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Revolution 4.0: Industry vs. Agriculture in a Future Development for SMEs

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Keywords: agriculture 4.0; industry 4.0; SMEs; application research; supply chain; open source

1. Introduction

The Industry 4.0 approach permitted the creation of an environment in which all elements are continuously and effortlessly linked together. All devices (e.g., CPS, cyber-physical systems) and functionalities are addressed as services, which constantly communicate with each other, thus achieving a high level of coordination [1–4]. In this way, the ability to coordinate activities is essential for improved supply chain management, where optimization normally requires the contemplation of many elements in constant competition with each other [5].

In this innovative background, despite the advantages of industry 4.0 for large enterprises, small and medium-sized enterprises (SMEs) often face complications in innovative processes due to the continuous development in innovations and technologies [6]. Such condition makes it difficult to monitor enterprises, increasing also the complexity of which these processes can be implemented [7,8]. SMEs, such as industrial players, must work on improving their operations management (e.g., production control, planning and execution, operational performance measurement, and assessment) [9,10] and meet more complex customer needs [11,12]. In fact, SMEs are firms known for their flexibility and nearness to customers [13–16]. Their size ease communication and changes among employees, thereby enabling quicker reconfiguration in the event of change in demand. Though,

SMEs mostly have short-term strategies, which do not favor long-term investments, consequently they end up weak on investment capacity and working performance [11,17], with high costs in respect to large firms.

These innovations also affect small and medium farms, which must invest in advanced technology to keep up with the evolution. Starting from the differences between traditional industry and agriculture, there are already some critical and divergent aspects. Farming supply chains diverge in numerous aspects from the industrial sector [18]. In agriculture, the flow of products, knowledge, and information among agricultural stakeholders (producers and consumers) at each stage of the agricultural processes, marketing, and consumption [19]. Such relations in the industrial sector take place only in the presence of industrial districts [20,21]. Nevertheless, industry strongly manage its supply chains based on quantitative methods compared to agriculture. In fact, experience-based heuristic methods play a key role in agriculture where environmental exposure and stochastic events contribute a high degree of supply chain uncertainty and a lack of predictability in rural activities (e.g., soil and nutrient dynamics, photosynthesis activity or pest infestation) [18].

Existing approaches in agricultural supply chains try to take benefit of recent technologies related to the digitalization era, such as precision farming, which makes use of positioning technologies combined with the application of extra sensors and the collected data increasing the yield [22,23]. Technological solutions deliver significant influences towards transforming the challenges of agricultural supply chain management into opportunities. Simple technologies, e.g., Bluetooth, GPS (Global Positioning System), or RFID (radio frequency identification), combined with the communication among operators and agricultural machinery at all levels of collaboration, make it conceivable to create a self-optimizing agricultural supply chain structure [23]. Fixed in an innovative agricultural management platform, these technologies can be easily organized and used by all involved stakeholders without committing to major investments. However, a modern farm produces data and, therefore, it requires interpreting them. Nevertheless, to digitalize the agriculture business, new technologies and software cannot solve all trials of the digital transformation along the supply chain [19,24–26]. Infrastructure, training and qualifications, an adequate structural and legislative operating environment, and willingness to implement new technologies are also decisive [19]. For Agriculture 4.0, a modern telecommunications infrastructure in rural areas is indispensable. Furthermore, the ability to apply data along the agricultural supply chain will prove indispensable for a fruitful revolution of existing agricultural processes towards farming during the Industry 4.0 period [27].

Given these traditional divergences, this work makes a reflection on the 4.0 era for industry and agriculture, reflecting mainly on the efforts and opportunities that are available to SMEs, with recent technological change. With the 4.0 revolution, the challenge is to rethink the current concept of the supply chain in the different sectors and processes that can be managed both internally (e.g., vertical integration of processes) and externally (e.g., horizontal integration of processes, in collaboration with external partners along the entire supply chain, such as farmers, wholesalers, and retailers). Furthermore, the specific challenges facing agriculture along the farming supply chain will be explored following the Industry 4.0 guidelines. Industry 4.0 approaches can be improved and be pertinent to the agricultural sector; however, industry is developing faster than agriculture since the fact that already today experts talk about Industry 5.0. On the other hand, the 4.0 revolution in agriculture is still limited to a few pioneering firms. For this reason, this review deals with how technological development affects these two (different) economic sectors envisaging their future advances and offering some potential suggestions.

