TECHNOLOGY WATCH REPORT

Smart Rural

hubb30.

Generalitat de Catalunya
Departament d'Empresa i Coneixement
Secretaria d'Universitats i Recerca

Unió Europea
Fons Europeu
de Desenvolupament Regional

TECHNOLOGY WATCH REPORT
Smart Rural

Authors
Roser Salvat Jofresa, UAB Research Park
Marta Tort Xirau, UAB Valorisation and Patents Office
Hafsa El Briyak Ereddam, UAB Research Park

Edition and design
Communication and Promotion Area
UAB Research Park

UAB Research Park
Av. de Can Domènech s/n - Eureka Building - UAB Campus
08193 Bellaterra (Cerdanyola del Vallès) Barcelona · Spain
www.hubb30.cat

An initiative of:

An initiative of:

With the support of:

1
Overview of innovation and tendencies in Smart Rural

According to predictions of the United Nations Department of Economic and Social Affairs, the **world population** will grow to 8,600 million in 2030, and reach **10,000 million by 2050.** In order to guarantee a **sustainable future**, this gradual increase in population implies the development of four major challenges[1], among others: 1) **feeding** the population, 2) reduce **wastage** by optimising supply chains to reduce risk of disruption, 3) protect the **environment** and 4) guarantee a **livelihood for agricultural businesses** and farmers.

The growing demand must be satisfied by maintaining the availability of natural resources. The sustainability in food production is achieved by implementing production techniques and distribution channels that generate **new opportunities**, not only for large, but also small food and livestock farmers of growing and developed economies. It is therefore necessary that the various stakeholders and responsible politicians promote and adopt **technological and social innovations** in these areas.

But innovations that affect the **profitability and sustainability** of these activity sectors are subject to continuous stress. The truth is that there are **various models of agri-food operation** that are struggling to survive and fighting to expand. They can be distinguished by their more or less restrictive interpretation of efficiency and cost factors, and because, as a result, they promote large capital-intensive operations aimed at global markets or, at the other extreme, less ambitious initiatives that appeal directly to the **territory**, its biodiversity and its people.

Emerging large scale agriculture

Let's look at the example of **indoor farming**, a current tendency associated with the promotion of interesting innovations. Advanced greenhouses and aeroponic and hydroponic-based vertical farms face considerable R+D+I challenges especially those related to automation, mechanics and energy.

Lighting and ventilation systems have a particularly strong influence on energy and water consumption, impacting directly on the yield of these operations which require quite large economic investments. But this **emerging agriculture based on controlled environments** has only been adapted to a limited variety of horticulture crops, in spite of the risk and costs of plagues in monocultures. These characteristics, related to long term returns on investment, hinder the rate of adoption of advanced vertical agricultural techniques in small and medium scale operations aimed at local consumers.

Sophisticated initiatives like this reveal that, at least in certain countries, the agricultural sector has undergone very important transformations, especially after the nineteenth century when **mechanisation** came to the fore. But, particularly since 1980, one segment of the sector, pursuing **maximised food production,** has decisively adopted digital technologies. **Digitalisation** is and, probably will continue to be, an important vector of innovation in the sector. But, over the last

1 Frost and Sullivan (2020) Technology Innovation award - Controlled Environment Agriculture Industry.

twenty years, the incidence of **biotechnology** has revolutionised the sector.

Synthetic biology and genetic modification

One of the fields with surprising advances is that of producing **in vitro meat** alternatives based on muscle cells that could enable commercialising meat without any need to breed or sacrifice animals. In fact, **synthetic biology** enables designing biological systems with "ad hoc" functionality. It has already been possible to design a synthetic chromosome that can replace that of a bacterium, and some people claim it is only a matter of time before we use bacteria as **biofactories** not only for therapeutic molecules, but also for producing food.

On the other hand, transgenic crops are usually considered to be the maximum expression of the **industrial agriculture** model. **Genetic modification techniques** are used to insert, eliminate or modify DNA in order to silence, activate or modify the genetic composition of an organisation. This branch of biotechnology enables creating high performance seeds that produce crops with specific features at "lower costs". But some experts claim that these costs are disproportionate if the environmental costs derived from **genetic contamination** are taken into account, as the coexistence between these and conventional crops is not recommended. In fact, the majority of European countries have applied a moratorium on transgenic crops. It is expected that, over the next few years, long term studies that correlate biological results with agricultural models and social and economic development will contribute to clarifying the benefits provided by genetically modified organisms.

Precision agriculture

The concept "Smart Agriculture" usually refers to precision and digital farming, both designed to **optimise the efficiency of intensive farming operations** destined to global markets.

According to the ISPA[2] (2019), precision agriculture is a strategy that collects, processes and analyses **time, space and individual data,** and combines it with other information to support management decisions in agreement with estimated variability, and thus improve efficiency in the use of resources, productivity, quality, profitability and sustainability of agricultural production.

Precision agriculture enables **collecting real time data** on climate, land and air quality, crop readiness and equipment. This type of agriculture is based mainly on **GPS.** But nowadays, taking advantage of advances in information and communication technology (ICT), farms all over the world are evolving from "si mple" precision agriculture towards smart agriculture.

Smart agriculture

Unlike precision agriculture, smart agriculture assumes **massive real time data communication** between various digital technologies (automation, artificial intelligence and robotics) to provide operational statistics.[3] Thus, it paves way for an efficient route for monitoring, tracking, analysing and optimising various agricultural assets and production processes.

In this model, farmers **systematically monitor** key parameters that directly impact crop yield (temperature, humidity, nitrates, growth, precision agriculture diseases, etcetera) of the farms using **sensors and other technologies,** including the following:[4]

2 International Society of Precision Agriculture

3 Frost and Sullivan (2020) Novel Innovations Facilitating Digital Transformation of Agricultural Sector - Utilization of Innovative Digital Technologies to Enhance Farm Productivity and Profitability.

4 Frost and Sullivan (2016) Analysis of the Smart Agriculture Technology Market - Technology Integration in the Agriculture Ecosystem will Increase Production Yields and Drive the Technology Market.

· **Sensor fusion** technologies refer to the distribution of multiple sensors and their combination with wireless data processing hardware acting as a source for detection, diagnosis and prognosis of soil variations and crop evolution.

· The agriculture **drones** capture multispectral images and use advanced accessible usability capabilities and enable aerial inspections of the scope, health and yield of farms, favouring farmer decision making.

· **Hyperspectral technology** enables imaging on the basis of wavelength analysis. HSI devices are capable of analysing all the pixels of the landscape and provide analysis of spatial and spectral details by combining all the data available, providing knowledge related to crop and soil health prior to visual inspection.

· **Autonomous farming** refers to many lightweight, small, autonomous, energy-efficient machines working together to weed, fertilize, and control pest and disease, all the while collecting valuable data that can be later used to correct and improve the process.

· Other tendencies are agricultural **robots** and, for livestock, the growing use of cattle **biometry.**

Different **types of sensors** including optical, electrochemical and mechanical sensors enable precise weather forecasts, the detection of crop stress and disease several weeks in advance thereby reducing crop loss by up to 25%.

The storage and processing of the farm data in cloud and blockchain platforms enhances the decision making ability of farmers. Following this tendency, over the next few years there will be an expected increase of automation in agricultural productions with capacity to assume the **high expenditure** involved: installation and maintenance costs, in addition to the acquisition of specialists, as well as the management of cybersecurity risks.

The great beneficiaries of these operations will be equipment/**machinery suppliers,** providers of specialised **products,** and **technological companies** that install connectivity, smart telephones, sensors, machine-machine (M2M) solutions, big data analysis systems, geomapping and other applications.

Digitalisation and food safety

But in large volume food markets, characterised by their dependence on oil, speculation, political turbulence and frequent commercial wars, **economic pressure** to improve profit margins and income from production crops is more than considerable.

