Chapter 1

The Fourth Industrial Revolution and Precision Agriculture

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Additional information is available at the end of the chapter

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Abstract

The Fourth Industrial Revolution will see the convergence of artificial intelligence and data technology as a new solution to address industrial and social problems across the globe, by integrating cyber and physical fields. The Fourth Industrial Revolution will send a ripple effect of far-reaching repercussions throughout the labor-intensive field of agriculture. Combining artificial intelligence and big data will evolve into a high-tech industry that operates itself. These technologies allow for precision agriculture, such as yield monitoring, diagnosing insect pests, measuring soil moisture, diagnosing harvest time, and monitoring crop health status. In particular, the Internet of things (IoT) will measure the temperature, humidity, and amount of sunlight in production farms, making it possible for remote control via mobile devices. It will not only boost the production of the farms but also add to their value.

Keywords: Fourth Industrial Revolution, precision agriculture, sensing

1. Introduction

The key phrase used at the World Economic Forum (WEF)[1] was the Fourth Industrial Revolution. Klaus Schwab, founder of the WEF, argued that the Fourth Industrial Revolution has already arrived. He argued that the pace, scope, and influence of social changes that follow the Fourth Industrial Revolution will be entirely different from previous revolutions.

[1]The World Economic Forum, better known as the Davos Forum, is a Swiss nonprofit foundation, based in Cologny, Geneva. Recognized by the Swiss authorities as an international body, its mission is cited as "committed to improving the state of the world by engaging business, political, academic, and other leaders of society to shape global, regional, and industry agendas." The Forum is best known for its annual meeting at the end of January in Davos, a mountain resort in Graubünden, in the eastern Alps region of Switzerland (from Wikipedia, accessed July 30, 2017) [1].

The Fourth Industrial Revolution, or 4IR, refers to the oncoming revolutionary era in which information and communication technology (ICT) will converge. The revolution will spark new technological innovations in six areas: artificial intelligence, robotics, Internet of things (IoT), unmanned vehicles, three-dimensional printing, and nanotechnology. The 4IR will include a variety of new technologies that use big data to incorporate the physical, biological, and digital worlds in a way that will affect all sectors of life.

One example of the 4IR is online to offline, or O2O, which integrates the physical and digital worlds. O2O can use smart watches that obtain real-time information from patients and confer it to integrated computer data. Other examples of the 4IR include virtual reality (VR) and augmented reality (AR).

4IR technologies have the potential to connect billions on the web, dramatically improve business organizational efficiency, and improve the natural environment through improved asset management.

The 4IR will become a new innovative division of life that will replace human intelligence and wisdom, combining artificial intelligence with robotic technology as a substitute for labor.

General Electric (GE) is a typical example of the 4IR occurring in the present. GE, originally a lighting company, has merged into the domains of electrical equipment, televisions, computers, home appliances, generators, and even medical equipment and aircraft engines. Already successful in previous fields, GE is now the top aerospace manufacturer as well.

Adopting the concept of the 4IR, GE created a new revenue model that surpassed the sales of all other aircraft engine manufacturers. Mounting sensors on aircraft engines was their key to success. The in-flight sensors connect to ground data centers and send more than 300 different values of real-time information to and from the aircraft. Data sent includes engine conditions, weather conditions, and fuel efficiency. These transmissions allow the ground centers to analyze the data and return an optimized flight path to the aircraft in real time, reducing fuel usage and saving an estimated two billion dollars per year. In addition, the sensors monitor the safety status of the aircraft in real time, anticipating abnormal conditions and dramatically reducing accidents and inspection costs, allowing airlines to improve security as well as operational safety.

The 4IR is developing in every sector of life, not only in telecommunications, automobiles, energy, manufacturing services, security, and bioenergy but also in the fields of medicine and robotics. The 4IR is now being commercialized in a variety of endeavors, including the Google Car, Amazon's Drone Delivery system, and Dr. Watson: an AI doctor. One of the ways in which the 4IR is expected to approach new problems is in the field of agriculture.

National policies related to the 4IR, based on global trends, are being implemented across the planet. The following chapter foretells changes coming to agriculture and preparations required in the field of science and technology in regard to the 4IR.

