European Commission

Digital Transformation Monitor

Industry 4.0 in agriculture: Focus on IoT aspects

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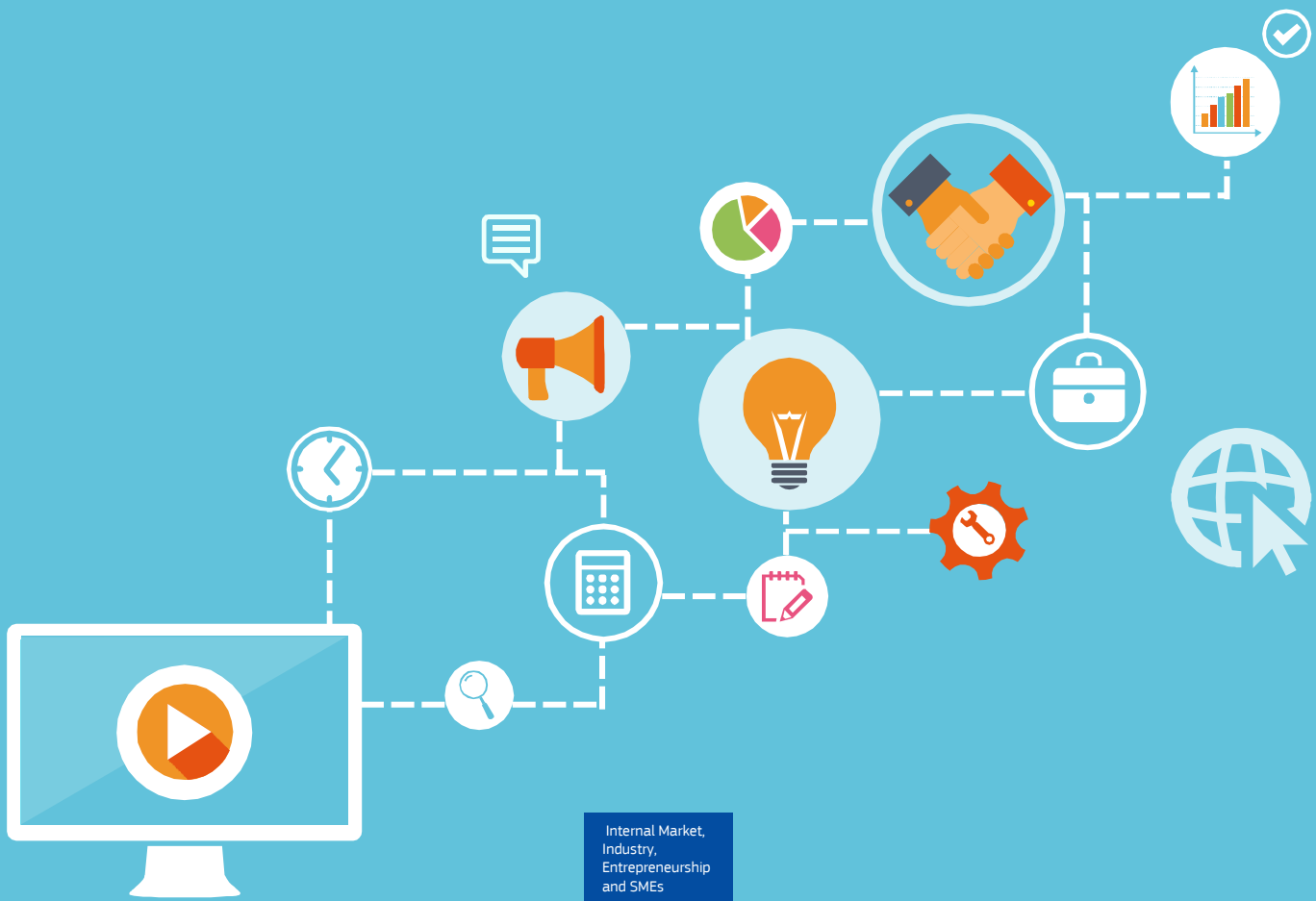
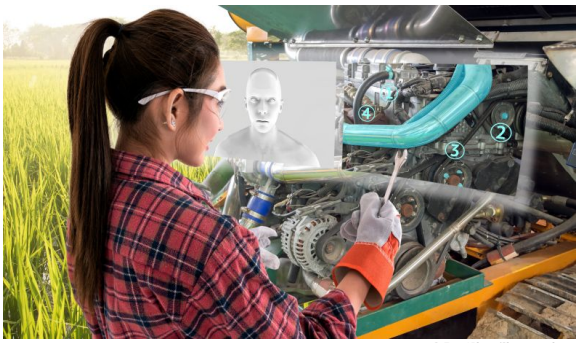