The need to minimise losses due to plagues, diseases and weeds over the last few decades, has driven the intensive use of **chemical pesticides** and this has brought about an increase in contamination incidents, food transmitted diseases, **food safety scandals** and consumer scares, thus highlighting the need to harmonise food safety requirements.

This being so, **traceability** takes on progressive importance. The use of **digitisation,** big data and application based services optimises and controls the use of chemicals for crop protection.

But food safety affects the whole food supply chain: from the use of chemicals on farms, to food processing, storage and retail point of sale. The tendency is clear throughout the chain: the security and traceability of foods is becoming progressively crucial, and artificial intelligence (AI) and **blockchain** technologies will expand in the large **agri-food industry.**

Industrial automation

Nevertheless, it is considered[5] that automation will continue to be the main driving force behind this large scale agri-food industry, a priori labour intensive, which strives to obtain greater yield with lower costs. Some tendencies in this field are:

- The main manufacturers of processing and packaging equipment invest more and more in automation to reduce manual handling and the impact of human error on food **safety,** as well as labour costs.

- Automation is also designed to resolve **production incidents** by means of early warnings and guidance about the most suitable decisions to resolve them.

- The adoption of sophisticated, fast and continuous technological **quality control** solutions is the driving force behind the growth of Internet of Things **(IoT)** for the production market and traceability.

- Improved **productive flexibility** is also a key benefit of Industry 4.0., which at one extreme enables order customisation.

- Big data analysis functions will finally enable faster and more precise decision making, as well as the **distribution and commercialisation** of agricultural food products.

Along this line, it is expected that semiautomatic and automatic equipment will undergo progressively greater demand in this industry.

Smart containers

It is also considered that over the next few years **safe, connected and sustainable containers** will increase their prevalence and use among the manufacturers, partly driven by consumer preferences.

The evolution of **consumer demands** is certainly pushing rapid advances in food packaging technologies and, more specifically, emerging tendencies in the use of packaging materials which are environment friendly and do not increase wastage: use of hybrid materials; recyclable paper, glass and metal to minimise plastic consumption; nano-containers, etc.

Progressively more environmentally aware, consumers continue to concentrate on the recyclability of materials, and companies promote innovations in ecological materials alternative to plastic that support this tendency.

5 Frost and Sullivan (2020) Technology Innovation award - Controlled Environment Agriculture Industry.

Consumers, a source of innovation

The evolution of consumer demands drives advances food packaging technologies, but also impacts on other areas and explains **new tendencies**.[6]

· **Diversity:** The speed of consumer learning promoted by digital contents divulged by Apps, social networks and multimedia platforms, drives greater demand for food options.

· **Functionality and health**: Foods with few ingredients, low in salt and sugar, gluten free and with little processing, are becoming a tendency. The health demands of consumers also impact on vegetable beverages and functional foods.

· **Vegetable proteins:** Education and awareness also indicate the need for meat alternatives and force the offer of substitutes and, in general, the innovation of products based on vegetable proteins.

· **Labelling:** The above points are in-line with the demand for clear, transparent labelling: reliable, and easy to read and understand.

· **E-Commerce:** the role of middlemen and retailers will evolve as a result of the possibility of direct contact with producers.

· The previous factor leads to **personalisation** of orders as well as the release of foods and other added value services.

Freedom Food is a tendency

Driven by millennials, there is a world-wide growth in the preference for Freedom Food. The demand for **food free** of characteristics **undesirable for people's health** and natural systems is on the increase in all its various **manifestations:**

· organic foods, foods free of environment damaging contaminants and allergens
· food of sustainable origin and ethical production
· functional foods and high quality and especially nutritional nutraceutics
· kosher and halal foods
· food with an animal welfare certificate

A growing segment of consumers in the food and beverage sector will demand products that are healthy, environment friendly, ethically produced and highly nutritious. These high added value products **will drive innovation** in the future. It is expected, for example, that **natural preservatives** will be in high demand to reduce spoilage and keep food fresh for as long as possible without impacting the natural profile of the food.

Conservation agriculture

But especially important will be to optimise the economic and environmental costs of food production, promoting **small scale productions that are more environment friendly.**
More and more experts point out that the practices of **conventional agriculture** contribute to **deterioration** of the quality of surface **water**, because the sediments of eroded agricultural soils transported by the runoff water are a very important contaminant. On the other hand, **intensive farming** and **stubble burning** produce superfluous carbon dioxide emissions and reduce the carbon storage capacity of the soil and, as a result, a reduction of the organic material.

6 Frost and Sullivan (2019) Outlook of the Global Agriculture and Nutrition Industry. Adapting to Digitalization, Adopting New Business Models, and Searching for Palatable Meat Alternatives will Define the Agriculture and Nutrition Industry.

Conservation agriculture (CA) systems moderate this impact on the soil, air and water, is this why they are a tendency.[7] Adopting practices such as direct sowing and cultivation without tilling the land, as well as other integrated management techniques, conservation agriculture achieves more efficient use of natural resources, and sustainable agricultural production that ensures conservation of the environment. Furthermore, scientists have shown that in dry-land farming systems, the application of this type of agriculture offers as much or greater **productivity** than conventional farming.[8]

But the conversion of classic industrial agriculture towards no-till farming is a **radical transformation** that requires changes in agricultural equipment, flexible job organisation, the concept of agriculture and **personal and professional identities**. In the context of small farms, the difficulties involved to access specialised seeders are an important barrier, but the human aspect can be even more relevant to explain the tendency not to change the model. In general, neither farmers nor agronomist technicians have sufficient understanding of the land as a valuable resource, nor do they see its degradation as a threat to their means of subsistence. This being so, the approach to innovation and "technology transfer" to promote new agricultural models should not ignore **local realities,** nor their social, economic, cultural and mental roots.

Agroecology

In short, the way in which farmers understand the soil has a decisive influence on the attitude that take towards it, and how they finally decide to act to manage it. Agroecology progressively takes on more importance with the hypothesis that **agroecological transition** requires not only an ecological effort, but also one related to **socio-cultural and political dimensions.**[9] This discipline is aimed at increasing the sustainability of agri-food systems from ecological perspectives and based on natural science. It delves into agrotechnological innovations, but in the context of wide agri-food systems that consider factors such as infrastructures, cultures, regulations, values, institutions and the practices of local social systems.

From these holistic approaches, the design of innovations must be centred on the **farmer's needs** and their reference agri-food systems, and simplifying innovations involves **knowledge sharing** to improve capabilities, in an exercise of non-formal adaptation.

Small scale social innovation

This means that new economies are closely united to **technosocial innovations** that attempt to ensure that free foods, apparently more expensive to produce, are **available and accessible** to the general population. And they also strive to be accepted by small farmers, as well as by other local and rural actors interested in activating sustainable agri-food models.

In fact, forecasts indicate that this will not only transform the way in which **organic and ethical foods** are produced, processed and consumed, but also the way they are moved, stored and **commercialised.** In this area, for example, innovations related to **food wastage** have a big future ahead. It is well-known that one of the main reasons for food scarcity is its loss at various stages, including logistic ones, and that this has economic, environmental and social consequences due to its effects on the use of limited resources such as soil, water and fuel.

7 Moreover, in our environment conservation agriculture is often applied in combination with transgenic seeds resistant to herbicides which facilitate less mechanical handling: http://fundacion-antama.org/agriculture-of-conservacion-con-variedadestransgenicas/

8 ConServeTerra (2019) Overcoming the physical and mental barriers for upscaling Conservation Agriculture in the Mediterranean. PRIMA Full Proposal Template.

9 López-García, Calvet-Mir, Di Masso i Espluga (2018) Multi-actor networks and innovation niches: university training for local Agroecological Dynamization.

Consumption of Km 0 organic food

The production of high quality **organic food** by small farmers who distribute to nearby markets to satisfy **local needs** is an extraordinary **economic, ecological and social value** as well as one with a good future ahead. In Catalonia in 2018, the area dedicated to ecological production grew by 5% a year and the number of ecological operators (marketers, importers, producers and processors) by almost 9%.[10] More than 60% of the destinations of the majority of sales of these products was Catalonia and Spain.