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2. The Fourth Industrial Revolution and agriculture

Over 200 years ago, more than 90% of Earth's population was engaged in agriculture, but now more than 80% of the populations of OECD major countries are engaged in the service industry. The population engaged in agriculture, at present, is merely 2–3%. Not only has the population involved in agriculture been reduced, in most developed countries, the age of individuals in farming households is increasing as well. In the Republic of Korea, more than 50% of the population of farm households is over 60 years old, and over 40% is over 65. The population of workers around the globe has shifted from agriculture to manufacturing and manufacturing service industries. Thus, in the current world economy, only 5 % of the world's population works in agriculture, yet it accounts for more than 60% of the world's business [2].

Accepting this reality, developed countries such as the USA and Japan are trying to solve agricultural issues through mechanization, automation, and modernization. The 4IR will serve as the opportune time to accelerate the scale and commercialization of agriculture.

In response to this trend, future agriculture is expected to evolve into high-tech industries where systems are coupled with artificial intelligence[2] and big data[3]. The systems will converge into a single unit in which farm machinery, seeding the soil, farm management, production forecasting, and irrigation are combined. Using the core technology of the 4IR, robots, big data, and AI will combine with agriculture to create a new era of superfusion. The era will evolve multifaceted economic, social, and ethical values fused with various industries and expressed in business models [3].

There are three means by which the 4IR will have a major impact on the agricultural sector. First, precise optimization will solve many current problems in agriculture. Agriculture is a representative industry in which inputs and outputs are inconsistent. In terms of worldwide food production, enough food is produced for the entire population, yet 30–50% of produced food is discarded, while many die of starvation. About 80% of the water on the planet is used for agriculture, yet only 20% of viable crop is grown, and the remaining unused surplus is discarded. In the UK, the use of nitrogen fertilizer resulted in blue disease. Each of these problems can be solved via precision agriculture. Precision agriculture,[4] a method by which

[2]Artificial intelligence (AI) is intelligence exhibited by machines. In computer science, the field of AI research defines itself as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of success at some goal. Colloquially, the term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving." As machines become increasingly capable, mental facilities once thought to require intelligence are removed from the definition (from Wikipedia, accessed 30-07-2017).

[3]Big data is a term for data sets that are so large or complex that traditional data processing application software is inadequate to deal with them. Big data challenges include capturing data, data storage, data analysis, search, sharing, transfer, visualization, querying, updating, and information privacy. Lately, the term "big data" tends to refer to the use of predictive analytics, user behavior analytics, or certain other advanced data analytics methods that extract value from data and seldom to a particular size of data set (from Wikipedia, accessed 30-07-2017).

[4]Precision agriculture (PA) or satellite farming or site-specific crop management (SSCM) or precision agriculture is a farming management concept based on observing, measuring, and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define a decision support system (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources (from Wikipedia, accessed July 30, 2017).

growth and soil conditions are calculated in order to accurately manage crops, can solve the problem by constructing an optimized agricultural system that connects production, distribution, and consumption.

Second, the reversion of rural production elements, including human resources, will have a major impact on agriculture. Capital, labor, and technological resources that left farming villages in previous generations are likely to return during the 4IR. This is because the workforce of cities will find that rural areas provide the only labor that gives time for rest and relaxation.

Third, 4IR technologies will have a significant impact on weather-related problems. Agriculture is heavily affected by the weather, and currently science has no means by which to accurately predict and control it. Hence, we say that we are fellow farmers with God. For this reason, farming is highly dependent on intelligence and wisdom, including human experience, and thus it is difficult to standardize. 4IR technology can make decisions that surpass human wisdom and experience. It will solve certain problems that cannot be solved with current technology, such as livestock odors, the cost of too much processing, and the likelihood of pest occurrence due to climate change. So, the 4IR can be seen as an "agro-friendly" revolution, unlike our current revolution. At the same time, it will lead to greater technological innovations and far-reaching changes throughout the economy, society, and life.

3. The Fourth Industrial Revolution and changes in agriculture

The agriculturally friendly Fourth Industrial Revolution will expand the scope of agriculture in various fields, such as culture, welfare, and healing in production-oriented agriculture. As shown in **Figure 1**, the 4IR will lead to a greater amount of communal and independent cultivation through cultural activities, such as combining agriculture with games and leisure, human welfare agriculture in the age of aging, and agricultural activities with plants and animals [4].

The expansion of agriculture through the 4IR is expected to vary greatly in the fields of production, distribution, and consumption.

