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The Smart Ways of Adoption IoT and AI for Sustainable Animal Agriculture

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ABSTRACT

There is a finite amount on Earth, and if resources are exhausted, resources cannot be used afterward. We must therefore be constantly concerned with responsibility for sustainability. This paper investigated how technically sustainability can be protected especially in the livestock and pet industries. The OIE describes the concept of animal welfare as "being able to express one's original habits in healthy, comfortable, good nutrition and safe situations, and not suffering from bad conditions such as pain, fear, and bullying." To step on this idea, a preemptive future response strategy is needed to cope with climate change, improve productivity, improve animal welfare, improve animal food nutritional quality, and prevent animal diseases by utilizing ICT-based smart livestock fused with the 4th Industrial Revolution. In this paper, the latest techniques are introduced - IoT, IIoT, and AI with how they can be used in animal agriculture and the pet industry.

Keywords: Sustainable, Animal, Agriculture, IoT, Artificial Intelligence

1. INTRODUCTION

By 2050, the world's population is expected to reach about 9.6 billion, many of whom need as many resources as three piles of earth to maintain their current lifestyle. The consumption of energy resources is increasing over time, and the amount of resources available in the future depends on how we consume them in the future. There is a finite amount on Earth, and if resources are exhausted, resources cannot be used afterward. We must therefore be constantly concerned with responsibility for sustainability. Through the COVID-19 crisis, consumers have become more interested in ethical values such as environment, ecosystem, sustainability, climate change, human rights, and animal welfare. According to a survey, about 60% of consumers said they have become more eco-friendly, continuous, and ethical consumption after the outbreak of the pandemic, and 90% of the respondents said they would maintain this consumption habit even after the COVID-19 incident. As such, the COVID-19 crisis that the world is currently experiencing highlights the importance of sustainability for the future. Sustainability should be applied to almost all areas, but this study investigated how technically sustainability can be protected especially in the livestock and pet industries.

The OIE (International Bureau of Water Services) describes the concept of animal welfare as "being able to express one's original habits in healthy, comfortable, good nutrition and safe situations, and not suffering from bad conditions such as pain, fear, and bullying." At the time, the EU announced that banning breeding of spawning cages in 2012 and banning breeding of stalls (metal frames) in 2013 would be difficult for Korea to accept, and the government is making efforts to encourage livestock farms to practice animal welfare. The Korean government's strengthening of animal welfare is aimed at strengthening the competitiveness of the domestic livestock industry to prepare for the upcoming FTA with countries around the world as well as the Korea-EU FTA and to practice the right to life and healthy lives. The social demand for animal protection continues to intensify. This is a reaction to the mass production of meat due to the "farm factorization" and the increase in the use of animals for entertainment like dolphin shows. In fact, it is said that many hens supplied in large quantities to chicken restaurants easily break their legs or wings. It is normal for hens to lay about 30 eggs a year in natural conditions. However, the hen on the farm produces more than 300 eggs a year in a narrow frame. At this time, all calcium is drained and osteoporosis occurs, and it easily breaks even with a small impact. Goose liver is mass-produced by inserting food into a tube on a goose that is trapped in a frame and has only a neck out.

In order to solve these problems, a preemptive future response strategy is needed to cope with climate change, improve productivity, improve animal welfare, improve animal food nutritional quality, and prevent animal diseases by utilizing ICT-based smart livestock fused with the 4th Industrial Revolution. The future animal life industry must integrate automation to improve sustainability and production efficiency. Intelligent precision livestock specifications and ICT-based smart livestock using IoT and big data in the digital era can collect, process, and analyze data from various sources in the animal life industry. It consists of a digital system capable of precisely remote control of environmental parameters inside and outside the barn. ICT-based smart livestock can monitor animal behavioral welfare and specification management using sensing technology for remote control through the Internet and mobile phones. It can also improve the quality by properly using AI technology.

2. Related Works

2.1 A. IoT and IIoT

The Internet of Things (IoT) includes all the objects that can connect to the Internet, from factory facilities and vehicles to mobile devices to smartwatches. But now IoT is more specifically defined as 'an object that is connected with sensors, software, and other technologies that can transmit and receive data to and from other objects'. While connectivity used to be largely Wi-Fi-dependent, modern 5G and other network platforms can reliably process large volumes of data sets faster. When IoT devices collect and transmit data, the final step is to analyze data and develop information-based measures. AI technology is used at this very stage. AI augments IoT networks with advanced analytics and machine learning capabilities.