Eating is a direct action of agricultural policy, and in order to support ecological farming, the best action consists of regularly purchasing what it produces at a fair price. But many agricultural companies and farmers still face the **challenge of selling at a better** price either because they cannot reach the right market; there is a lack of infrastructure in the food chain, or because of the precariousness of their own productive structures. In this context; the consumption of local organic food helps ecological agriculture maintain its reason for existing. **Food sovereignty** places food production, distribution and consumption within the framework of social, economic and environmental sustainability. It defends local and organic peasant farming.[11]

Over the last few years the **channels for commercialisation** of organic food have diversified considerably, often in association with **consumer groups** promoting projects with greater resources, visibility and infrastructure, where voluntary work is almost dispensable. **Cooperative supermarkets** are on the rise, but so are country-style markets and **purchases direct** from the **organic farmer.**

Tendencies indicate that, in the face of progressive supply options, the consumer of organic products will buy **on-line**, or select **points of sale** on the basis of **different factors** such as accessibility, comfort, variety, added value services and the degree of social and environmental commitment.

In this context; **committed cooking of organisations, educational centres, groups and companies,** as well as restaurants partaking in the Slow Food movement, also contribute to putting consumer in contact with local organic producer, becoming quite outstanding examples of social innovation.

Finally, countries such as France and England progressively offer very interesting examples of "community-supported-agriculture" (CSA). Community-supported agriculture, also called **"shared responsibility agriculture"** is an association between farmers and their local community where they share the risks and benefits, with prior agreement on the orders for the produce as well as the stable income to be received by the farmer. This same philosophy can also evolve to include application for example to meat, eggs, dairy and other natural food products, or forestry resources.

---

10 Generalitat de Catalunya (2019) Informatiu especial sobre Producció i Consum local d'Aliments Ecològics - Setmana Bio per l'alimentació ecològica.

11 Generalitat de Catalunya (2019) Informatiu especial sobre Producció i Consum local d'Aliments Ecològics - Setmana Bio per l'alimentació ecològica.

Challenges and opportunities for the rural environment

From an environmental point of view, organic and proximity agriculture has also represented a reduction of the environmental pressure associated with agricultural activities that favour conservation of the **biodiversity** and, as a result, ecosystem functions. The development and deployment of more respectful productive, logistic and commercial models is already naturally contextualised in **small scale economies,** and in **peri-urban and rural environments.**

But pandemics such as COVID-19 do no more than reinforce the ideas of **post-globalisation** which claim that the future will be considerably altered by new social, economic and political events. In short, they forecast the end of the world hegemonic status of the last decade, because of a reduction of globalisation and liberal democracies in an attempt to re-establish world order to confront the rise of terrorism, biological insecurity and the consequences of capitalism. In this order of things, the rural world is revalued in developed countries.

At the same time, the rural world also claims the resolution of long lasting **challenges** including depopulation (emigration of young people and women), ageing, loss of income, gender inequalities, reduction of the workforce in the agricultural sector, high unemployment rates, territorial dispersion and, finally, the digital divide.

In the **case of Spain**, where rural areas located in the south and along the Mediterranean and Atlantic coast enjoy good demographic health but, on the other hand, those located in the centre and north are more affected by depopulation, the figures being quite revelant.[12] The rural environment covers 90% of the territory, but only has **20% of the population,** a density of less than 20 inhabitants per square kilometre and a loss of -0.3%, especially in towns with a mean age above 65 and among women, all favouring abandonment because of harshness of the social, economic and cultural conditions. In spite of the decrease of 7% in the ownership of farms by women, for the State, the **agricultural** sector, **with 27%** of the population employed, is the main source of income for the rural environment.

Towns at risk of irreversible depopulation show the lowest birth rates, the highest death rates, constantly negative natural growth, more net internal migration and less attraction for outside immigration. According to the 2017 AROPE report[13], **35%** of the rural population are at **risk of poverty or social exclusion.** Figures such as these sound alarms and encourage the need for

intervention **inclusive in projects** designed to reduce the vulnerability of the population in the rural environment. Some of the **opportunities for social and economic development** that could encourage social innovations are:

- Attract residents, whether neo-rural or not.
- Encourage the manufacture of natural resources, as well as the food industry.
- Recover the agricultural sector, and organic agriculture.
- Attract rural tourism and associated services.

12 Rural Citizen 2030: La ruta de la Innovación social (2020).

13 Juan Carlos Llano Ortíz (2017): 7º Informe anual sobre el estado de la pobreza y la exclusión social en España. Ed EAPN España.

Sustainable local development

Therefore, Joaquín Recaño[14] claims that in certain areas the **economic resilience** expressed through second homes, the existence of territory specific resources and rural tourism, could guarantee the economic continuity and maintenance of minimum population levels.

Beyond the post-globalisation hypotheses already mentioned, it is considered that there are **new social tendencies** in developed countries that also favour increased **opportunities for innovation and development** in the rural environment[15]. Among others, we could include:

- the economic, health and social risk of urban areas,
- access to Internet, and the capacity and habit of telecommuting,
- the availability of low-density second homes and renovated houses,
- improvements in mobility,
- e-shopping, on-line education, and other digital services,
- the negative impact of the agricultural industry,
- agroecological businesses, encouraged by the value of nature, health and responsible consumption.

The purpose behind it all is to push a new model of **sustainable local development** in line with Objectives for Sustainable Development **(OSD).** In a context of predictable health, energy, environmental and economic crises, the rural population and particularly small and medium farming, need to **gain economic viability and representativeness**. The transition towards healthier, fairer and more sustainable models of territorial development must necessarily include a commitment to proximity, respect for nature, and the **construction of networks of local actors:** the production sector, schools, restaurants, processors, retailers, consumer associations and healthcare centres, among others.

It is also important for young people to be able to specialise in these new local economies through **professional and university training** cycles, and that they have the opportunity to put this experience into practice by experimenting giving them their true value.

Public policies are a **source of innovation** complementary to that available from large innovative companies through research and technological centres, as well as from consumers themselves. It is expected that government commitments to confront climate change, for example, will impact on the majority of economic activity sectors, forcing innovations in many areas. The policies of resource availability could also positively influence the evolution of opportunities for development of the **agroecological model**. But reality shows that this is a **marginal and small scale** model which, even though to date it has gleaned a certain amount of support from local policies, it does not form part of the innovation agenda of large agricultural and food policies, decisively aimed at industrialised, global agri-food systems.

Public institutions could play an important role through various types of **measures:** facilitate generational relief and access to the land, subsidise the conversion to organic production and "bio" enterprises, recognise the recuperation of species adapted to local geo-climatic conditions, subsidise access to infrastructures and resources for traditional food processing and natural resources, as well as grants for their commercialisation, and promote campaigns for the consumption of local foods, among others. Equally important is the design of policies to improve the metabolism of cities,

14 Joaquín Recaño (2017) La sostenibilidad demográfica de la España vacía.

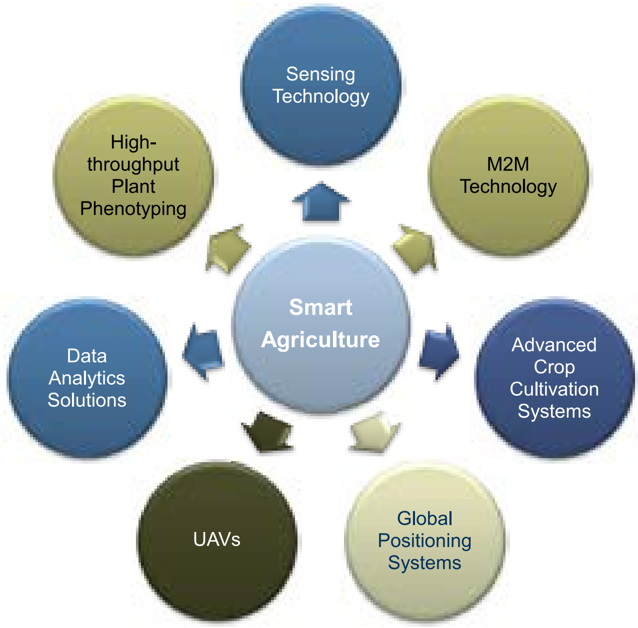
15 Francisco Vázquez: La ruta de la Innovación social (2020).

increase the reserve of undevelopable land, repopulate the rural environment, generate seed banks, restore the productive capacity of land and, especially, encourage dynamic cooperation with the actors leading the adaptation to new scenarios.