3.1. Production of agricultural products

Changes in agricultural production in the 4IR will occur primarily in agricultural facilities with smart farming technology. In capable facilities, controlling the growth environment will add to the value of agricultural products. In Korea, three stages must be completed in order to promote smart farms in agricultural facilities. The first stage, completed prior to 2017, is the convenience improvement stage. In this stage, facilities were upgraded to allow farmers to check the growth status of agriculture via mobile devices. Thus, farmers do not need to travel to farms for menial tasks such as temperature control. The second stage, which is expected to be completed by 2020, is productivity improvement. In this stage, profits are increased through precise control and optimal prescription of agriculture. The

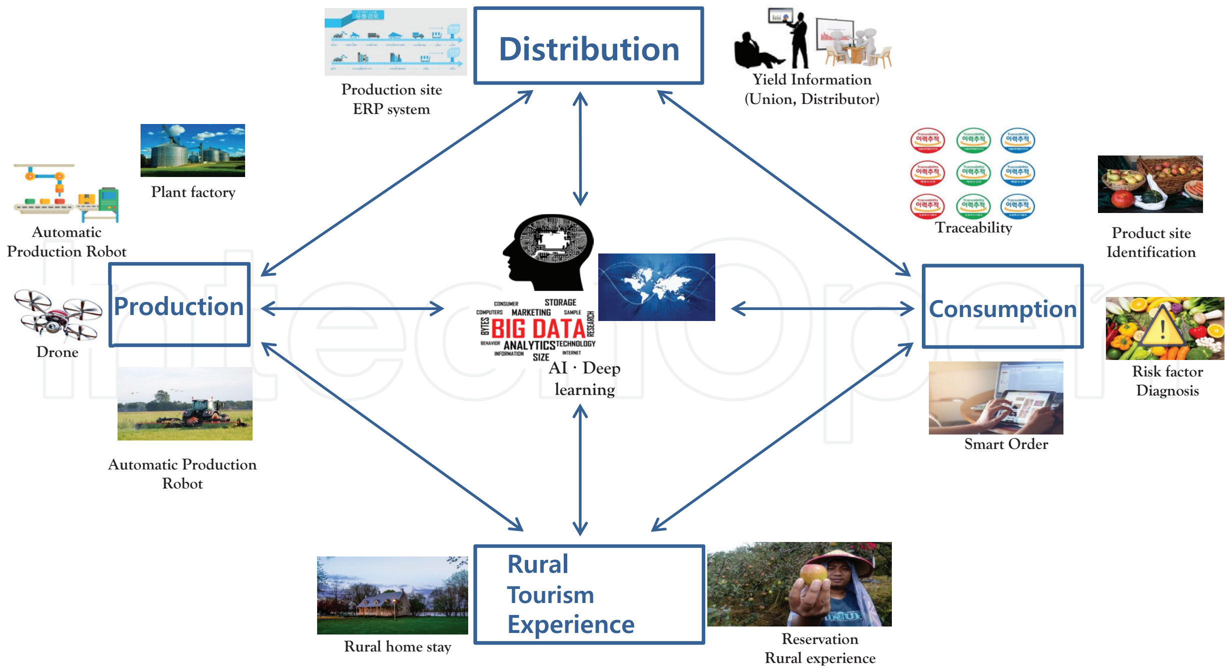

Figure 1. Illustration of the future agriculture with the Fourth Industrial Revolution (source: Fourth Industrial Revolution and Agriculture, Korea institute of planning and evaluation for technology in food, agriculture and forestry, 2016) [4].

third stage is the completion stage, in which all of the facility conditions are automated according to the growth conditions of the crop based upon the crop's growth model. The Korea Rural Development Administration provides a platform[5] for testing various sensors and technologies in smart farms, in order to help farmers quickly and efficiently move through the three stages.

As shown in **Figure 2**, the 4IR will also make a big difference in open-field agriculture. There are three stages in which this technology can be used: monitoring the area for crop growth, analyzing data in the decision-making stage, and carrying out variable rate application using smart farm machinery.

