# BIOCIRCULARnewsletter

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**Circular Agriculture decision support system**

Integration of individual tools of smart farming (smart farming) and processing (smart processing) in a single management system of the production chain of a vertically integrated dairy unit of small and medium capacit.

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης
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ΕΠΑνΕΚ 2014-2020
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Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

# 1. The importance of Circular Precision Farming

The Conventional agricultural practices along with inadequate operation and data processing have proved to lead to non-optimal value chains, with adverse consequences to the producers and consumers. Especially in the dairy industry, many different inputs are involved, taking into account that milk pro-duction includes both crop (used for feed) and livestock farming. Considering the above, dairy farming shows great potential for improvement in various pro-duction processes aiming at input reduction, taking advantage of the rapid development of ICT technologies. Consequently, it is important to investigate the mitigation potential of the environmental impacts of the entire production process of agricultural products, both in the crop and dairy section, their by-products, and the management of agricultural waste in a circular system. More specifically, all the important issues related to ineffective and unsustainable agricultural practices that lead to inappropriate or less efficient use of resources (such as water and fertilizers) should be addressed.

Water is one of the most important resources in agricultural production, while agriculture is one of the most water demanding sectors requiring more than 70% of the total water consumption globally. Thus, the need for limiting its use has triggered several potential actions and developments. More specifically innovative irrigation techniques can be investigated aiming at reducing in-puts and subsequently the environmental cost of cultivating field crops. Additionally, modern irrigation methods with high irrigation efficiency, such as deficient irrigation and Fixed Partial Root zone Drying (FPRD) using modern more efficient irrigation systems such as drip irrigation, subsurface irrigation, and advanced management practices such as smart irrigation, should be investigated further. The effectiveness of irrigation is an issue examined in almost all commercial crops; however, it has still not been thoroughly investigated under an integrated assessment system. Lastly, the relationship between the physiological and morphological characteristics of crops grown for feed, as well as optimal

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fertilization and irrigation levels should be examined to determine the ways in which these characteristics can be used for effective use of water. For example, the selection of varieties that are more resistant to water deficiency based on specific morphological and agronomical characteristics, would lead to increased water use efficiency and higher yields in dry climates.

Basic aim of the above is to decrease the environmental impact of the activities of the entire production chain of dairy units. This can be achieved through the utilization of modern technologies for reduction of inputs and improved waste management, in both crop and animal production, as well as in the processing and standardization of dairy products. Several economically sustainable advanced "smart farming" and "smart processing" technologies and tools are being developed towards that direction. These tools incorporate multiple levels of decision making in agricultural holdings, examining, and combining business intelligence, engineering, and computer science systems. All these systems can be incorporated in an integrated milk production management system which sets the basis for the development of a Circular Precision Farming system that supports circular farming decision making.

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# 2. Industry 4.0 in Agriculture

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.

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.

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.

The digitalization of agriculture is based on the development and introduction of new tools and machines in production. The tractor and the implement are key instruments of the development of the agricultural industry. Connectivity and localization technologies (GPS) are optimizing the usage of these agricultural tools. This includes driver's assistance to optimize 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 (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.

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 that automate parts of the production process.

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.

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.

A key requirement is of course the ability of communication networks to deploy and cover rural areas efficiently. 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 considered, these factors can significantly delay the technology adoption.

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 can 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.

Bibliography: Digital Transformation Monitor Industry 4.0 in agriculture: Focus on IoT aspects, July 2017

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# 3. Industry 4.0 in Dairy Manufacturing

Many food and beverage sectors are experiencing struggles right now with small to mid-sized dairies being especially vulnerable. The dairy process is complex, very regulated and margins are tight due to a variety of internal and external factors. In addition, consumer preferences for dairy are constantly changing and it's getting tougher and tougher for smaller enterprises to compete. Industry 4.0 can help, but it's not a straight line to success.

Many dairy processors have experienced a financial bump from the covid-19 pandemic, but most have not adjusted adequately. Production demands have increased and there has been little downtime to implement improvements, let alone perform much needed maintenance. As a result, many dairies have fallen critically behind, and not able to meet demand.

Covid-19 has also accelerated the advancement and deployment of technology in factories across all industries – everything from robots and collaborative robots to augmented and virtual reality (AR/VR), to artificial intelligence and machine learning (AI/ML). For the most part, however, only the larger dairies have been able to implement and capitalize on these innovations. These advancements have only created a larger gap between the capabilities of large dairies and small dairies.

Despite these headwinds, it's not all negative for smaller dairy enterprises. There are ways for smaller dairies to improve on the margins without breaking the bank or incurring significant downtime to the detriment of production. The benefits of automations and integration such as improvements to food safety, quality, reliability, flexible production, and traceability are well within their reach.

The key is to not get stuck on the formal definition of Industry 4.0. Achieving Industry 4.0 results without upgrading and/or throwing out the entire infrastructure is not only doable, but preferable in most cases. Small changes and simple additions can make a world of difference.

Implementing improvements with quick payoffs and using them to fund the obsolescence upgrades is important. Start replacing unsupported programmable logic controllers (PLCs) with those that provide increased functionality.

Even if there is little automation now, there are low-cost products and technologies dairy farmers can deploy to lay the foundation for future improvements. For instance, there is process control software available with supervisory control and data acquisition (SCADA) and manufacturing execution systems (MES) built in. Since it impacts your product directly, it's best to start with the control automation and then add on layers of improvement later.

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# 4. Circular Agriculture & Entrepreneurship

BIOCIRCULAR system includes a set of intelligent tools for real-time analytics, prediction, and recommendation systems, integrated into a platform which enables Circular Agriculture. The expected results are the following:

- Promote low-cost and easy-to-use tools and data platforms, so that SMEs could adopt Circular Economy principles with limited investments from an ICT platform and Data Space point of view
- Incorporate a set of components that support Circular Agriculture, by modernizing farming's functionalities in the adoption of Circular Economy principles
- Identify processes not performing optimally and recommend further improvement
- Accelerate businesses' digital transition to boost their advancement and recovery
- Continuous monitoring of the agricultural activities to early react and improve the Circular Agriculture related metrics

There is a strong push in the agriculture industry to look beyond the 4 walls of the enterprise to seek innovation and exploit emerging business models. Digital transformation is super-national in nature, with little national specificities in terms of regulatory model, market structure, operational and distribution models. This enables the creation of regional or "worldwide" consortia and initiatives that bypass the single national markets.

Technology is mature and ready to be used. The more cloud-based applications are used, and open APIs are provided, users will find it easier to share and exchange data. There is also the ability for the circular agriculture technology providers to join digital marketplaces and alliances which enables the integration of developed solutions in a wider pool of customers at a much shorter time.

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However, data need to be captured and managed in a common format so that it can be utilized by all stakeholders in an ecosystem enabling interoperability. Also, the collaboration between technology owners towards joint exploitation strategies, requires the definition of their IPR (Intellectual Property Rights) and ownership issues, marketplace model, revenue sharing model, etc.