The present work begins by explaining how the industrial sector has evolved over time, passing from the first industrial revolution to the present-day. Nevertheless, this work aims to compare the industrial revolution with the primary sector, viewing whether agriculture has been able to keep up with the times. In this sense, a virtualization of an agro-food supply chain helps to understand how current agricultural processes can be structured with new technologies. Furthermore, revolution

from 4.0 to 5.0 in both industry and agriculture is dealt with, focusing on Agriculture 4.0 progress in recent years.

2. Industrial Revolution

Digital technology offers innovative benefits for the economic business [19]. In industry, the first revolution began around 1780 with the introduction of mechanical production plants powered by liquid water or steam (Figure 1). The second industrial revolution was born 30 years later when the first mechanical assembly line powered by electricity was built: the era of mass production had begun. The third industrial revolution began in the late 1960s when the first programmable logic controller (PLC) was built. From that moment on, it was possible to automate production using electronics and information technology (IT) [28].
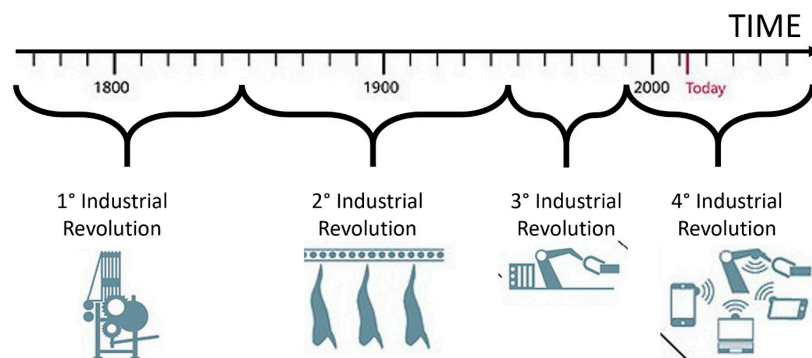

**Figure 1.** From Industry 1.0 to 4.0. Source: own elaboration.

The fourth industrial revolution began in 2011 in Germany with a German government project to promote deep computerization and conceptual innovation of production [29]. In these few years, German firms (and not only) have transformed the theory (born during the Second World War) into successful applications [30]. The fourth industrial revolution is today's and makes use of cybernetics [31–34]. The elimination of the separation among the physical and the virtual world is an essential pattern of the Industry 4.0 [19]. The concept Industry 4.0 is a "collective" term that brings together technologies and typical concepts of the "value chain" [35]. Industry 4.0 connects machines, work, and systems in general through intelligent networks (as the Internet of things) [36,37], created along the entire value chain, which can control themselves autonomously and each other [38,39].

Based on these premises, the virtual object structure is linked to the Internet of Things (IoT) concept. In industry, as also in agriculture, the IoT combines the concepts of "Internet" and "thing", which can be explained through some key features of the IoT, that are: interconnectivity, object-related services, heterogeneity (due to varied devices in the IoT), dynamic changes (since device status can change with dynamism), and high scalability (Table 1).

The IoT can therefore be semantically defined as a worldwide network (World Wide Network) of uniquely addressable objects interconnected through standard communication protocols (Figure 2). Consequently, the Internet serves as a storage and communication infrastructure that contains a virtual representation of things that connect relevant information with physical objects. Virtual objects act as central object information hubs, combining and continuously updating data from a wide range of sources. Virtual objects can be used to coordinate and control business processes remotely via Internet.

Table 1. Key features of the IoT.