For rural areas to advance, any initiatives must be aligned with firm outlooks, participative strategies and precise objectives. Favouring the welfare of the rural population, ensuring the sustainability of resources and the environment, taking advantage of technology and improving the economic future of agricultural areas is undoubtedly a **complex challenge,** but also a necessary and exciting one.

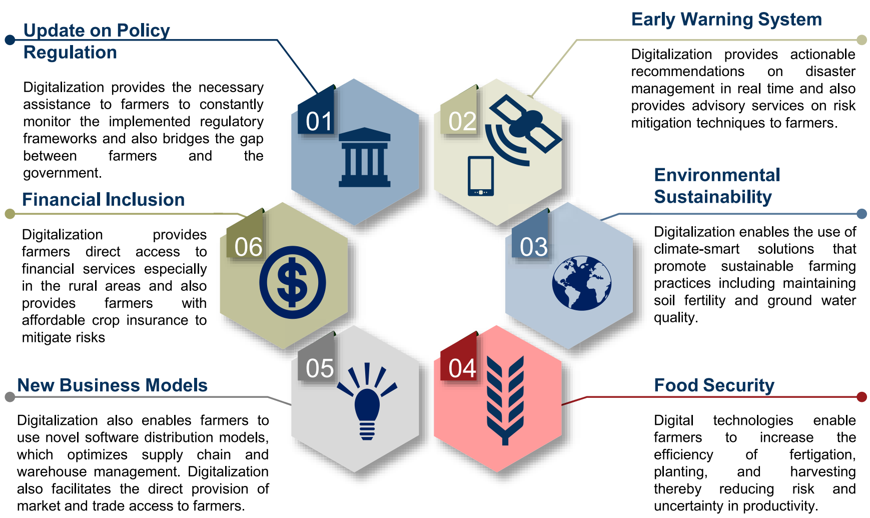
2
Smart Rural: Key infographics

2.1. AgroTech: Tecnological convergence



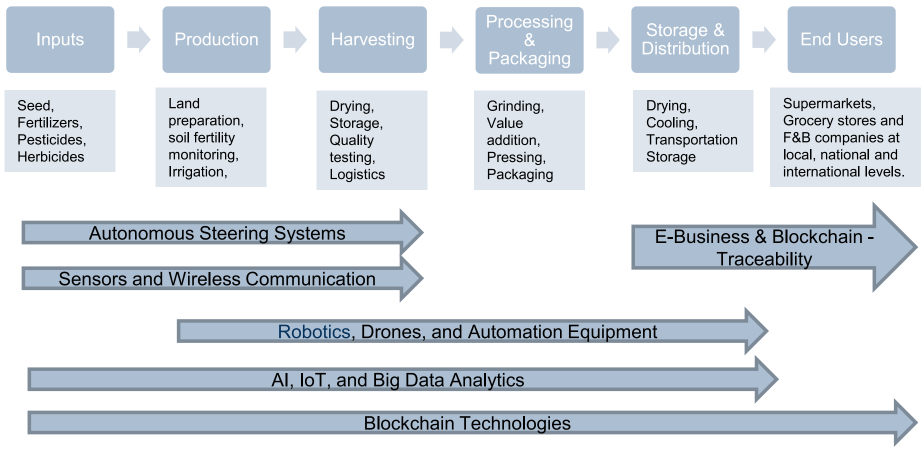
Source: Frost and Sullivan (2016) - Analysis of the Smart Agriculture Technology Market - Technology Integration in the Agriculture Ecosystem will Increase Production Yields and Drive the Technology Market.
Source: Frost and Sullivan (2020) - Novel Innovations Facilitating Digital Transformation of Agricultural Sector - Utilization of Innovative

2.2. AgroTech: Rol of digitalitzarion



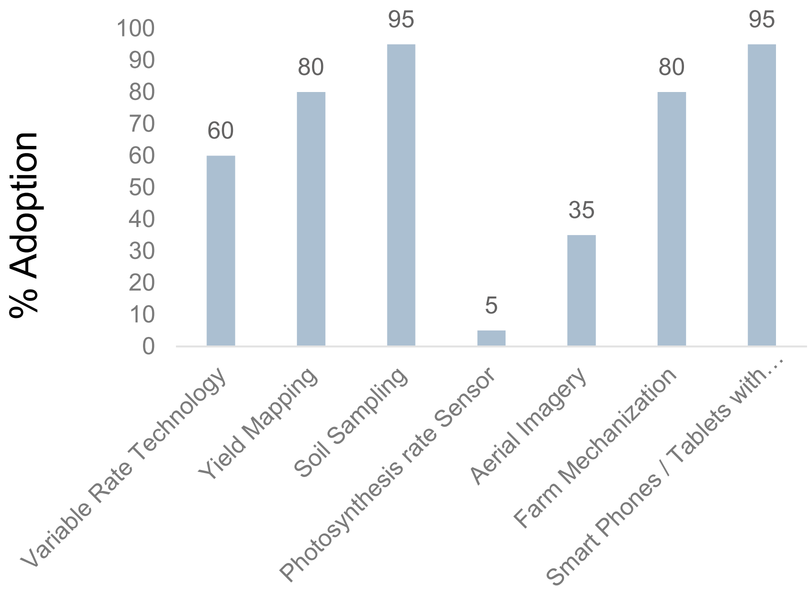
Source: Frost and Sullivan (2020) - Novel Innovations Facilitating Digital Transformation of Agricultural Sector - Utilization of Innovative Digital Technologies to Enhance Farm Productivity and Profitability.

2.3. AgroTech: Digital global landscape (2020)

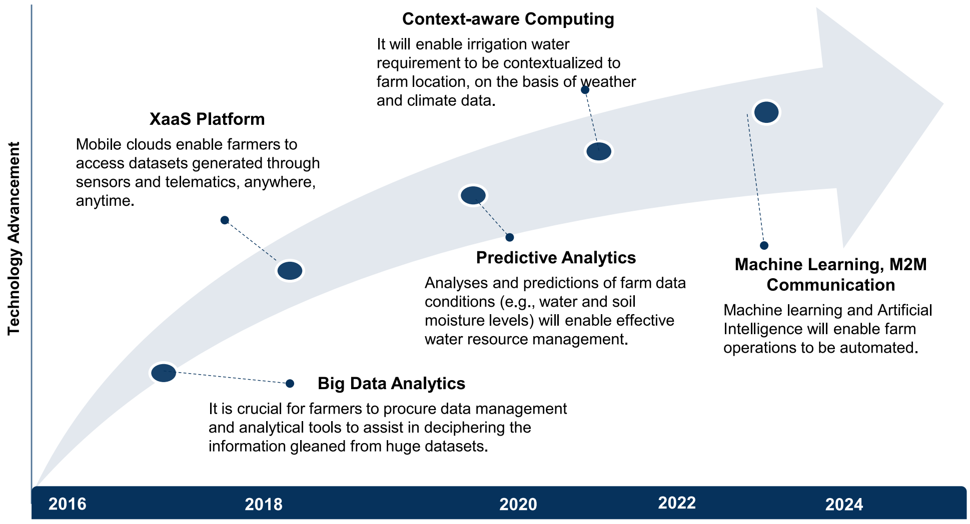


Source: Frost and Sullivan (2020) - Novel Innovations Facilitating Digital Transformation of Agricultural Sector - Utilization of Innovative Digital Technologies to Enhance Farm Productivity and Profitability.