Monitoring the area for crop growth conditions includes not only the health status of crops but also climatic information, environmental information, and growth information, and it is rapidly developing in both large-scale extensive agriculture,[6] as in the USA, and intensive

[5]Platform: In a dictionary sense, it means a flat place that is installed above the ground by the railway so that passengers can get on and off at the station. In the information age, the meaning is expanded to mean the hardware or software on which the computer system is based and the computer system that forms the basis on which the application program can be executed. In the first connection society like the Fourth Industrial Revolution, it is a place where people and information gather to create a new business. This is where the needs of suppliers and producers are exchanged, so that as more people participate, network effects occur and maximize value (e.g., Facebook, users communicate with their acquaintances, and providers connect with their ads).

[6]Extensive agriculture: used in relative terms with intensive agriculture. Use pesticides, fungicides, herbicides, etc. to reduce labor and capital inputs, and use machines in sowing, cultivating, and harvesting. Because yields are small per unit area, large crops are needed to earn revenue.

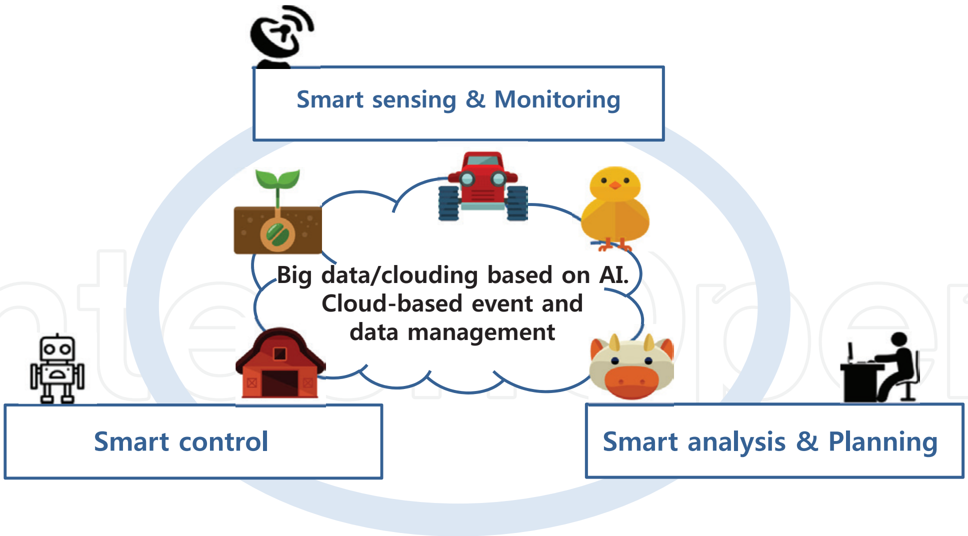

Figure 2. The Fourth Industrial Revolution and changes in agricultural production [2].

agriculture,[7] as in Korea. It is possible to maximize production volume and minimize the possibility of failure due to natural disasters, system errors, and other factors by acquiring data on growth, the weather, and agricultural equipment.

Analyzing data in the decision-making stage involves analyzing data from the monitoring stage and determining agricultural work required. In this stage, collected data is accumulated, processed, and analyzed as big data. Then, efficient and precise decisions about the data are made in a way that surpasses human intelligence, wisdom, and experience.

Furthermore, it is possible to collect environmental data on cultivation through an agricultural service platform using big data. The information can be used to evaluate market sale trends according to market preference analysis, and then the data (the cultivation environment, pest information, climate and weather information, soil fertility, topographical relevance, etc.) can be fed back to farmers to optimize production environments. In recent years, big data and artificial intelligence have been used to greatly expand the fields of genetic engineering with respect to agriculture and livestock. Within the premise of resolving laws, regulations, and ethical issues, it will be possible to cultivate edible crops and biota crops that grow in extreme climates or droughts. It will also be possible to transform animals' genes in order to make them more economical and suitable for local environments.

Variable Rate Application[8] using smart farm machinery is the third stage of this process. In the previous stage, the optimal decision was chosen for each location. In this stage, it is necessary to input the prescribed farm material suitable for the location. In extensive agriculture,

[7]Intensive agriculture: used in relative terms with extensive agriculture. Agriculture that maximizes economic efficiency by appropriately using tools and machines with the input of labor and capital

[8]Variable rate application (VRA): When there is a need to distribute the amount of farming material differently by location, the amount is changed mechanically. For example, when spraying herbicides, apply herbicides only in the presence of weeds, but increase the application rate in places where there are many weeds.

several tractors will be able to accomplish the same tasks (i.e., herbicide spraying) at different positions (i.e., variable rate application) by following certain intervals.