Interconnectivity	Everything can be interconnected with global information and communication infrastructures.
Object-related services	The IoT can provide object-related services, within the limits defined by objects such as privacy protection and semantic consistency between physical and associated virtual objects.
Heterogeneity	Devices in the IoT are heterogeneous as they are based on different hardware platforms and networks. They can interact with other devices or service platforms across different networks.
Dynamic changes	Device status can change dynamically, such as connection and/or disconnection, as well as the context in which devices operate, including location, speed, quantity of product, etc. The device's status can also change dynamically. The number of devices can also change dynamically.
High scalability	The number of devices that need to be managed and that communicate with each other can be extremely large.
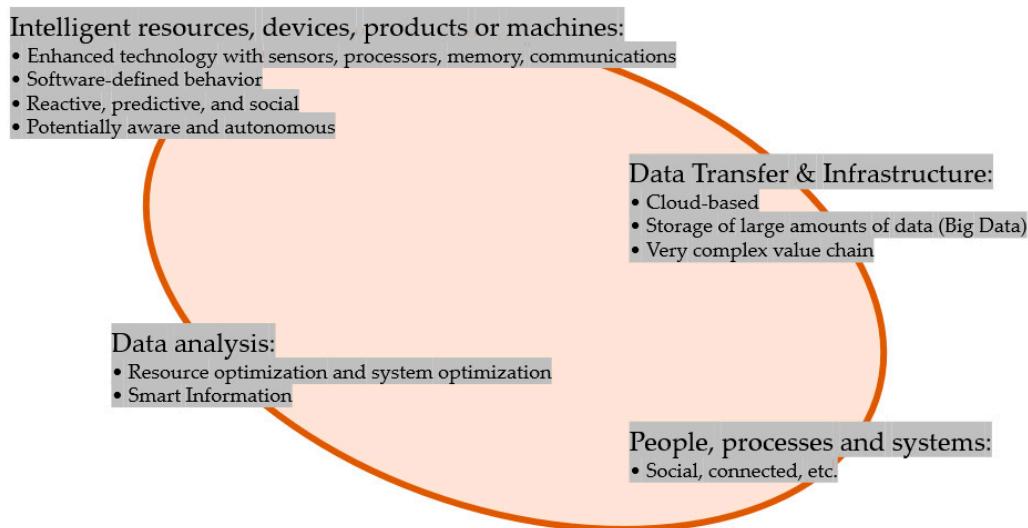
Figure 2. Agriculture 4.0 and the Virtual Object Structure.

Cyber-security, cloud computing, big data, open source technology, and digital twins are some of the most current concepts that were introduced by 4.0 revolution [2,31,35,40,41]. Highlighting the application of the Industry 4.0, several governments proposed some advanced initiatives around the world, e.g., the Nouvelle France Industrielle in France [42], the Made in China 2025 initiative [43], and the Smart Manufacturing Leadership Coalition in USA [44,45].

3. Concept of Agriculture 4.0

Based on concepts such as Internet of Things, the Industry 4.0 in the primary sector is defined Agriculture 4.0 (or Farming 4.0) and its methods have been examined in some rural areas [19,28,46,47]. Correspondingly, revolutions in agriculture can be hypothesized, which have gone hand-in-hand with the innovations in the industrial sector in recent years. Agricultural technology revolution started with Agriculture 1.0 with animal power; then the combustion engine defined Agriculture 2.0, passing to Agriculture 3.0 in recent years with guidance systems and precision farming, starting when military GPS-signals were made accessible for public use [23]. Nowadays, Agriculture 4.0 farm activities are connected to the cloud. Though, following European agricultural machinery in 2017, the next step with Agriculture 5.0 includes digitally-integrated enterprise, which rely their production processes using robotics and some forms of artificial intelligence.

The Agriculture 4.0 evolution happens in parallel with comparable evolutions in the industrial sector (Industry 4.0), based on an idea for future manufacturing. Agriculture 4.0, like to Industry 4.0, stands for the combined internal and external interacting of farming operations, offering digital information at all farm sectors and processes. Even in agriculture, as in the industrial sector, the 4.0 revolution represents a great opportunity to consider the variability and uncertainties that involve the agri-food production chain [48–51]. Factories become smarter, more efficient, safer, and more environmentally sustainable, due to the combination and integration of production technologies and devices, information and communication systems, data and services in network infrastructures [27,28]. A Smart Farm must be able to adapt autonomously and in real-time to these changes in order to remain competitive on the market [26,52]. One of the primary needs to be met is a constant communication between market and production, and within the business itself [24]. The methodology used to effectively connect all the actors of this continuous and data-rich communication [53] is that of virtualization (Figure 3).
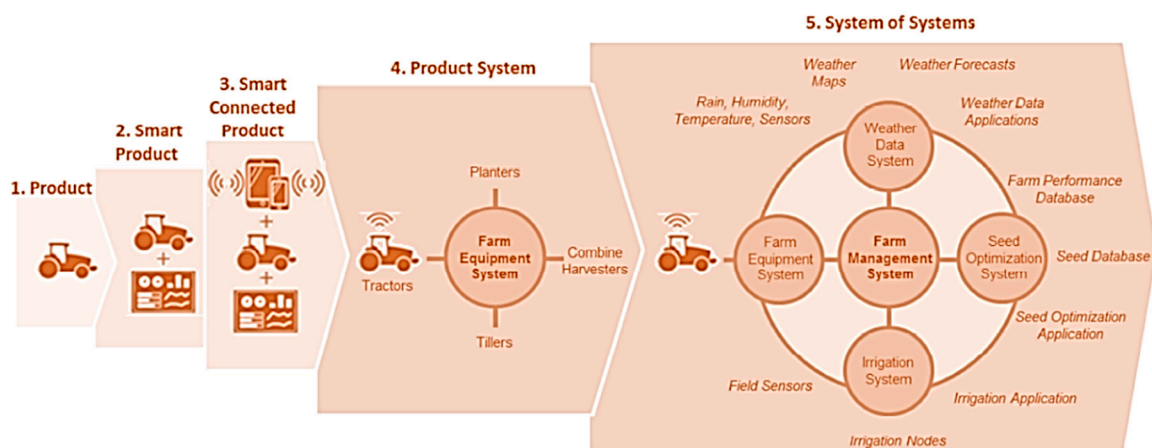