Internal Market, Industry, Entrepreneurship and SMEs



Industry 4.0 in Agriculture: Focus on IoT aspects

The development of the connectivity of agricultural tools is leading to important progress in agricultural practices. They enable the development of precision agriculture and increase the transparency of the industry. However, they also face significant challenges in the key necessity to enable data exchanges in the business ecosystem and the need to invest in new infrastructure and tools.

1

Digitalisation of agriculture

The Industry 4.0 trend is transforming the production capabilities of all industries, including the agricultural domain.

Connectivity is the cornerstone of this transformation and IoT a key enabling technology that is increasingly part of agricultural equipment.

From Industry 4.0 to Agriculture 4.0

The Industry 4.0 trend is seen as a transforming force that will deeply impact the industry. The trend is building on an array of digital technologies: Internet of Things, Big Data, Artificial Intelligence, and of digital practices: cooperation, mobility, open innovation.

They imply a transformation of the production infrastructures: connected farms, new production equipment, connected tractors and machines. They will enable both an increased productivity and quality and environmental protection. But they also generate modifications in the value chain and business models with more emphasis on knowledge gathering, analysis and exchange.

Transformation of the production methods and tools

The digitalisation of agriculture is based on the development and introduction of new tools and machines in production.

Connected tractors

The tractor and the implement are key instruments of the development of the agricultural industry. Connectivity and localisation technologies (GPS) are optimizing the usage of these agricultural tools.

This includes driver's assistance to optimise routes and shorten harvesting and crop treatment, while reducing fuel consumption.

But it also relies on the deployment of sensors on implements to enable precision agriculture[1](PA). The sensors tight monitoring and control over crop treatments enable important gains in efficiency and productivity.

Furthermore, connectivity is also enabling business models evolutions with more precise tracking of usage of equipment and thus more precise billing of equipment use by contractors[2].

Automation

Another important transformation in the agricultural production process is the rising role of automation that increases productivity by reducing the need for human workforce.

This can take several forms, from the automation of vehicles, to the development of task specific robots[4] that automate parts of the production process.

New measurement tools

Finally, a key transformation resides in the ability to collect more data and measurement about the production: soil quality, irrigation levels, weather, presence of insects and pests. Here also this ability takes several forms from sensors deployed on tractors and implements to direct deployment of sensors in the field and soil or to the use of UAVs/drones or satellite imagery to collect measurements from above[5].

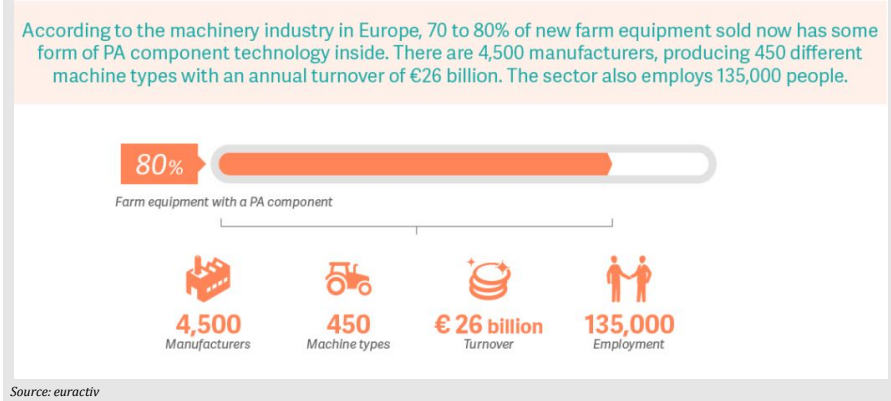
IoT requirements: connectivity, robustness and legacy technologies.