At night, when the farmer is asleep, a robot could be guided via FPS and electronic maps, enter the field, finish any necessary agricultural work, and return to the house before down. This dream will be a reality in the near future. It will be brought on by the Fourth Industrial Revolution.

3.2. Agricultural product distribution

Agricultural distribution is another field in which 4IR technologies will cause innovations. In each previous industrial revolution, the consumption pattern of agricultural products changed greatly. Prior to the First Industrial Revolution, 90% of the world's population was engaged in agriculture, so the distinction between producer and consumer was unclear. The First Industrial Revolution was an era of self-sufficiency in which the producers soon became the consumers. Raw materials were quickly consumed, and only very little raw materials were processed.

Through the Second Industrial Revolution, surplus products began to emerge so processing and storage technologies were developed. During this period, the agricultural production population shifted to manufacturing and service industries. The separation between rural producers and urban consumers became clear, thus increasing the necessity and importance of distribution.

During the Tertiary Industrial Revolution, the surplus product increased, and the central value of consumption moved from quantity to quality. Thanks to the increasing number of consumers, selective consumption has become more prevalent, and distribution functions have become more important.

The introduction of a customized agricultural product ordering system that takes into consideration the aging population and the expansion of single-person households in the agriculture and rural areas, including the control of shipment volume through the big data and the consumer's dietary style, suggests that the Fourth Industrial Revolution could revolutionize agricultural distribution.

Information such as the prices of agricultural production, crops, and distribution include the basic data necessary to manage supply and demand. By applying 4IR technology, comprehensive data, including agricultural production, climate information, population structure, and consumer data, are analyzed comprehensively. In this way, it is possible to produce customized products to optimize supply and demand autonomously. At the same time, the government can adjust timing and output in order to stabilize prices.

3.3. Agricultural consumption

During the Fourth Industrial Revolution, consumption is expected to be once again distinguished from previous revolutions. When consumer and producer information are linked in real time, it will be common to choose that best match both. 4IR technologies will also provide trade information through cyber and mobile production history and quality information. AI linked with big data will be able to stabilize transactions by connecting production information and transaction information.

For example, intelligent refrigerators will be able to automatically refresh its stocks in real time, based upon consumption. A refrigerator like this could also be linked to a system that manages family nutrition and health information. It could even cook food for family members based upon the nutritional needs of the individuals in the family.

Furthermore, 3D printing will allow people to be individually and creatively involved in the self-production of food, farm materials, agricultural machinery parts, and tools. Three-dimensional printers can even be used to make healthy functional foods for children and the elderly, including soft processed food that are easy to chew.

3.4. Influence on the rural environment and rural life

The Fourth Industrial Revolution will change production, distribution, and consumption as well as the rural environment and rural life.

At the same time, it will continue to develop agricultural systems by overcoming difficult problems that have yet to be solved by existing technology. It is expected that these techniques will be applied to actual farming sites, so they will require preparation and time for rooting.

4IR technologies can expand the agricultural industry diversely, from simple production-oriented agriculture to urban agriculture, healing agriculture, material agriculture, and industrial convergence. Examples of this include IoT, CPS[9], cloud-based agriculture experience and tourism materialization, aged farmer health information using wearable IoT, rehabilitation applied to animal and plant healing models, IoT and cloud, and urban agriculture using mobile technology. In addition, 4IR technologies are expected to find solutions to ongoing problems and malignant diseases that cannot be solved with existing technologies, such as animal odor, avian influenza, and foot-and-mouth disease. Above all, the 4IR will create new jobs by combining diverse technologies such as industrial convergence and hybrid technology. In addition, major changes will occur in risk management, bio-industrialization, and unmanned intelligence.

4. Preparing for the Fourth Industrial Revolution

In the era of the Fourth Industrial Revolution, new technologies and new businesses that cannot be defined by existing laws and systems will be developed. The positive regulation method of controlling gene expressions in gene therapy is currently illegal. In order to use

[9]Cyber-physical system (CPS): robots, medical devices, and real-time integration of software and environment in cyberspace.

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positive regulation, businesses waiting to use new technologies and services will have to wait for laws to be enacted, which allow the use of positive regulation.

In order for the 4IR to be rooted in agriculture, it is necessary to promote the safety of agricultural work and rural life and to create a convenient environment for cyber technology and cloud infrastructures. This will prevent medical and cultural inconveniences in rural areas.