Figure 3. Agriculture 4.0. Source: own elaboration.

Among the benefits, this recent rural revolution permits (i) to realize more efficient systems that operate in conditions of greater safety both for the environment and operators, and (ii) to reduce the operating costs of the processes, e.g., allowing the realization of more complex processes at equal costs [23,54–58].

Virtualization of an Agro-Food Supply Chain

The virtual term is opposed to the real and physical terms. Virtualization allows to cancel some important limits of physical reality: (i) place, since virtual representation does not require on-site presence to observe, process, control and act accordingly; and (ii) time, since the representation of real objects in a virtual world allows not only the historicization of data but, above all, to simulate possible evolutions in the future and to imagine answers to extreme external stimuli to carry out sensitivity tests (e.g., to verify the effects of sudden, even if temporary, machine downtime, lack of raw materials caused by adverse local climatic events, etc. [59]) (Figure 4).

Applying the same concepts to different realities, virtual reality permits to create virtual environments with a virtual team (as a virtual work place where the actors of the production process collaborate) and a virtual reality. It aims to create a virtual environment that must be perceived by human beings as real through interfaces that allow to simulate visual, auditory, and tactile experiences. In this sense, virtual organization emerges as dynamic organizational structures that temporarily bring together resources from different organizations to better respond to business opportunities. While virtual objects define physical entities, e.g., products and resources, which are accompanied by a rich virtual counterpart, accessible at the global level, which connects all current and historical relevant information, about the properties of the object itself, its origin, the sensory context, etc.
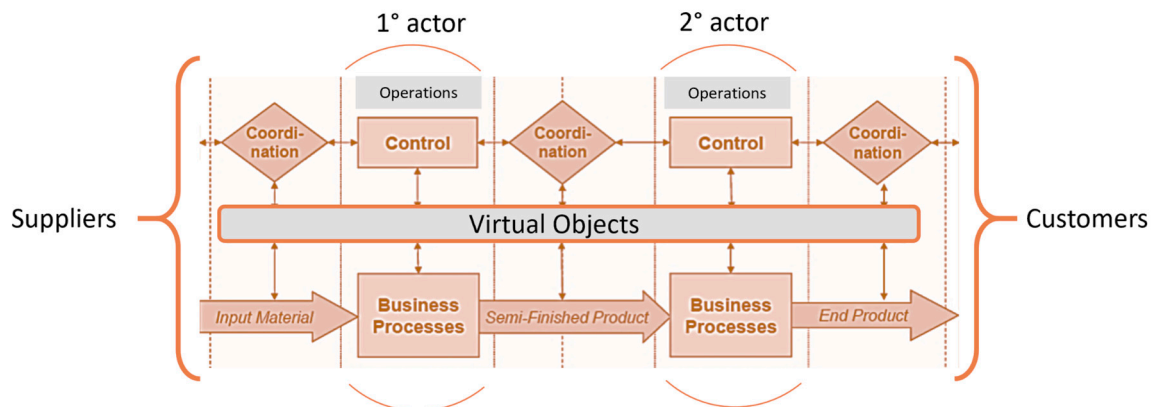
Figure 4. Virtualization of a supply chain management through the Internet of Things (IoT). Source: own elaboration.