The development of these new tools and practices in agriculture relies strongly on the development of connected objects. Yet the domain has specific requirements in terms of connectivity.

Covering rural areas

A key requirement is of course the ability of communication networks to deploy and cover rural areas efficiently.

Figure 1: The Agriculture 4.0 Industry[3]



Source: euractiv

The main connectivity requirements of agriculture IoT applications are a large coverage and low costs of deployment or maintenance. Most applications, focusing on monitoring and data collection have however relatively low needs in terms of bandwidth and low latency.

This makes technologies such as the legacy 2G network and LPWA technologies (LoRa, Sigfox) particularly suited for most current deployment.

However, the long term sustainability of these networks is not guaranteed and given the lifespan of agricultural equipment, this uncertainty can lead manufacturers to delay technological choices.

But more advanced use cases (such as the use of video, full automation or augmented reality) will require either to be able to function with intermittent connectivity, or to wait for the deployment of new generations of networks (5G).

Additionally, to be able to deploy efficiently in rural areas, IoT solutions also need to be able to withstand the specificities of the environment (limited access to power, dust, rain, vibration, etc.). When not taken into account, these factors can significantly delay the technology adoption.

Dealing with legacy technology.

Another import requirement of the agricultural industry is the ability of IoT systems to deal and interact with legacy technology.

Although most agricultural equipment sold nowadays integrates digital capabilities, most of the fleet remains pre-digital tractors, implements and machines that will take a long time to replace.

The lifespan of agricultural technology largely outplays the lifespan of communication technologies. It is thus important that innovations are able to deploy on existing machines.

Plug and play solutions that deploy on top of traditional equipment are thus developed to facilitate adoption. But this reinforces the challenge of technology interoperability and standards.

27.5 years

The average age of tractors in Germany, due to high purchasing costs[6].

2

Connecting machines and farms

Agriculture 4.0 is about connectivity

Beyond the introduction of new tools and practices, the real promise of Agriculture 4.0 in terms of productivity increase resides in the ability to remotely collect, use, and exchange data.

Transparency of productions

A first range of application is the use of IoT to collect and publish information on the production processes and the farm.

This can go from using digital tools to facilitate and automate legal and tax declarations, to increased food traceability through the publication of detailed information on goods, quality and origins[7]. This type of use case is relatively easy to deploy and ahead in adoption, as it only requires a limited integration with the production ecosystem.

Preventive maintenance

Another class of use cases relies on connecting agricultural tools data with their manufacturers. In that respect, a key use case of agricultural equipment is predictive maintenance[8].

Sensor deployments and connectivity enables the manufacturers to track the usage of the product. They can detect early a loss of performance and offer preventive maintenance operations. Additionally, the data collected helps the manufacturer to better understand needs and usages to improve its line of products.

Shared knowledge for optimised farming

Beyond these initial use cases, a third class of opportunity exists in using the collected data to directly improve the production practices, the crops and the tools.

This approach is very promising as it could enable important productivity increases and optimisations in the use of fertilizers, herbicides and fuel. According to early estimates, it could enable a 20% increase in income[9] while reducing herbicide and fuel consumption by 10% to 20%[10]

However, these use cases will take time to deploy as they require extensive data collection and exchanges at the level of the ecosystem (enabling data analysis over several exploitations).