IoT devices collect data from the environment around the device through sensors. These data can be as simple as temperature or as complex as real-time video feeds. IoT devices follow the instructions to access these data from a public or private cloud over an available network connection. In which the software is programmed to perform operations such as operating a fan or sending a warning based on that data. And finally, it takes action based on data. Data accumulated from all devices within the IoT network is analyzed. This analysis provides powerful insights to help you take confident actions and make business decisions.

In 2019, IoT devices generated about 18 zettabytes of data, and IDC predicts that by 2025, this number will more than triple to 73 zettabytes, the equivalent of 73 trillion gigabytes. It's hard to physically quantify digital data, but if you convert all that data into 1990s floppy disks and spread it out, you can make more than 5,000 trips to the moon from Earth. For IoT to evolve, a series of specific technologies must evolve simultaneously. First, Connectivity: This surge in IoT data volumes is only possible with very strong Internet and cloud connections that transmit and receive data. Today, many IoT devices use local Wi-Fi networks to transfer complex and large volumes of data. However, as 5G and other wireless networks evolve, McKinsey has recently published a report on the impact and the potential for IoT devices to be freed from Wi-Fi networks. Sensor Technology: With the steady rise in demand for IoT sensor innovation, the centerpiece of the market has shifted from high-cost niche operators to highly globalized and price-competitive sensor manufacturing for specific customers. Since 2004, the average price of IoT sensors has fallen by more than 70%, and they are introducing better functionality and diversity as related needs soar. Computational power: More data is expected in the next three years than combined in the previous three decades. Today's businesses need to steadily increase memory and processing power to take advantage of all of this data. The rapid competition to meet these needs has expanded the relevance and applicability of IoT. Artificial intelligence and machine learning: These technologies allow companies to manage, process, analyze, and learn large amounts of IoT data. Big data is the most popular food for AI and machine learning. The larger and more diverse the dataset is, the more powerful and accurate the insights and intelligence gained from advanced AI-based analytics. Artificial intelligence has developed with the surge in IoT devices, and data from IoT devices is becoming a strong foundation for artificial intelligence. Cloud Computing: Just as connectivity is a key component of IoT development, the growth of cloud computing is closely related to the evolution of IoT. With cloud IoT services that can deliver processing power and large storage on demand, IoT devices can seamlessly collect and transfer large and complex ever-growing datasets. Private cloud solutions also enable companies to manage large volumes of different types of IoT data while maintaining the security of closed systems.

IIoT means the use of connected machines, devices, and sensors for industrial use. If you are operating the latest ERP that provides AI and machine learning functions, you can analyze data generated from IIoT devices and use it to improve efficiency, productivity, and visibility. IIoT networks typically support machine-to-machine (M2M) communication and data transmission. In addition, devices with IIoT built-in receive automation programming on a regular basis from the central system. There is a difference in how you use it rather than how it works. Most IoT solutions around the world are often used by individuals as of end users and are mainly used in things such as smart home appliances, digital assistants, and mobile phone location trackers. IIoT is a subset of IoT and, while operating with the same basic technology, focuses more on automation and efficiency of the entire connected organization rather than on isolated individual users. Collecting and screening data in IIoT networks is just the first step in a much more complex process. Artificial intelligence and machine learning must be applied to these data to provide accurate insights and optimize workflows and automated tasks to maximize organizational deployment.

2.2 AI

Artificial intelligence (AI) refers to various technologies, software, and computer systems that embody human intelligence in computers. At a meeting at Dartmouth College in the United States in 1956, John McCarthy first defined the term artificial intelligence as "making machines behave as they do in the knowledge of human behavior." In addition, Alan Turing, a British mathematician, suggested that computers can think like humans, and argued that computers should be considered accidental if they can't communicate and tell if the other person is a computer or a person. This theory has been the basis for the field of artificial intelligence so far and is used as a criterion for determining artificial intelligence under the name Turing Test.