The constituent elements are products (inputs, such as pesticides and fertilizers, mature agricultural products, harvests, shipments and orders, packaging, any ingredients for processing) that flow between transformations and actors (e.g., agricultural producers, product processors, traders) (Figure 5). In the Internet of Things (IoT) all kinds of devices-smart objects-are connected and interact with each other through local and global, often wireless network infrastructures [60–63]. Therefore, precision agriculture results to be the most recent discipline of this development as an important driver for Big Data [23,26,64,65]. Radical changes in farm management can be expected due to the access to clear information and decision-making abilities that before were not possible [66]. Consequently, farms have evolved, and each rural activity will transmit data via wireless transfer technology [23,26,64,65].
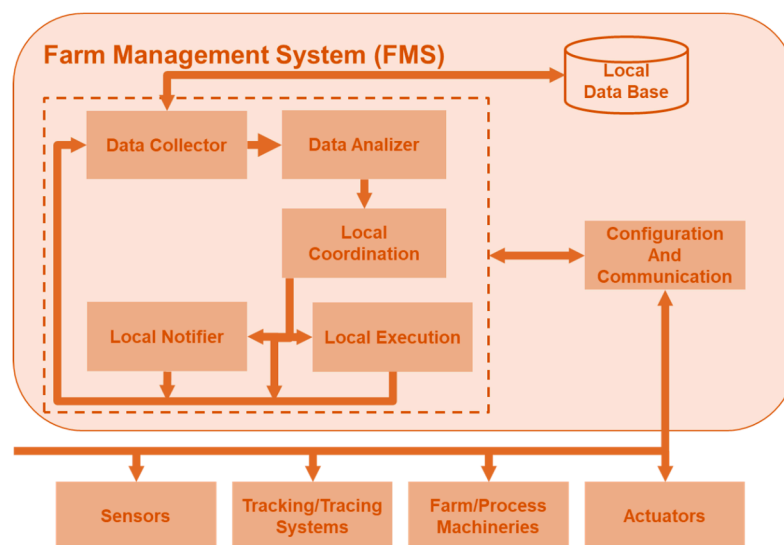

Figure 5. Agriculture 4.0. Structure of a management system (FMS) by virtualization of an agri-food chain.

The technical equipment of farms has reached today a comparable level to that of industries. The developing use of data announces a digital agricultural revolution in agriculture driven by several innovations [48,67]. Advances in robotics have permitted a greater automation [26,68] and the decreasing cost of sensor technology has allowed farmers to monitor factors, e.g., soil proprieties and animal movement in almost real-time circumstances [68]. Accessible and affordable computing power in this condition has created new decision support tools (e.g., on-tractor dashboards and mobile applications) for a better management practice [69–71]. Emerging Big Data analytical platforms, e.g., cloud computing and machine learning algorithms, drive artificial intelligence [26,71–74] and

have supported a relevant growth in the volume, velocity, variety, and veracity of data generated in agriculture [26,75,76]. Subsequently, agricultural data are quickly providing a main driver not only of revolutions in output and the food chain, but also in environmental management [67,75]. Agriculture 4.0 technologies refer to production systems that deploy robotics, sensors, and Big Data analytics allowing farmers to manage their farms at detailed spatial and temporal scales [26]. Though precision agricultural technologies have been in use for about a decade and normally take the form of yield monitors in cropping systems and robotic milking parlors for dairy, the step of innovation has picked up since the cost of sensors and robotics has fallen [67].

Nevertheless, the high mobility of production facilities makes planning and control more difficult since the surrounding conditions are not always clear, and communication is often inconsistent due to the low availability and bandwidth of wireless connections. The wireless technologies result to be the most convenient solution in terms of power consumption and communication range in agriculture [23,26,64,65,76,77]. Particularly, narrowband-IoT (NB-IoT) is a new IoT system constructed from existing Long-Term Evolution (LTE) functionalities [78]. The NB-IoT enables the interconnection and communication among ordinary objects through many applications in many domains, such as industry-focused applications (e.g., supply chain management, transportation, and logistics) and environment-focused applications, such as in agriculture activities [79]. The design goals of NB-IoT cover high coverage area, extended battery life (about 10 years), high network size (52,000 devices/channel/cell), and low-cost devices [80]. In the future, NB-IoT technologies will take place in agricultural applications due to low power consumption and will be used when the agricultural information is to be communicated over long distances [79].