2.4. AgroTech: Technology adoption in developed countries (2019-2020 variation)

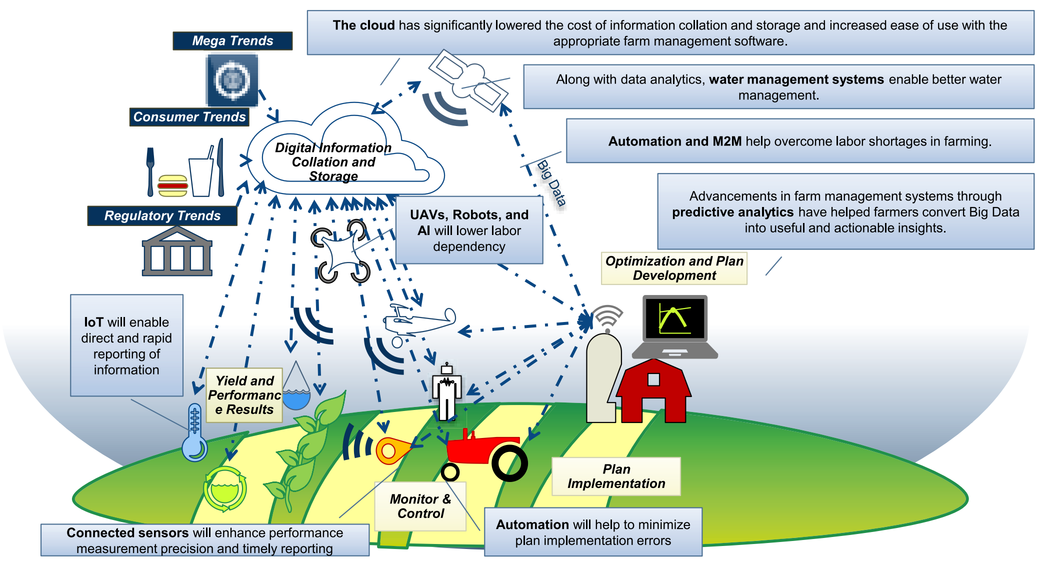


2.5. AgroTech: Digitalitzation in farming industry



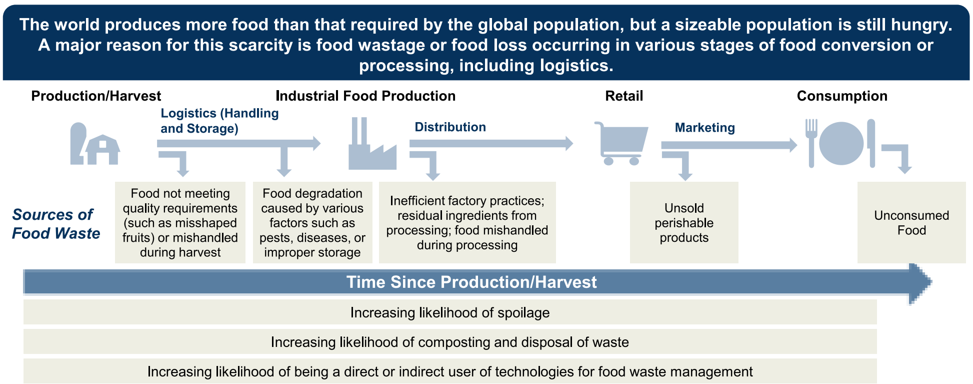
Source: Frost and Sullivan (2017) - Connected Services and Big Data Analytics in the Global Farming Industry, Forecast to 2022 - Integration of Big Data Analytics with Connected Farm Equipment Signifies the Next Frontier of Competition

2.6. Smart Agriculture ecosystem transformation



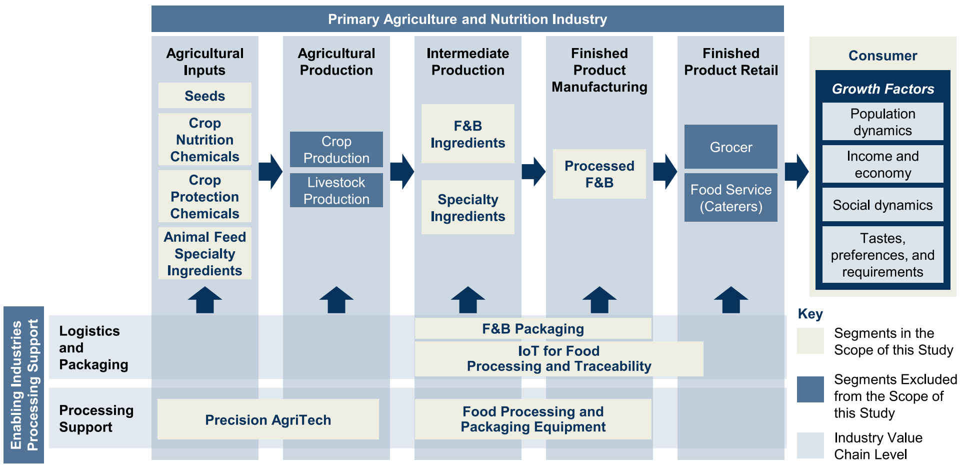
Source: Frost and Sullivan (2016) - Analysis of the Smart Agriculture Technology Market - Technology Integration in the Agriculture Ecosystem will Increase Production Yields and Drive the Technology Market.

2.7. Agriculture & Nutrition Industry value chain



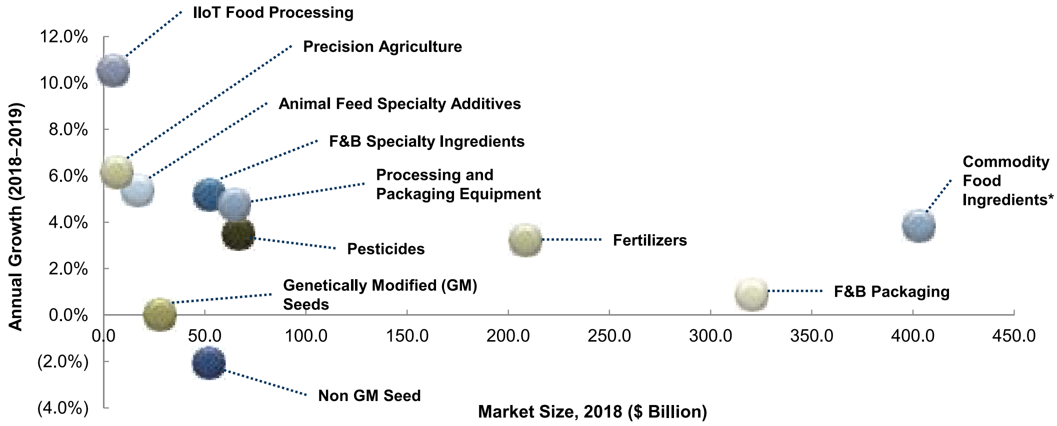
Source: Frost and Sullivan (2019) - 2019 Outlook of the Global Agriculture and Nutrition Industry - Adapting to Digitalization, Adopting New Business Models, and Searching for Palatable Meat Alternatives will Define the Agriculture and Nutrition Industry.