Artificial intelligence, which first began to be mentioned in the 1950s, remained in theory or performed only limited functions not long ago. However, with the advent of big data in the late 1990s, rapidly developing computer hardware and newly emerging deep learning have converged into one, and it is currently a field that is evolving at a very rapid pace. Until the 2000s, artificial intelligence had mainly been implemented in a way that machines learned the knowledge that humans had collected and created in advance. In other words, we were able to create artificial intelligence in a specific field by collecting the necessary knowledge in each field in advance, modeling it elaborately by experts, and learning the results from machines. This method of pre-preparing the knowledge that humans will learn directly from machines requires considerable time and money depending on the competence of experts, and the limitations of human language, expression, and computational ability are very limited. However, AI, which has developed little by little through big data technology and machine learning, which allows computers to use huge amounts of data, begins to produce AI that shows overwhelming performance with the advent of innovative deep learning algorithms that mimic the human brain. As a result, the machine learning process, which took months or years in the past, can now be processed in a few minutes or minutes, and it provides the basis for computers to acquire knowledge by recognizing and learning information on their own like humans in the real world.

2.3 Sustainability

Sustainable Development (SD) is a development that meets the needs of the present generation to the extent that it does not undermine the basis on which future generations can meet their needs. This means that human society meets the needs of the present generation but does not destroy the possibilities of future generations, and has a free opportunity for development in harmony with the surrounding environment. This concept originated from the willingness of mankind to live a rich life by solving global problems derived from population growth and economic growth while coexisting with nature. The term was first officially known through the "Our Common Future" (Bruntland Report) presented at the World Commission on Environment and Development (WCED) held in 1987. Since then, sustainable development has been widely interpreted as related to maintaining sustainability not only in the environment but also in the entire social and economic fields through various discussions for a long time. In addition, the concept of sustainable development is not fixed but has a characteristic of constantly changing. Therefore, each country and region is interpreting and applying it according to their own situation while considering the historical meaning of the formation process of the concept of sustainable development.

The problem of human production and consumption has continued since the Industrial Revolution, and major environmental accidents such as London Smog, Itai-Tai-Tai disease, and Minamata disease in the 1950s have raised their seriousness and brought attention to the impact of industrial activities on humans and ecosystems. From the 1960s to the early 1970s, various related writings were published. By showing the specific process of ecosystem destruction (Carson, 1962), looking at the whole planet as an ecosystem, examining the appropriateness of human activities in it (Meadows et al, 1972), or highlighting the problems associated with economic activity and other areas (Schumacher, 1973). These theories became the foundation for environmental administration with the boom of environmental movements around the world.

In 1968, the Club of Rome was formed to study environmental issues. To gain insight into the limitations and limitations imposed on human activities by the limitations of the Earth's system, the Roman Club began to study the key factors influencing the long-term behavior of the Earth's system and their interactions. This study was conducted by rotating simulations with five variables: global population, industrialization, pollution, food production, and resource depletion, and trends in which each variable interacted until the 1970s. As a result, it was concluded that if the previous growth trend does not change, the limit of growth will be reached within 100 years due to environmental pollution and resource depletion. Based on the conclusions drawn by the Club of Rome, it submits a report on the environment and growth in 1972, The Limits to Growth.

In the 1970s and 1980s, the UN became aware that the problem of environmental destruction and natural resource depletion was getting worse day by day. Since then, the Bruntland Commission has been established to simultaneously meet the economic aspects of the need for environmental conservation raised by concerns over the destruction of the global ecosystem and the basic needs of human life. The Commission wrote a report to define sustainable development and guide various trends in the various sovereign states that we're exploring it. The study, which began in 1972, was finally declared the direction of sustainable development for mankind in a three-year report by Norwegian Prime Minister Gro Harlem Brundtland. The concept of 'sustainable development' first presented in the report is 'development that meets the needs of the present generation to the extent that it does not undermine the basis on which future generations can meet their needs. It has paid attention to population, food security, reduced biological diversity, energy, industry, and residential issues, and is meaningful that the term sustainable development is officially stated. The report, also known as the "Our Common Future" or the "Brundtland Report," highlighted environmental issues addressed by the United Nations Conference on Human Environment, defined sustainable development, and said, "If the current economic policy continues, there is a risk of irreversible catastrophe." In addition, four major factors that threaten the future of mankind are (1) popular poverty, (2) population growth, (3) global warming and climate change, and (4) environmental quality destruction, and as an alternative to these threats, sustainable development is presented as a new paradigm. In other words, they argued that they should overcome the threat to the future of mankind and pursue sustainable economic development.