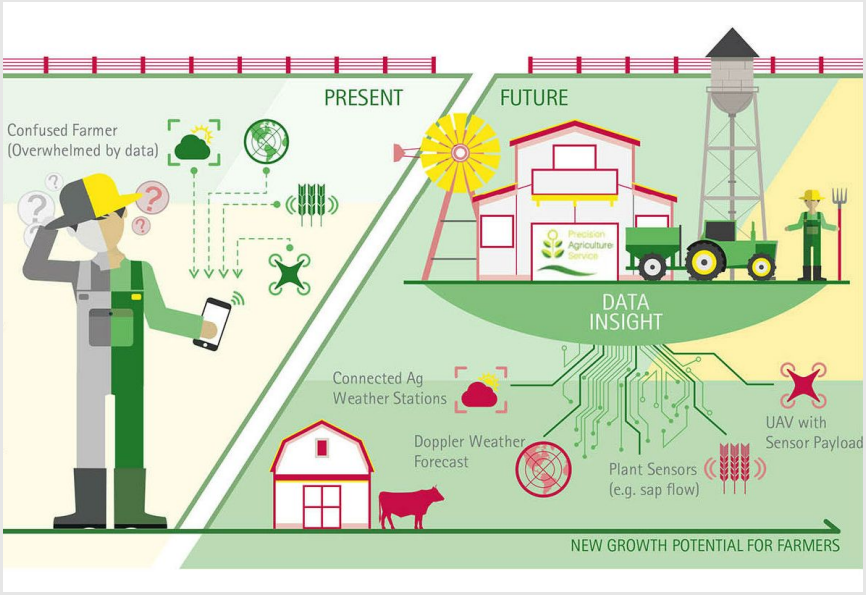
Impact on business models and ecosystems

Agriculture 4.0 is transforming the business ecosystems and opening up new room in the value chain and development of new revenue modes.

Servicization

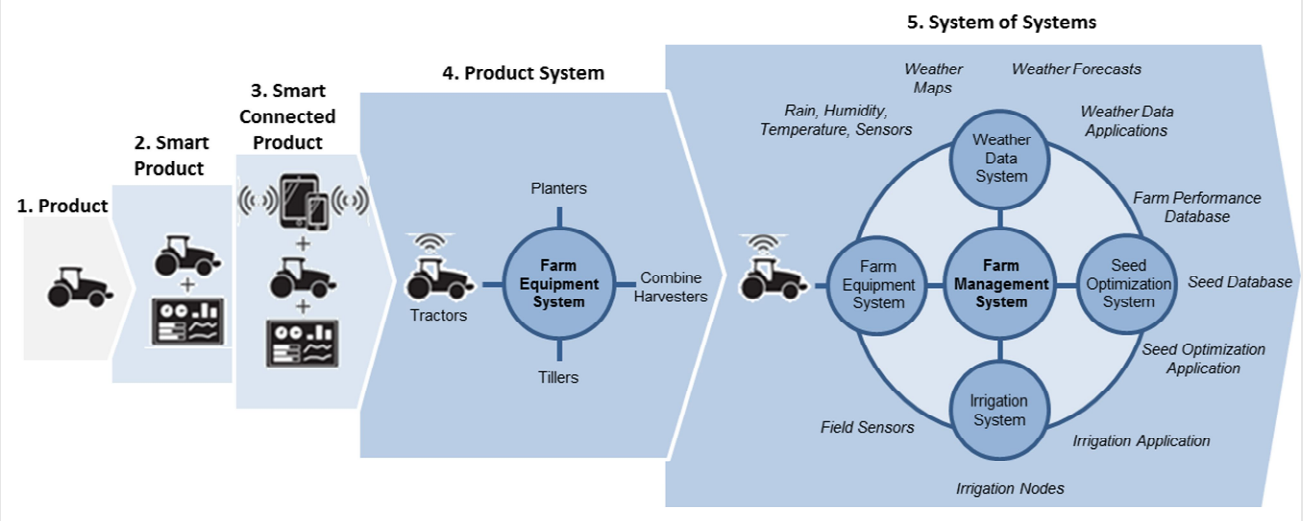
Connected objects are often seen as a way to provide additional services on top of existing equipment.