2.8. Agriculture & Nutrition Industry: Value chain and Market segmentation



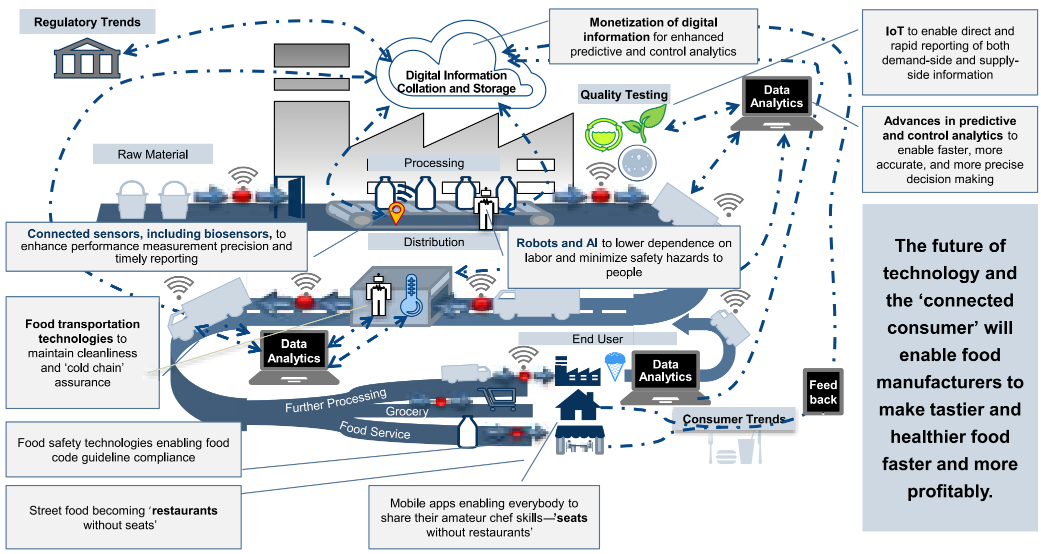
Source: Frost and Sullivan (2019) - 2019 Outlook of the Global Agriculture and Nutrition Industry - Adapting to Digitalization, Adopting New Business Models, and Searching for Palatable Meat Alternatives will Define the Agriculture and Nutrition Industry.

2.9. Agriculture & Nutrition Industry: Growth opportunities of technological markets (2019-2020)



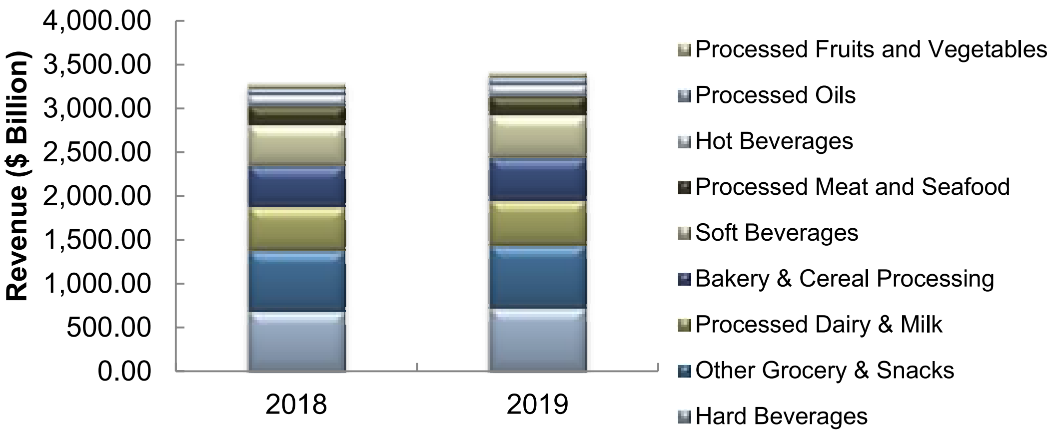
Source: Frost and Sullivan (2019) - 2019 Outlook of the Global Agriculture and Nutrition Industry - Adapting to Digitalization, Adopting New Business Models, and Searching for Palatable Meat Alternatives will Define the Agriculture and Nutrition Industry.

2.10. Food & Beverage industry: Digital disruption in the ecosystem



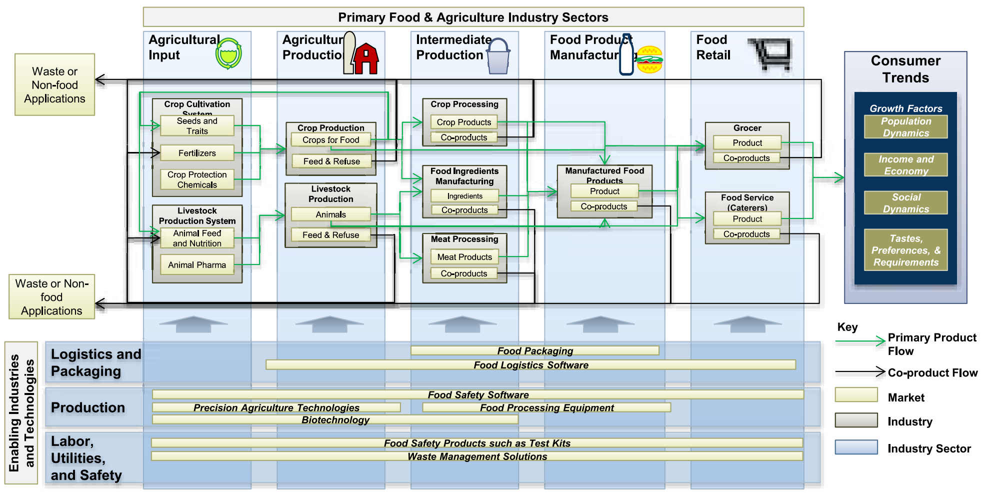
Source: Frost and Sullivan (2019) - 2019 Outlook of the Global Agriculture and Nutrition Industry - Adapting to Digitalization, Adopting New Business Models, and Searching for Palatable Meat Alternatives will Define the Agriculture and Nutrition Industry.

2.11. Food & Beverage industry: Global Revenue by sector (2018, 2019)



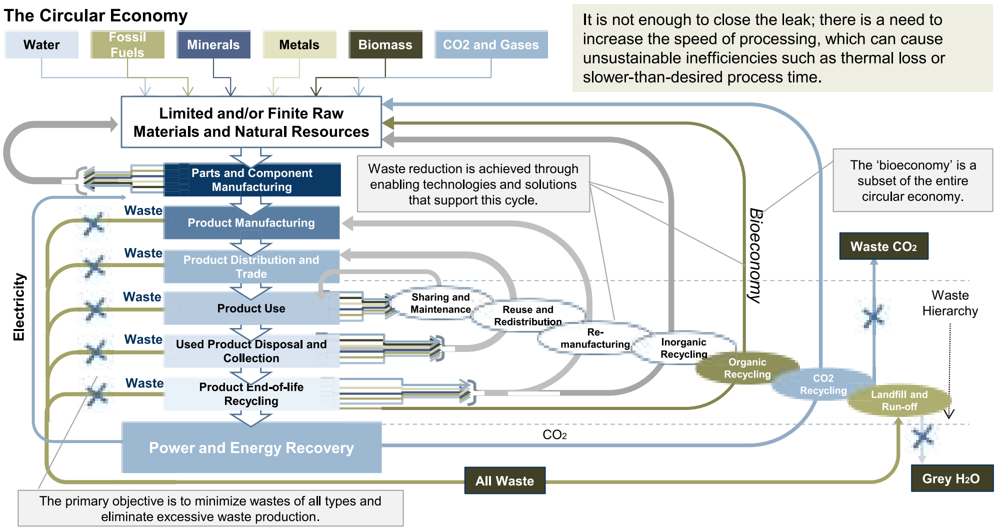
Source: Frost and Sullivan (2019) - 2019 Outlook of the Global Agriculture and Nutrition Industry - Adapting to Digitalization, Adopting New Business Models, and Searching for Palatable Meat Alternatives will Define the Agriculture and Nutrition Industry.