Another key differentiator among agricultural and industrial supply chains is the amount of the division of work (rationalization effects in the industrial production vs. the small division of labor/workforce in a family environment in agriculture). Furthermore, employees in the industrial sector are highly specialized in their skill levels, while farmers carry out a great variety of responsibilities.

4. Revolution from 4.0 to 5.0: Industry vs. Agriculture

Through a literature review, Industry 4.0 and Agriculture 4.0 appeared very recently in literature (Figure 6). A wide-ranging literature, including proceedings paper, articles, editorial material, book chapter, review, book) was carried out from a scientific database (Web of science) related to knowledge sharing, transfer and flow. However, there is a gap among these two terms. Industry 4.0 is strongly cited from 2014, while Agriculture 4.0 is only recently quoted. The most examined suggestions derived from the field of manufacturing e.g., details of the new production methods [80–83], combination of firms, suppliers, and customers [34,84,85], logistics processes [86], lean production [87,88], qualified workers [89], and new managerial practices [90]. Among these contributions, Industry 4.0 also refers to SMEs [91] since Industry 4.0 characterizes a greater challenge due to the reduced size and SMEs are also recognized in a different cluster of studies [92], while recent articles on agriculture 4.0 dealt with digital transformation and environmental attention [47,50].

Less than a decade has passed since the literature started talking about Industry 4.0, which is already moving towards the next revolution: Industry 5.0 [93–95]. While the current revolution emphasizes the transformation of factories into intelligent IoT-enabled structures that use cognitive processing and interconnection via cloud servers [37,40], Industry 5.0 focuses on the return of human hands and minds to the industrial environment [93,96].
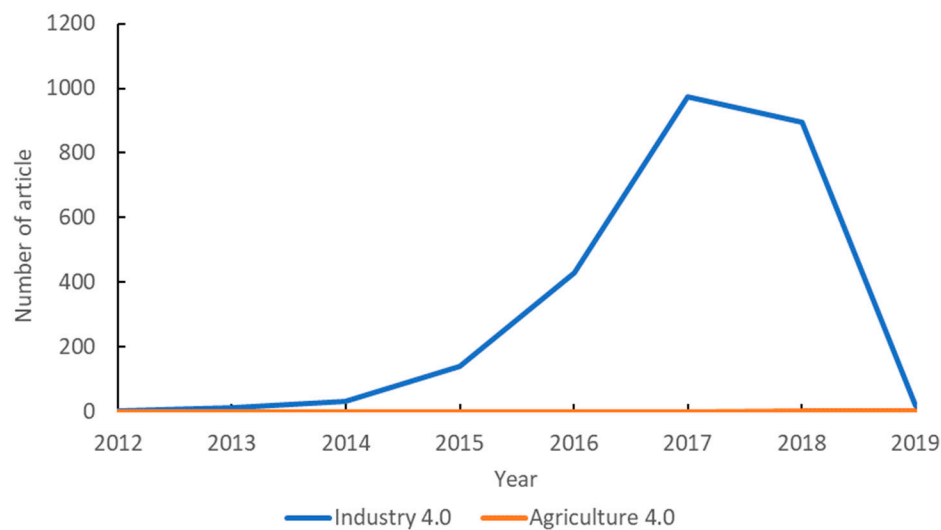
Figure 6. Number of scientific works published year-wise. Source: Own elaboration.

The transformation of the modern industry into a smart chain is the keystone of the industry of the new millennium. No matter how quickly or slowly some firms implement the Industry 4.0 or 5.0 models, the basic principles will undoubtedly determine the world of production of the future [95] Firms that properly implement these new principles will experience significant growth with the capabilities provided by IoT devices, computer systems, and cognitive computing [97,98].

In a few years' time, factory workers and robots may end up working together on the design and sharing of workload across a variety of manufacturing processes [99–101]. While robots are excellent for producing standard products in standardized processes in a high volume of production, customizing each individual product can be a challenge where robots need to be guided [102]. Therefore, it is essential to maintain human contact within production processes. In production processes, automation can only be exploited to its full potential when there is a spark of human creativity that influences the processes: collaborative robots or "cobots", working with people [103–105].

The major advances, expected from Industry 5.0, concern the interaction between machinery, Iot, and people, which is expected to take production to new levels of speed and accuracy [103]. As artificial intelligence improves, the interaction among computers, robots, and workers will eventually become more significant [102,103]. As technological innovations become faster and faster, revolutions could eventually follow one another in rapid succession over the next 10 years. While the first three industrial revolutions took decades, today's revolutions only last until industrial implementation is complete [106].