Wearable IoT and mobile devices are concrete methods in which we can implement agricultural work safety, cyber physics systems (CPS), remote medical, cyber cultural life, and aged farmer's life safety and health information big dataization.

4.1. Agricultural robots

A robot is a machine that moves independently, imitates humans, recognizes the external environment, and makes independent judgments about how to handle different situations. Agricultural robots will operate in every area of the agricultural process, including production, processing, distribution, and consumption. They will recognize the service environment and autonomously provide intelligent work or services. Agricultural robots can be defined as "intelligent agricultural production systems that can minimize human intervention, control themselves, and maximize efficiency." Traditional farming machines and unmanned aerial vehicles can be utilized by robots in the fields of agricultural product selection, automated distribution systems, facility horticulture, and automated livestock care.

Robot usage can be divided into three fields, depending on where they are used. These fields include open-field agriculture robots, facility agriculture robots, and livestock robots. These fields will aim to improve productivity through automation, unmanned farming, and the promotion of eco-friendly farming.

The global robot market[10] is expected to grow at a CAGR[11] of 17% from $ 71 billion in 2015 to $ 135.4 billion in 2019. The robotics market for agriculture and fisheries[12] is estimated to be $ 900 million in 2013 and is expected to increase rapidly to $ 19.1 billion by 2020. The target is expected to be a weed control and harvesting robot (see **Table 1**) [4].

4.2. Precision agriculture

Environmental problems continue to plague the Earth, yet the production of safe agricultural products is emerging. Interest in precision agriculture is increasing, in order to minimize environmental pollution and maximize the production of agricultural products. Scientists as well as those involved in agriculture are showing interest in this research. In

[10]The International Data Corporation (IDC) selected six technologies that were highly likely to grow: Internet of things (IoT), cognitive (recognition) systems, next-generation security, AR-VR, robot and 3D printing, and the market for each technology (2015.10.).
[11]Compound annual growth rate.
[12]International Federation of Robotics (IFR) 2014 Wintergreen Research report.

Division	2013	2014	2015	2016	2017	2018	2019	2020
Agricultural robot market	956	1386	2329	4634	8110	11,760	15,288	19,109
Growth rate (%)	34	45	68	99	75	45	30	25
Milking and livestock facilities	879	1203	1615	1918	2004	1735	1798	1611
High value-added crop	29	55	116	275	568	941	1376	1911
Cereal crops such as wheat, rice, corn, etc.	11	28	186	695	2109	2940	3669	4395
Grape pruning and harvesting	6	6	137	941	1272	1570	1413	969
Seedling management	14	42	116	292	616	1047	1682	2389
Grass management (lawn care)	14	43	140	371	811	1411	2410	3058
Unmanned aerial management	3	7	19	139	730	2117	3210	4777

(Source: World Robotics 2012. IFR).

Table 1. The global robot market scale in agriculture and fisheries (Unit: million $).

fact, many are interested in precision agriculture because it does not belong to any one field; all fields contribute in a joint effort to solve the problems facing precision agriculture. Breakthroughs in agricultural machinery are of utmost importance; thus emphasis is being placed on engineering in the field. As the world's population continues to increase, there is an urgent need for an increase in food production. This need is hindered by industrial pollution and difficulty producing safe agricultural products due to harmful pesticides and fertilizers. Precision agriculture has emerged as a solution to this need, as it can increase the production of agricultural products while reducing the amount of harmful chemicals applied to the environment. Every crop field has different characteristics that can be measured in quality and quantity. Some examples of these characteristics include soil, nutrients, flow of irrigation water, and pest resistance. These differentiations of characteristics can all exist within a single crop field, so we have found that if we understand the different characteristics of each part of a field, and if site-specific processing is done for each location, the most profit from the least investment can be achieved. Therefore, precision agriculture follows the concept of variable rate agriculture. Yet it is prescription agriculture as well, as optimal profit is obtained based on past information. It has the ability to regulate future field conditions and yield through site-specific management. Precision agriculture is a concept that meets the needs of an advanced society that requires environmental preservation.

As shown in **Figure 3**, the concept of precision agriculture is one in which agriculture work is not actually made more precise, but instead the agricultural system as a whole moves from a statistical approach to a quantitative approach. Therefore, it is not an exaggeration to say that the scope of precision agriculture is the entire agricultural system. As a system of agriculture, three divisions of technology must be utilized in order to fully develop precision agriculture.