Figure 2 : Centrality of data insight in future farming solutions



Source: Accenture

Figure 3 : Farming product offering toward integrated systems of systems solution



Source: IDATE based on Harvard Business Review.

A first notable example of service development is preventive maintenance services. But connected objects are also enabling other types of services such as advice on production practices and timing, or forecasting and scheduling services.

New roles and actors

The IoT deployment in the agricultural industry creates a more complex value network, with potentially new actors in the value chain (such as connectivity providers) and new roles of service and application providers. The business and competition ecosystem for agricultural equipment sellers and manufacturers broadens as their products become increasingly connected[11].

To remain competitive they need to offer more complete services of "Farm Management" rather than just traditional products. As the offers diversify they face the competition of more actors while also needing to establish relationships with new actors such as connectivity providers (MNOs) or software application providers.

A need for connected ecosystems

The development of precision agriculture is based for a significant part on the ability to collect and analyse data.But to achieve significant results and optimise production, data often need to be gathered and confronted at a higher level than a single exploitation/farm to detect patterns.

This implies the development of data exchange mechanisms, and the collaboration of numerous actors with varying and potentially conflicting interests.

The organisation of these data exchanges is set to be a crucial spot in the value chain with the ability to generate knowledge from data and set up a business model of optimisation services.

Emergence of platforms

To take advantage of this opportunity, and similarly to other industries, the agricultural industry sees the development of IoT platforms.

The strategy of actors (often large players in the industry[12] such as equipment manufacturers like John Deere or crop providers such as Monsanto) is to establish themselves in a dominant position through both technological and data platforms.

The role of technology platforms, centered on the control of technological enablers, can be important in setting up standards and securing the market early on.

However, most of the value is set to be found in the case of the agricultural domain in the control of data.

By taking control of the data set, and providing services that enable an optimisation of production processes, industrial actors can secure a strong position with both strong barriers to entry and recurring revenues. This trend is however set to reinforce the captivity of farmers to industrial actors.

4.1 Million

According to OnFarm (a connected farm IoT platform provider), this is the number of data points the average farm will generate by 2050[13].

3 Challenges to adoption

Although the prospects of eventually integrating the Industry 4.0 technologies, practices and mindset in the agricultural domain are good, adoption will take time. The sector faces significant challenges, from the standardisation of technologies to the ability to invest to modernise the equipment and supporting infrastructures.

A need for standards

The development of Agriculture 4.0 requires technological standards to ensure the compatibility of equipment.

Indeed, given the lifespan of agricultural equipment, standards are a necessity to ensure that any technological choice remains interoperable with newer equipment and is supported over time by the manufacturers and other industrials.

Standardisation in the field is mainly achieved by the AEF and the AgGateway, each focusing on different aspects of interoperability (at the machine level or at the farm administration level)[14].

The new challenge of Agriculture 4.0 is the need to have data exchange and communication standards that link the different systems together in a unified system covering all aspects of the agricultural exploitation.

The AEF and AgGateway have recently joined forces to define data exchange standards for the field[15].

Ability of farmers to modernise

Another essential challenge in the adoption of Agriculture 4.0 is the ability of farmers to invest and to modernise their practices of production.

They often face a tight economic situation with very limited investment ability in new production tools and limited access to credit.

Additionally the workforce is ageing[3], with over 56% over 55 in Europe (2013). The digital skills of the workforce are thus limited and require additional investment in training to adopt technologies.