The fourth industrial revolution allows firms to combine productivity and speed to respond to the market, making the system more productive and competitive. It is evident that those, who do not take this path, risk being excluded from global competition.

Agriculture 4.0 Progress

The first 4.0 project ("Fabbrica 4.0") in Italy was launched by Confindustria (the largest national association of industries) in 2014. The aim was to promote a better information on possibilities that digitalization can offer to current industries. Additionally, the Minister of Economic Development has stated "Industry 4.0" as an area of strategic investment in a recent paper about the Italian situation on the industrial digitalization.

A 5.0 revolution represents the immediate future in the industrial sector [94,103]. How far is Agro-Food Industry from Industry 4.0 (and 5.0)? Digital investment in the agricultural sector in Italy is still limited. In this context, the Smart AgriFood Observatory wants to become the reference point in Italy, with the aim of understanding digital innovations (e.g., on process, infrastructure, applications)

that are transforming the agricultural and agri-food chain, unifying the main skills needed (e.g., economic-management). Its aim is to convey the research results to decision makers, offering (i) opportunities for meeting and discussion among stakeholders to promote dialogue and innovation of value, and (ii) culture, spreading information and knowledge about digital innovation in the supply chain. According to the findings of the Polytechnic of Milan with its Smart AgriFood Observatory and the Rise Laboratory of the University of Brescia, there is a slight growth as several small and medium-sized Italian firms are adapting 4.0 technologies. These firms are supported by the innovative drive of about 500 international start-ups Smart AgriFood, born since 2011 and of which 60 of them are Italian.

The fusion of precision agriculture and the Internet of farming leads to Agriculture 4.0 (or digital agriculture), which interconnects different technologies aimed at improving yield and sustainability of crops, increasing working conditions, and the quality of production and processing. Additionally, the development of Agriculture 4.0 is good not only for farms but also for sustainable development [27]. In fact, the cross-analysis of environmental, climatic, and cultural factors allows to establish the irrigation and nutritive needs of the crops, to prevent pathologies, and to identify weeds before they proliferate; consequently, it is possible to intervene in a targeted way, saving material and temporal resources and carrying out more effective interventions, which have a positive impact on the quality of the finished product.

The benefit is, therefore, both qualitative and quantitative. On the one hand, the farms achieve a saving on production inputs of 30% with an increase in production of 20%, and on the other hand, they have obtained products of higher quality without any residue of chemicals. Thanks to these technologies, it is, in fact, possible to establish the most appropriate time for harvesting and manage it, if necessary, in several phases, to capture the product at the most suitable time depending on the use that will be made along the supply chain. It is precisely by exploiting these data along the supply chain that the greatest value of Agriculture 4.0 is grasped. It is conceivable to trace and certify products from the field to the processing industry, set up short supply chains, obtain products of the highest quality, and create efficiency not only in the production processes, but also in those of the exchange of goods and information among the different actors in the value chain.

Agriculture 5.0 predicts the attendance of autonomous systems in rural environments. With a view to further technological development, advances in autonomous driving technology for cars, including object detection capabilities through multi-camera systems, and radar and lidar technology, have already reduced the cost of developing autonomous agricultural machinery [107–109]. For some farmers, self-driving equipment is already a reality and is not limited to large agricultural machinery. Robotic milking machines are widely used [102,110–112]; many of the field operations can be automated, but the harvesting of horticultural crops and fruits in some geographical areas, even in advanced countries, depends largely on manual labor [113]. There is also interest in smaller tractors and robots working in groups in a swarm-like action. Development of an integrated system with self-learning capabilities to achieve a high degree of autonomy in its functions e.g., automatic course recognition and tracking of operational boundaries, autonomous driving in safety and swarm-robotics [114]. The collaboration among several ground rovers and small air drones with specialized roles and other agricultural vehicles that "talk" and collaborate with each other while they are in constant communication [102].

A greater interaction with the environment passes not only through the sense of sight, but also through the sense of touch, the real keystone to ensure a high adaptability of the machine to environmental changes. The use of force sensors, for example, allows the latest generation of robots to manipulate fragile objects or objects of variable shape. The manual operator transforms from a simple conductor of the plant to a conveyor of experience and knowledge. The use of virtual reality is significant to be able to "immerse" completely in the simulated machine, both during the design and programming, set-up and use phases.