The concept of sustainable development has changed from discussions centered on environmental sustainability to aspects of economic growth, social integration, and environmental preservation, and again to a balanced concept that pursues the overall improvement of the socioeconomic system. In terms of conceptual structuring, it also described sustainable development as a structural framework in three categories: environmental, economic, and social, where environmental, economic, and social sustainability are not independent of each other. These three categories have recently been transformed into economic, environmental, social or ecological, economic, and equity or some scholars have added areas such as culture and institutions. In other words, like the environment, economy, and society closely influence each other, "conservation of the environment", "economic development" and "social stability and integration" as human development strategies are gradually expanding in a comprehensive sense, and play an important role in determining sustainable development goals and education. In addition, in sustainable development, the process of setting and implementing the direction of change is more important than maintaining the current state, so it is necessary to ensure and implement the participation of various stakeholders.

Recently, a broadcasting station has been criticized by the public for causing controversy over verbal abuse during the drama production process. About 150,000 people participated in the national petition bulletin board criticizing the drama. As the number of pet households in Korea reaches 6.5 million (2020), the consensus on animal rights is increasing, and animal welfare is emerging as another non-financial management factor for companies. This problem, which many pointed out about animal abuse that occurred during the production of the drama, occurs equally in the investment area. This is because his investment can unintentionally flow to companies that abuse animals. The problem is the opacity of information. Walt Disney Co., Ltd. was classified as an animal exploitation company due to controversy over monkey abuse when the movie "Pirates of the Caribbean" was produced. Here, the U.S. non-profit organization Cruelty-Free Investing appeared. The organization monitors the exploitation and abuse of animals by U.S. companies every day and discloses a list of companies in two categories, not those that exploit animals. The organization has so far disclosed whether a total of 5,903 U.S. companies have exploited animals, especially 10 of the worst companies. At this time, the definition of animal exploitation (or abuse) defined by organizations is wide-ranging, such as the manufacture and sale of all food and clothing including animal products, and animal testing.

BBFA Grades on the Welfare Status of Livestock Animals. However, since Krultifree excludes the majority of companies that manufacture and sell animal products, there is a limitation in that it is difficult to determine whether there are exploitation activities that occur during the production process. Accordingly, the business benchmark (BBFA) on farm animal welfare provides corporate evaluation information on livestock animal welfare. The organization investigates animal welfare policies, management systems, and information disclosure of 150 global food companies and grants tiers 1 to 6. Cranswick, England, which is listed as the highest grade as of 2020, raises animals based on five free principles, including animal discomfort, pain, and freedom from fear. Specifically, Kraswick rejects existing practices such as cutting pigtails and cutting poultry beaks and says it raises 100% of poultry in a free-grazing manner, not a cage.

MSCI (Morgan Stanley Capital International) ESG Research provides information on animal exploitation of investment companies as closed sources only to customers who request it. MSCI ESG Research provides investors with data on whether an investee is involved in controversial activities, including animal welfare. The research company checks and informs whether companies are involved in animal experiments, animal exhibitions, and factory-style livestock.

3. Survey

3.1 IIoT in Animal Agriculture and Pet Industry

For industries that depend on weather and natural forces, it's very useful if you have tools to reduce risk and vulnerability. Forbes magazine published an article saying that the adoption rate of IoT solutions in the modern agricultural sector is increasing and that "thousands of sensors are currently being distributed to improve water resource sustainability, imaging, production, and farming convenience." Also, Animal owners can continue to connect with their workforce with IoT monitors and wearable devices, allowing them to engage more actively in care. The data provided by these devices give healthcare owners a better understanding of the animal's condition. The result is a more detailed approach to diagnosis, treatment, and comprehensive well-being.

3.2 AI for Animal Agriculture

Using learning methods, phylogenetic reconstruction can be performed, especially contributing to novel evolutionary scenarios and transmission pathways of pathogens. For example, phylogenetic models provide an interesting perspective for identifying environmental bacterial strains that are likely to be infected or for predicting the presence of estimated host reservoirs or vectors. Pathogen sharing analysis between hosts was used to classify potential repositories of animal disease using machine learning. Analysis of pathogen genomes can also be used to identify genotypes of animal pathogens that are more likely to infect humans. Using phenomenological niche models that rely more on data distribution than hypotheses for active ecological processes can relate to the risk of exposure to disease-causing data or retroactive serological data combined with environmental variables to pathogens. Thus, it may help monitor the potential spread and new risks and anticipate the spread of infectious agents. For example, artificial neural networks (ANNs) have identified levels of gene introduction between wildlife populations and domesticated animal populations in a spatialized context which may help understand gene proliferation such as the host×pathogen system that characterizes a sample pool that includes several host species and is at high risk of acting as a pathogen diffuser or sink. Other AI approaches, such as multi-agent models, which are more mechanical approaches, have been used in explicit spatial contexts for vector-mediated pathogen transmission and have been proven versatile enough to adapt to several different specific situations. It should be noted here that several studies reveal the relatively old nature of AI research in AH. Such AI methods have often enabled more traditional statistical processing to identify less visible or almost undetectable signals (e.g., genetic intrusion) or even specific patterns or characteristics (e.g., the importance of density dependence in vector-mediated delivery). All of these approaches contribute to a better understanding of pathogen delivery in complex system networks commonly observed in infections appearing in tropical and developing regions of the world. In this matter, improved knowledge is key to protecting humans from these new threats, and AI/AH interface development and training collaboration with the poorest countries will promote synergy and action to predict and cope with new disease threats.