2.12. Agriculture & Nutrition Industry bioeconomy and generalized value chain



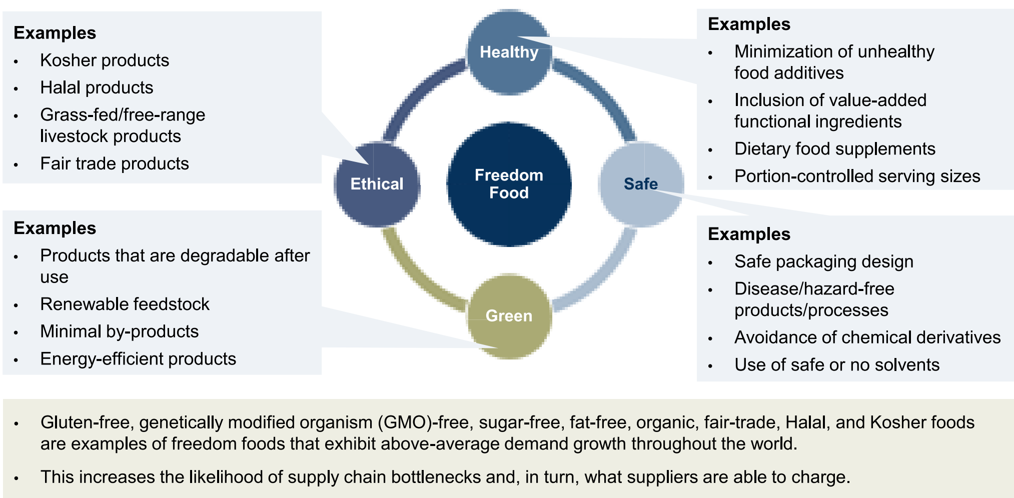
Source: Frost and Sullivan (2016) - Analysis of the Smart Agriculture Technology Market - Technology Integration in the Agriculture Ecosystem will Increase Production Yields and Drive the Technology Market.

2.13. Agriculture & Nutrition Industry Circular Economy: leaks and wastes



Source: Frost and Sullivan (2019) - 2019 Outlook of the Global Agriculture and Nutrition Industry - Adapting to Digitalization, Adopting New Business Models, and Searching for Palatable Meat Alternatives will Define the Agriculture and Nutrition Industry

2.14. Freedom Food consumer priorities



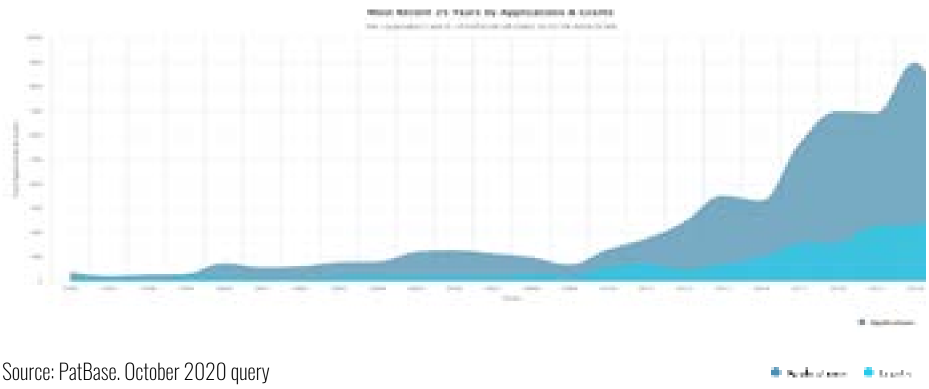
Source: Frost and Sullivan (2019) - 2019 Outlook of the Global Agriculture and Nutrition Industry - Adapting to Digitalization, Adopting New Business Models, and Searching for Palatable Meat Alternatives will Define the Agriculture and Nutrition Industry.

3
Patent analysis

3.1. Evolution of patents applied for and granted

The analysis of patents applied for and granted in the field of Smart Rural enables seeing a **growing tendency** over the last two and a half decades. In the specific case of rural technological industry, it is important to emphasise that, even though patent activity was practically inexistent in the 90's, the growth **as of the 2014** has been **exponential.**

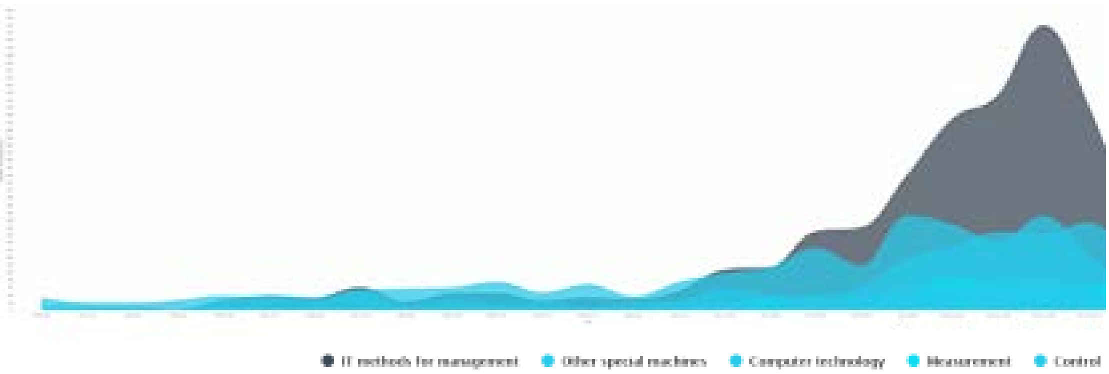
It is also relevant to note that, over this period, **28%** of patents applied for were finally **granted.** This figure is far from the fifty percent that leads to the conclusion that it is an area of **complex patentability.**



Source: PatBase. October 2020 query

3.2. Technological sector of the patents applied for

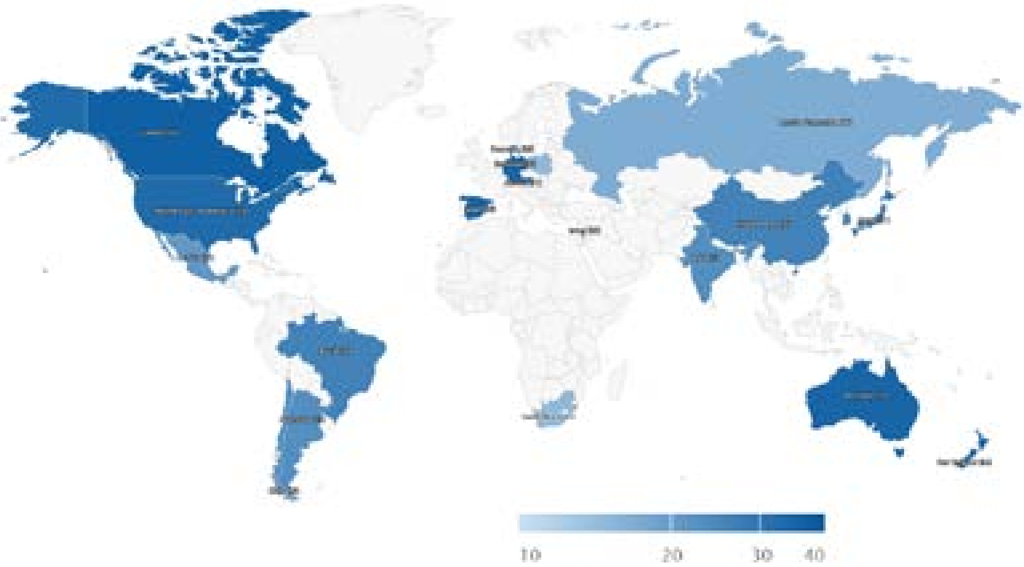
Over the last two decades, the most active technologies in patents applied for in this area mainly belong to the following fields: **IT management methods; other machinery; computer technology; measurement and control; and other** sectors.



