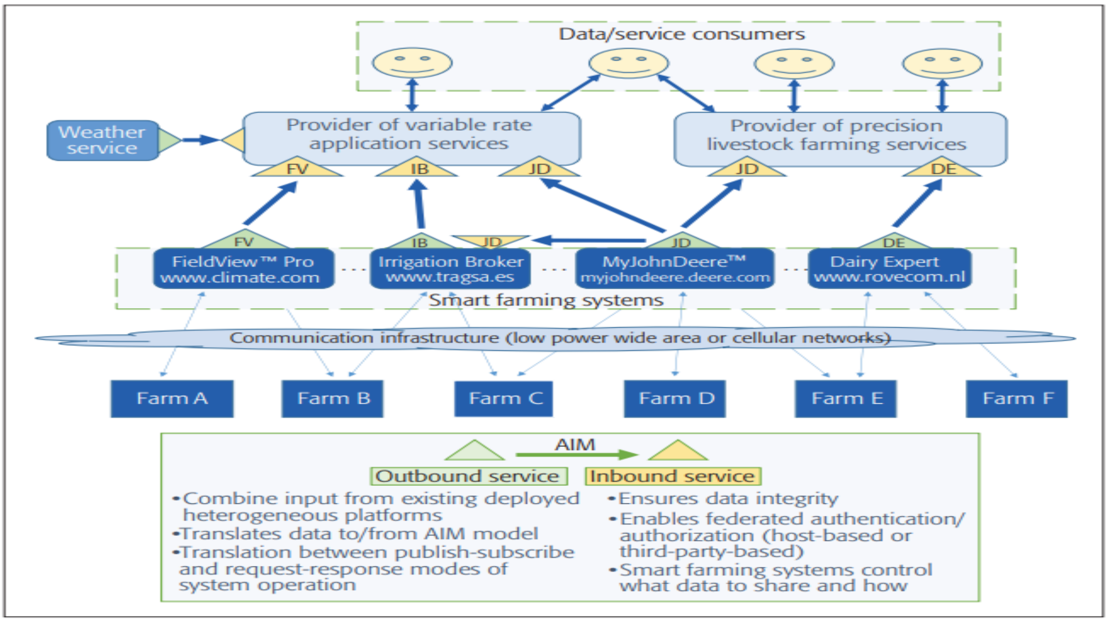

Figure 1. An IoT-based large-scale agricultural experiment using a system-of-systems architectural approach[10]**.**

In order to persuade consumers of the use of IoT technologies in agriculture, LSPs must address various goals unique to the agrifood industry in addition to the sectoral and technical problems mentioned above. The following are some of them:

- Create new business and collaboration possibilities by developing or enabling business models that are tailored to an IoT ecosystem.
- Enable food traceability and consumer food awareness by monitoring and controlling plant/animal products throughout their full life cycle.
- Ensure that certification systems (for example, organic) are functional and free of fraud across the food supply chain.
- Facilitate and improve food security and safety.
- Productivity and animal health/welfare will both improve.
- Reduce manufacturing expenses while improving output quality and quantity.
- Reduce agricultural practices' ecological footprint and environmental effect, and adjust crop management to climate change needs.
- Improve soil quality while conserving water and other natural resources.

2.2. Overall Architecture:

There are already a number of "precision agriculture" systems and platforms in use, which use a range of communication, sensor, and data processing technologies. Due to possible scalability (e.g., preserving state in a pub/sub method) and governance (e.g., access to agricultural data) problems, the strategy of creating a new master system to integrate others may not be viable for an LSP. As a result, a system-of-systems (SoS) strategy is suggested. This allows current agricultural knowledge information systems (AKISs) to continue to operate while also allowing such systems to make data from cooperating systems inside the SoS accessible and consumed. In addition, the SoS may inform collaborating AKISs about newer technologies and services that may be of interest. In terms of usability, market acceptance, and long-term viability, this is more feasible.