Better understanding and prediction of pathogen proliferation often requires explicit and integrated representation of mechanisms related to the dynamics of AH systems, regardless of size. You can use math (equation) or computer-based (simulation) models. Such mechanistic models (i.e., representing mechanisms related to infection dynamics) enable the prediction of the effectiveness of conventional but innovative control measures. However, to evaluate realistic control measures, mechanical dynamics models require the integration of observational data and knowledge in biology, mechanics, evolution, ecology, agriculture, sociology, or economics. Their development can quickly face issues of reliability, transparency, reproducibility, and usability. Moreover, these models are often newly developed with little use of previous models from other systems. Finally, these models can be considered negatively by end users (health managers) as black boxes, even on the basis of realistic biological hypotheses, as the underlying assumptions are hidden in codes or equations. The integration of multiple modeling perspectives (e.g., fields, perspectives, Spatio-temporal scales) is an important question in the field of modeling simulations. Mechanical modeling can benefit from existing tools and methods developed in this field. Essential but good programming practices alone cannot address these challenges in 6 of Ezano et al. Scientific libraries and platforms accelerate the implementation of complex models frequently required for AH. For example, the R library SimInf helps to incorporate observational data into a mechanistic model. The BROADWICK framework provides reusable software components for multiple scales and modeling paradigms but still requires the modeler to write a large amount of computer code. New methods at the crossroads between software engineering and AI can enhance the transparency and reproducibility of mechanical modeling, thereby facilitating communication between software scientists, modelers, and AH researchers throughout the modeling process (e.g., home formulation, evaluation, and revision). Using advanced software engineering methods, such as domain-specific languages, formalized symbolic AI's knowledge representation methods allow access to model components in structured text files that are easy to read instead of computer code. This allows scientists and field managers in various fields to participate more in model design and evaluation. Scenario exploration and model modification also no longer require rewriting the model code. Other AI methods can improve model flexibility and modularity. Autonomous software agents allow different levels of abstraction and composition to be expressed. It helps the modeler move back and forth more easily on a small and large scale, and ensures that all relevant mechanisms are properly formulated on an appropriate scale (i.e., the determinants of hierarchical living systems and the scale dependence of drivers). Combining knowledge representations (via DSL) with such multi-level agent-based simulation architectures can cover several types of models (e.g., compartment, individual base) and scale (e.g., individual, population, domain) and address repeated demands for transparency simultaneously, reliability, and flexibility in pandemic modeling. This approach

wearable technology dominates the market. Most PLF applications are based on an animal (neck, leg, or ear tag) or a monitoring tag attached to the animal. Therefore, current PLF should also facilitate the production of supporting decision tools for veterinarians and public health managers and stakeholders in the future.

3.3 Combined AI with IIoT

Precision Livestock Breeding (PLF) can be defined as "a real-time monitoring technique aimed at managing the minimum units of production that can be managed, known as the 'sensor-based' individual animal approach. A few years before the term PLF was coined, the first widely adopted electronic milk meters for cows in the 1970s and early 1980s, followed by behavior-based rutters, ruminant tags, and online real-time milk analyzer. However, cows are not the only animal species in PLF stadiums and are almost simultaneously applied to other species. Without a doubt, these technologies will continue to change the way animals are managed. Moving forward, these technological changes provide an optimistic reason for the improvement in the well-being of both animals and farmers. Producers can review real-time data compiled in reports to identify abnormal deviations from baselines. However, data itself is meaningless unless it is translated into the information available in a good decision-making program. Precision livestock monitoring technology does not replace producers' intuition and management, but it can be improved by allowing producers to make better-informed decisions.