By combining collaboration, artificial vision, touch, sensitivity and adding even a minimum of decision-making skills, surprising results can be obtained following the trend towards increasingly greater autonomy [114]. The latest generations of vision systems, for instance, not only have real-time object tracking capabilities, but have already acquired classification and conceptualization capabilities, so they are able to self-learn figures and objects, to distinguish them based on details by placing them in different categories.

5. Discussion and Future Implications

The fourth industrial revolution allows firms to combine productivity and speed to respond to the market, making their system more productive and competitive. However, those who do not take this path risk being excluded from a worldwide competition.

Thanks to agriculture 4.0, many technologies make it possible to accomplish smart farms. However, their acceptance by individual farmers depends on several additional factors, such as usability and the identification of best practices. Both an agricultural and a farmer-centered approach are needed. Only in this way will the concept of smart farming prove sustainable for the future. The importance of a change in the mindset of farmers is crucial to activate an effective and sustainable production system that will last in the long term [24,27]. Instead, these notions are the basis of a competitive industry.

Considerable research effort has been spent on the development of models in the agricultural sector. However, the application of innovative models to individual farms is limited, despite the many advantages that smart agriculture could bring; the way in which these could be achieved within the dimensions of productivity, profitability and sustainability remains unclear [24]. An adequate structural and legislative operating environment through new technologies, training and qualifications is decisive for Agriculture 4.0 [19] and a possible Agriculture 5.0. Policy makers need to launch calls for proposals to further promote start-ups based on these technologies and even to support SMEs to invest in these technologies (i) to keep up with the coming technological revolution, and (ii) to be competitive and at the forefront of other economic realities [6]. Moreover, a training process must be planned to lead to effective solutions for farms, responding to the needs and interactions of the operating contexts of farmers. The ability to apply data along the agricultural supply chain can permit a productive growth of existing agricultural processes towards innovative farming.

By highlighting strategies to Industry 4.0 or Agriculture 4.0, it is indispensable for SME managers to understand how approaching to innovation and which advantages can be derived [43]. Especially the positioning as user and/or provider strongly impact on SME business models. Several restrictions concern methodology and findings, especially considering Agriculture 4.0. Revolution 4.0 offers a new background for studying the diffusion of economic boundaries, allowing future researchers to deliver generalizable fallouts as to how firms transfer or extend their business models from manufacturing to ICT (Information and Communications Technology), and vice versa [91].

The processes being pursued by industry are also influencing the food production process in agriculture. Recent industrialization of the agricultural production process has led to major environmental concerns, e.g., soil degradation, erosion, compaction, and pollution [115,116]. This translates into a loss of soil quality and of the eco-systemic services that the soil has guaranteed us over time [117–120]. Some evidence of this dramatic situation of soils can be found in different parts of the world, offering some potential solutions [116,118–122]. Understanding how industrial techniques are managing agriculture has resulted in soil degradation that should be updated. In this sense, the 4.0 revolution should include not only technological innovation but also environmental issues [121,122]. In this sense, United Nations objectives include economic sectors as both responsible and useful actors for sustainable development [123]. Therefore, natural resources, e.g., soil, in the primary sector must be treated in accordance with sustainability criteria in order to advance towards increasingly sophisticated technological development [124–127].

6. Conclusions

The recent debate about innovation reveal that the economic sectors differ among them. This review permits to explore and reflect on the current state of art, comparing agriculture and industry. While industry 4.0 is, today, very advanced, both from the scientific and research standpoint and from the practical attitude, since many firms apply it, Agriculture 4.0 is still restricted and put off in theory. Furthermore, the future of industry is progressing towards a 5.0 industry, while the primary sector is still inadequate. The 4.0 revolution in agriculture is still limited to rare pioneering firms. For this reason, this work suggests to policy makers and decision makers to invest on technological progress and offer to all the economic sectors (e.g., industry and agriculture) different ways to promote innovative and even sustainable development following United Nation Sustainable goals [123]. In such a background, Industry or Agriculture 4.0 can offer numerous advantages for large enterprises, while SMEs often face difficulties. For this, policy makers should offer policies or calls for proposals, supporting a technological and advanced enlargement of SMEs [13–17,91], making them more competitive in the marketplace.

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