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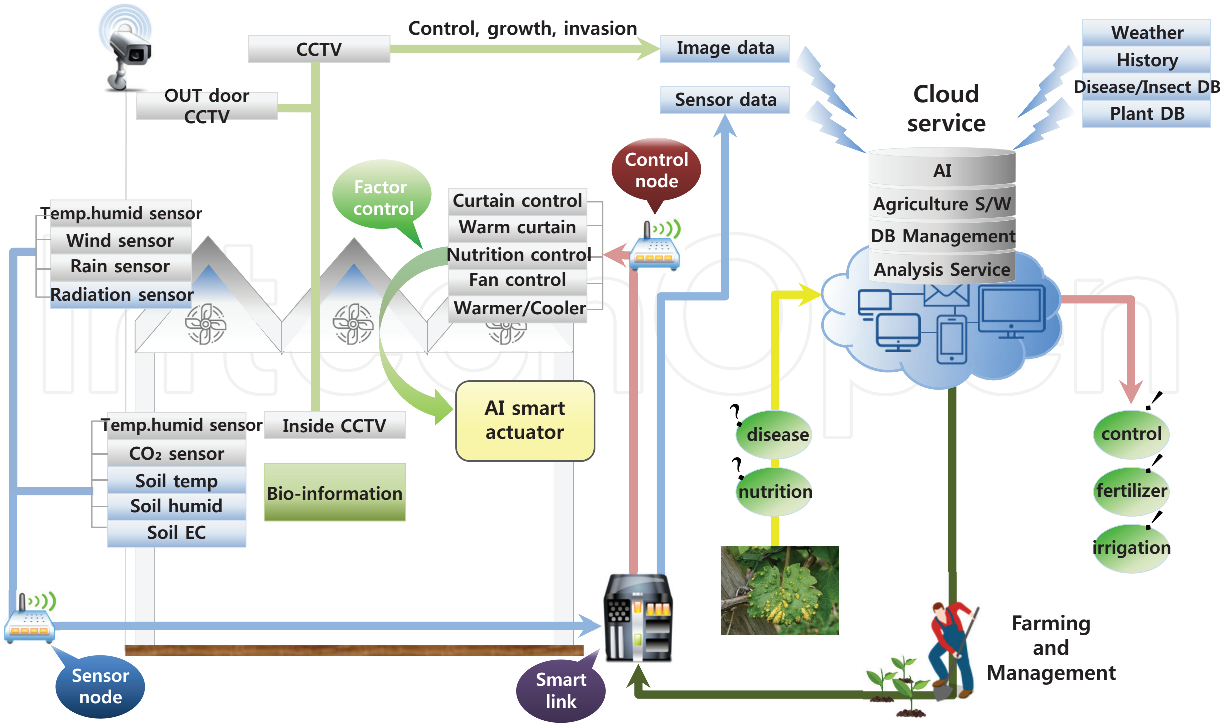

Figure 3. Crop production environment through biometrics and artificial intelligence (source: Convergence of agriculture R&D and Fourth Industrial Revolution, 28p) [5].

The first division is the acquisition of information related to the environment where crops will be grown, such as crop growth status, soil fertility, and climate by location. The means of obtaining such information is via sensors placed at each location, which can monitor different conditions including the yield of crops, moisture content of the soil, soil nutrients, moisture stress, and the occurrence of pests or weeds. These sensors do not collect information to be later analyzed in a laboratory; they are capable of instantly processing and storing information in real time.

The second division is the distribution of necessary, measured agricultural material into the crops. Based upon outcomes determined in decision-making and crop management, machinery will release seeds, nutrients, and chemicals to the crops.

The third division is the processing of computerized geographical information and databases along with the farmers' prescribed inputs in order to drive the control systems of various farm machineries. Even if the first two divisions are well developed, it is difficult to carry out precision agriculture if the third decision-making process is lacking (see **Figure 4**).

As one sector of agriculture changes and one farmer's agriculture becomes technologically advanced in this way, it does not mean that precision agriculture has been established. That is, precision agriculture does not change farm by farm. Precision agriculture is not a word referring to a single technology, but an overall concept of new changes in agriculture.