Here are some practical examples: Dairy Body Condition Scoring with Machine Vision, Early Detection of Lameness in Dairy Cows with Response surface and Machine vision, Feed Intake/Feeding Behavior, Quantifying pain/stress, various positioning systems, Quantifying the animal welfare by catching their emotional state in specific situations. Electronic Nose.

By increasing the amount of information available, technology for providing accurate data can only improve a well-managed system. How the data provided by these technologies transform into a viable solution is a key point in PLF success. At this point,

applications are mainly used in larger animals such as cows, cattle, and horses. The economic value of each large animal justifies the investment of monitoring tags per animal, and large animals provide many places to hang sensors. One sensor, such as cameras or robots, should be enough for many smaller and less valuable animals, such as small ruminants (sheep and goats). Most traditional commercial applications for pigs, fish, and poultry monitor groups using data from cameras, sounds, or feeding systems. New sensor systems will be introduced into the market, primarily from wearable technology with more image and milk-based systems. In systems with a low value per animals such as sheep, goats, pigs, poultry, and fish, per-group sensors, not per-animal sensors such as cameras and robots, will be much more common. Investment decisions should include a thorough and formal assessment of profitability. Human factors related to successful technology adoption cannot be overlooked. Farmers are often skeptical of new business models, especially when new technologies are involved. Often, it is difficult to persuade farmers to cooperate in digital innovation. That is one reason why the collaborative business model in the livestock sector is in a relatively early stage. If scientists are able to transfer knowledge to farmers in a reliable and transparent manner, perhaps with the help of knowledge-sharing platforms and e-learning tools, they are likely to overcome such implementation barriers and create significant value for all parties along the value chain. The excitement of technological competence should be balanced in consideration of implementation challenges and economic reality. In some cases, although technology can be scientifically and technically sound, the economic benefits of system costs limit the adoption of new technologies. It is important to remember that livestock systems are inherently quite complex and that PLF technology should be considered in the context of the entire system. In most cases, many of these technologies are still in the early stages of adoption. As these technologies evolve and become mainstream, end-user demand for technology performance will increase.

4. Factor Analysis

4.1 Livestock

They are domesticated animals in agricultural conditions that are used to produce labor and products such as eggs, meat, milk, fur, wool, and leather. The livestock industry is currently a component of agriculture and refers to the breeding, maintenance, and slaughter of livestock.

4.2 Pet

These are made up of all living creatures that invade or damage crops, livestock, or human structures. Pest often occurs in large quantities and harms agricultural products. It is important to control and monitor these creatures through IoT/AI technology to avoid serious diseases, including infectious diseases and malaria, as well as plant and livestock diseases.

4.3 Human Resource

This consists of people, policies, and practices within the agricultural environment, which are as important as weather and technology as in other areas. They have a significant impact on production, finance, and marketing decisions. Whatever its size, agricultural companies need effective human resource management and planning, including employment and employment, and hiring high-performing and effective communicators. Providing up-to-date knowledge opens up the means to potentially adopt smart technologies in agricultural environments.

4.4 Climate

This plays an important role in determining the success of the agricultural process. Most field crops and livestock depend entirely on climate conditions to provide life-sustaining water and energy. Bad weather can cause loss of agricultural products, especially at a critical stage of growth.

Weather factors (solar radiation, temperature, precipitation, humidity, wind) affect the physiology and production of plants and animals. Severe weather (e.g., tornadoes, droughts, floods, hail, and storms) can cause considerable damage and destruction to fields and livestock.

4.5 Other environmental factors

Soil forms an important aspect of successful agriculture, becomes a source of nutrients used to grow crops and is then transferred to plants and to humans and animals. Healthy soil produces healthy and abundant food. However, soil health tends to decline over time, and farmers must migrate to new fields. Soil health depends on local conditions and climate, especially when irrigated, soil nutrients are likely to be worse, which, if not carefully managed, can lead to salinity, and accumulation of salt and chemical levels in the

healthy and rich soil to be obtained by monitoring chemical conditions using IoT sensors using specific sensors (e.g., moisture sensors) to assist in decisions related to fertilizer needs. Also, agricultural water demand is currently increasing worldwide, especially in Mediterranean countries, and pressure is increasing to conserve available

water. Data readings are sent to the data management and analysis layer for analysis, enabling

freshwater resources. Smart and sustainable agricultural processes should therefore focus on new and efficient technologies to improve agricultural productivity, which facilitate significant savings in terms of food consumption and wastewater.

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