Source: PatBase. October 2020 query

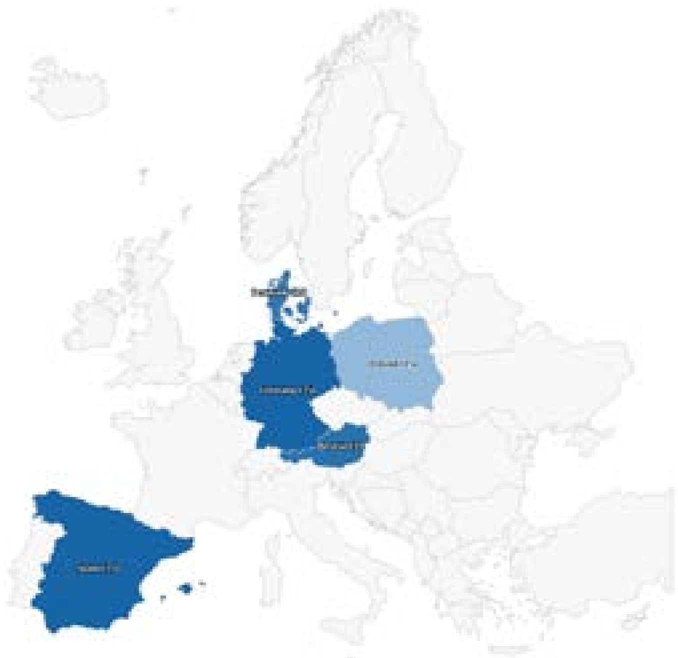
3.3. Territorial location of patents

On a **global level,** the regional offices leading the demand for patent applications over the last 25 years are the **United States and Canada,** followed by Australia, Germany, Spain, Brazil and Argentina.



Source: PatBase. October 2020 query

Within the **European Union,** the countries with most patent applications are, as shown on the map below, **Germany, Spain, Austria, Denmark and Poland.**

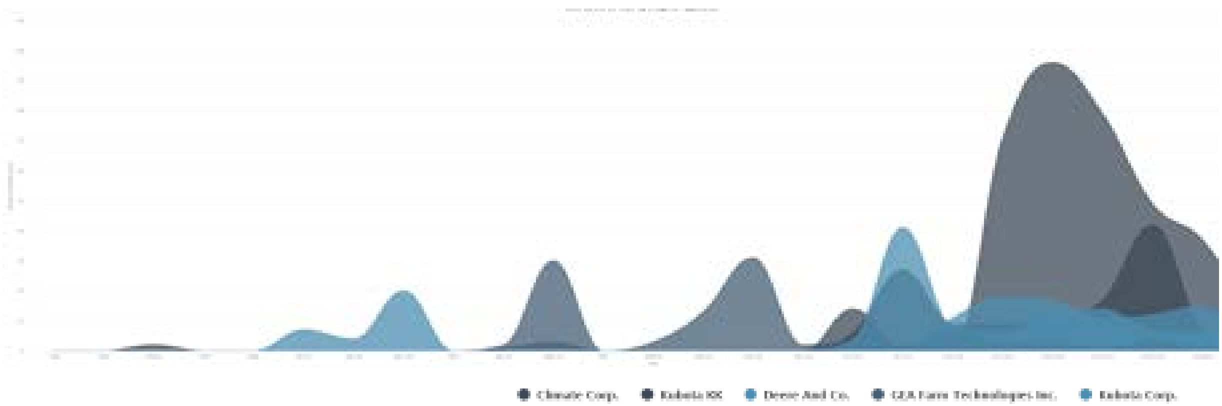


Source: PatBase. October 2020 query

3.4. Most active patent applicants

The graph below shows the organisations most active in patent applications since 1996, as well as the periods of time when these applications are more concentrated.

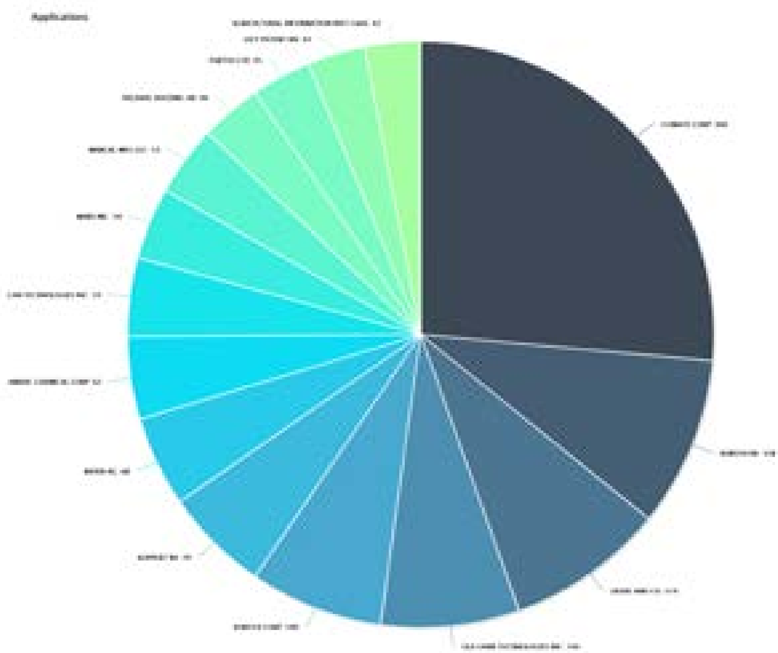
Outstanding, among others, are the following five: **Climate Corp, Kubota KK, Deere And Co, GEA Farm Technologies and Kubota Corp.**



Source: PatBase. October 2020 query

3.5. Other active patent applicants

The 15 **bodies** (companies, institutions or people) filing patent applications, including the **number of applications** for each one, are shown below.



Source: PatBase. October 2020 query

3.6. Keywords attributed to patents in this field

The main keywords associated with patent applications in the field of study are: **electronic systems and control technicians, various devices, and quality control systems for agricultural products, livestock and crops.**

Source: PatBase. October 2020 query

3.7. METHODOLOGICAL APPENDIX

The information provided in the "Patent analysis" section refers to the study performed on a sample of **6,076 patent applications** in the field of Smart Rural.

3.306
Patent family

Total number of families in this set of results

1.944
Family of patents granted

Total number of families with publications granted with this set of results

6.076
Applications

Applications with this result

7.576
Publications

Publications within this result

Source: PatBase. October 2020 query

Considerations about the method

• The source for this analysis is **PatBase**.

• The query was performed in October **2020.**

• The study was focused on **global** patent activity over the last **twenty-five** years, with special emphasis on **Europe.**

• The criteria used for the query to generate the sample were of **maximum scope** within the field. The query used **keywords** as well as field associated patent **kind codes.**

• In order to limit the sample to the "cybersecurity" field the main keywords used, among others, were:
- Agriculture
- Livestock
- Agritech
- Technologies applied to agriculture
- Information technology; Computer systems

• Furthermore it is important to note that in Europe, the computer programmes or **algorithms** are, per se, excluded from patentability. If they are patentable, they must be inventions that apply algorithms to **resolve** technical problems.

• Patent databases are organised using different **international classification systems,** the most common being the International Patent Classification (**IPC**) and the Cooperative Patent Classification (**CPC**) for more specific fields.

• The number of **IPC** or CPC codes in the Smart Rural field is very low, for this reason the research was extended by entering a keyword search.

Patent kind codes selected to obtain the sample

The sample included in this report was obtained by only considering the inclusion of **IPC** indexes. More specifically:

- Y02P60/00:
  Technologies relating to agriculture, livestock or agroalimentary industry

- G06Q 50/02:
  Agriculture; Fishing; Mining [2012.01]

- A01K29/00:
  Other apparatus for animal husbandry

hubb30.

AN ALLIANCE TO PROMOTE THE INNOVATION AT THE B30 AREA

www.hubb30.cat

An initiative of:

Parc de Recerca UAB

UAB Universitat Autònoma de Barcelona

eurecat Centre Tecnològic de Catalunya

Associació Àmbit B30

Universitat Politècnica de Catalunya BarcelonaTech

ALBA

esadecreapolis

Consell Comarcal del Vallès Occidental

Generalitat de Catalunya

ACCIÓ

sce

A project co-financed by:

Generalitat de Catalunya
Departament d'Empresa i Coneixement
Secretaria d'Universitats i Recerca

Unió Europea
Fons Europeu de Desenvolupament Regional

With the support of:

Diputació Barcelona