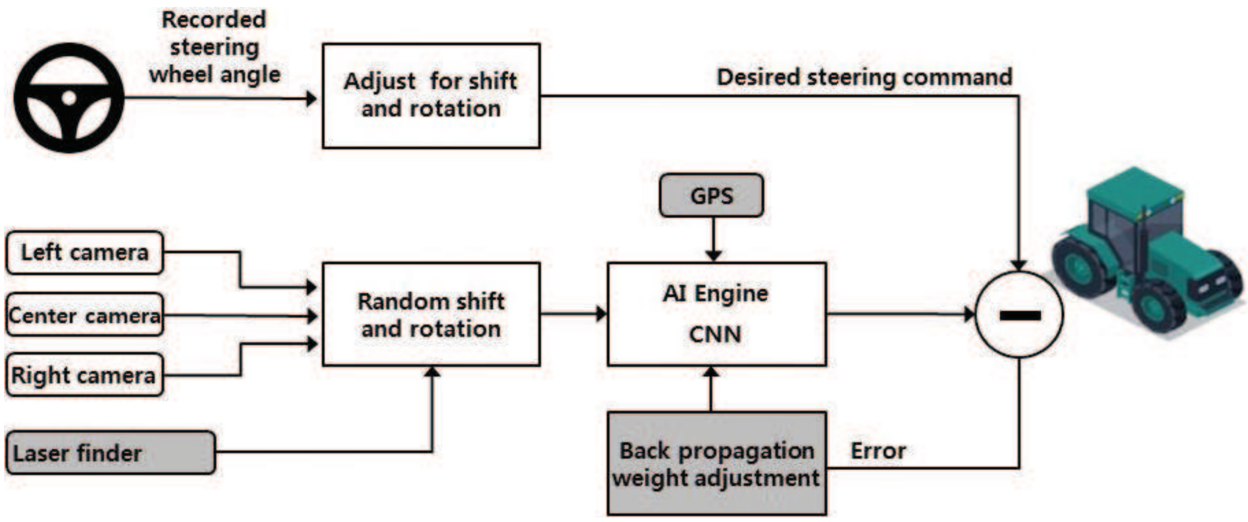

Figure 4. Artificial intelligence autonomous driving and unmanned agricultural farm machinery (source: Convergence of agriculture R&D and Fourth Industrial Revolution, 37p) [5].

5. Conclusion

Just as the first, second, and third industrial revolutions did, the emergence of new technologies achieved via revolution always begins with the destruction of an existing order. Breaking the existing order creates a gap in which opportunities can emerge. The Fourth Industrial Revolution technology presents a chance to increase agricultural competitiveness and an opportunity to overcome the structural weaknesses of our current agricultural system and the limits of intensive agriculture. There are three steps that we must take in order to lead the change.

First, we must analyze the impact of the 4IR on our agricultural ecosystem. It is necessary to analyze the impacts on all fronts of agriculture, the effects on rural and agricultural life, and the effects on agricultural structure and work.

Second, we must consider data management and its effects. In the future, data will be a resource, and data quality will be competitive. Data should be standardized so that quality agricultural data can be continuously produced and managed.

Third, we must facilitate the construction of an infrastructure that supports technology-based agriculture. The fifth-generation (5G) communication network, the Internet network infrastructure, and the Cloud Service System must maintain support for these technologies in order to allow them to integrate easily into the agricultural industry.

If research and development supports the fusion between heterogeneous technologies and heterogeneous industries and the agricultural industrial ecosystem allows creative talents to freely exercise their capabilities, the Fourth Industrial Revolution can occur. In this way, agricultural technology will grow to new heights and leap to new opportunities.

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References

[1] [Internet]. Available from: www.wikipedia.org [Accessed: July 13, 2017]

[2] Lee JR. The Fourth Industrial Revolution and Future Agriculture. Rep. of Korea: Science and Technology Policy Institute; 2017; 200 ed

[3] Lee HJ. The Fourth Industrial Revolution and the Future of Agriculture. Smart Farm and Shared Economy. Rep. of Korea: Science and Technology Policy Institute; 2017; 200 ed

[4] The Fourth Industrial Revolution and Agriculture. Rep. of Korea: Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry; 2016

[5] Lee YB, editor. Convergence of agriculture R&D and 4th Industrial Revolution. 1st ed. Jeonju, Rep. of Korea: SY Ra; 2017. 117 p