The suggested architecture, as illustrated in Fig. 1, comprises of an incoming and outgoing service that allows AKISs to expose and consume data. Survey services that do not need a constant feed from a specific AKIS would benefit greatly from rapid deployment. Such a service would install and start an incoming service for that specific AKIS, collect the required data, and then terminate the service. The service will be packed in a lightweight container that includes all of the software required for self-contained deployment (runtime environment, libraries for supported communication protocols, encryption techniques, etc.).

3. CONCLUSION

This paper is intended to help industry stakeholders and academics who are working on large-scale agricultural pilots that rely significantly on IoT technology. The agrifood sector's IoT-related difficulties and limitations, as well as the fundamental goals of IoT-based LSPs, are discussed. The use of a system-of-systems architectural approach is suggested, with a focus on interoperability, which is essential for the adoption of IoT technologies in the agrifood industry. To solve semantic interoperability, the Agricultural Information Model methodology is suggested, as well as a farm-to-fork management information system solution that ensures data compatibility. Many difficulties remain, including the need for new business models, security and privacy solutions, and data governance and ownership solutions, all of which are essential for implementing IoT-based LSPs in agriculture. Finally, a comprehensive description of the most suitable IoT technologies and agrifood applications to be utilized is provided, as well as the major key performance indicators that can be used to assess the success of the proposed LSPs in a measurable way. The implementation of such LSPs would certainly encourage the use of IoT in agriculture, thus improving different activities throughout the whole food supply chain, resulting in decreased effort and costs for farmers, improved food quality and safety, and more consumer food awareness. However, the primary hurdle to overcome before IoT is widely used by stakeholders throughout the food supply chain is a cultural shift that is required to recognize the benefits and possibilities offered by IoT technology.

REFERENCES

1. J. C. Aker, I. Ghosh, and J. Burrell, “The promise (and pitfalls) of ICT for agriculture initiatives,” *Agric. Econ. (United Kingdom)*, 2016, doi: 10.1111/agec.12301.
2. V. N. Malavade and P. K. Akulwar, “Role of IoT in Agriculture,” *Natl. Conf. "Changing Technol. Rural Dev.*, 2016.
3. “Horizon 2020.” https://ec.europa.eu/programmes/horizon2020/en/home (accessed Sep. 20, 2018).
4. H. M. Jawad, R. Nordin, S. K. Gharghan, A. M. Jawad, and M. Ismail, “Energy-efficient wireless sensor networks for precision agriculture: A review,” *Sensors (Switzerland)*. 2017, doi: 10.3390/s17081781.
5. F. J. Ferrández-Pastor, J. M. García-Chamizo, M. Nieto-Hidalgo, J. Mora-Pascual, and J. Mora-Martínez, “Developing ubiquitous sensor network platform using internet of things: Application in precision agriculture,” *Sensors (Switzerland)*, 2016, doi: 10.3390/s16071141.
6. “The Future Of Agriculture,” 2016. https://www.economist.com/technology-

quarterly/2016-06-09/factory-fresh (accessed Sep. 20, 2018).

7. "With us, digital farming is not a vision. But everyday life." https://www.365farmnet.com/en/ (accessed Sep. 20, 2018).

8. S. Rajbhandari and J. Keizer, "The AGROVOC Concept Scheme - A Walkthrough," *Journal of Integrative Agriculture*. 2012, doi: 10.1016/S2095-3119(12)60058-6.

9. J. D. Adriano, Y. C. T. Mendes, G. A. B. Marcondes, V. Furtado, and J. J. P. C. Rodrigues, "An IoT Sensor Mote for Precision Agriculture with Several MAC Layer Protocols Support," 2018, doi: 10.1109/ICTC.2018.8539713.

10. C. Brewster, I. Roussaki, N. Kalatzis, K. Doolin, and K. Ellis, "IoT in Agriculture: Designing a Europe-Wide Large-Scale Pilot," *IEEE Commun. Mag.*, 2017, doi: 10.1109/MCOM.2017.1600528.