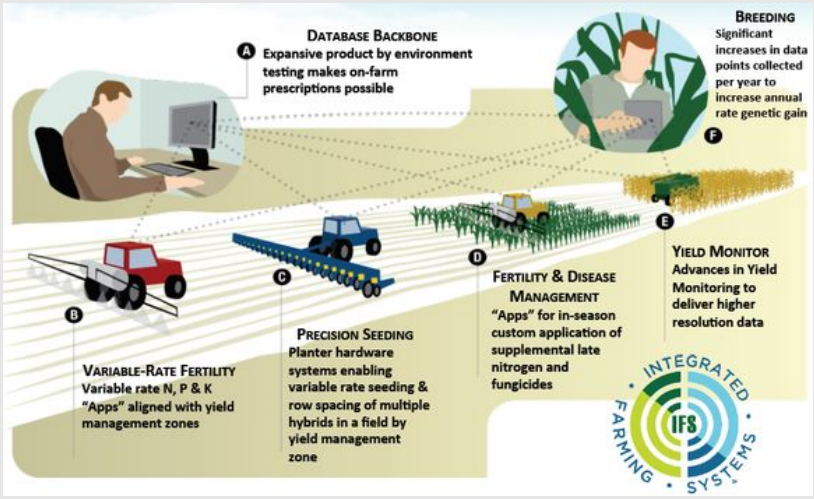
Furthermore, the willingness and ability to invest in new technologies face important disparities[16] with the risk of creating important gaps in production abilities between regions and exploitations.

Modernising infrastructures

Finally, another important challenge in the adoption of the IoT in agriculture is the development of communication infrastructures in rural areas. Current wireless communication networks have been deployed with a B2C focus, having a strong emphasis on urban areas.

As we have seen, the ability to exchange and analyse data (often at the platform level) is key to the success of Agriculture 4.0. Thus, communication networks will have to be developed in rural areas.

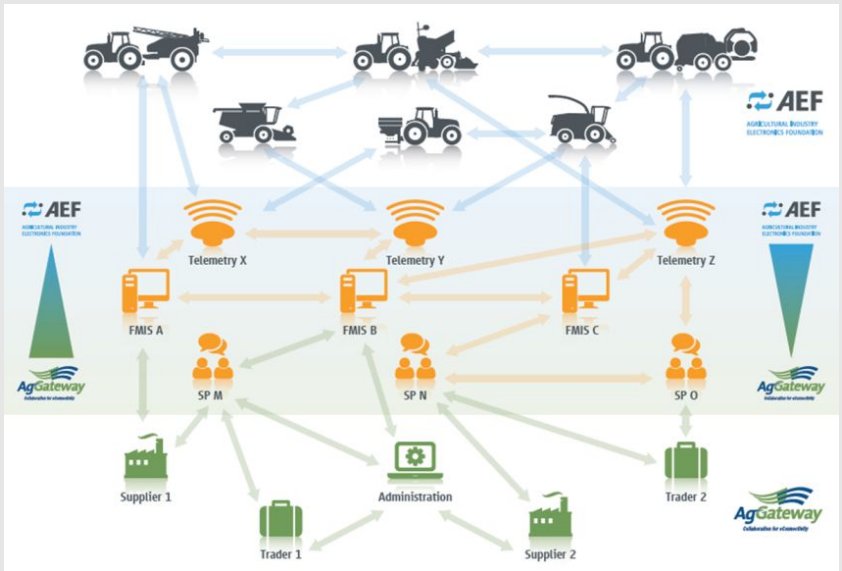
Figure 4: Data platform enabling precision agriculture.



Source: Monsanto

Wireless coverage availability in rural areas in Europe is around 40% but with still important regional diversities[17] despite the use of the European Regional Development Fund (ERDF) and the European Agricultural Fund for Rural Development.

Figure 5 : Standardisation ecosystem in Agriculture 4.0



Source: CEMA

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About the Digital Transformation Monitor

The Digital Transformation Monitor aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. The site provides a monitoring mechanism to examine key trends in digital transformation. It offers a unique insight into statistics and initiatives to support digital transformation, as well as reports on key industrial and technological opportunities, challenges and policy initiatives related to digital transformation.

Web page: https://ec.europa.eu/growth/tools-databases/dem/

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