

18. The smart village program challenges in supporting national food security through the implementation of agriculture 4.0

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23

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30

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The smart village program challenges in supporting national food security through the implementation of agriculture 4.0

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Abstract. The purpose of this study is to: (1) look at the possible concept of agriculture 4.0 which can be an important part of the smart village program; (2) evaluate the relationship between the concept of agriculture 4.0 and the principles of sustainable agriculture in line with the achievement of the Village Sustainable Development Goals; (3) analyze the opportunities of the agriculture-based smart village program 4.0 to be able to contribute to food security. The method used in this study is a qualitative approach with case study methods and is analyzed descriptively. Data is collected from written and audio-visual materials, in the form of policies, field data, opinions and experiences of experts and practitioners, and others. The results of this study show several conclusions, including; (a) The concept of agriculture 4.0 is very likely to be part of the implementation of the Smart Village program, considering that Indonesian villages in general are agricultural villages that still need digitalization in agricultural activities. (b) Agriculture 4.0 technology has characteristics that are in line with the principles of sustainable agriculture, including minimizing the use of inputs, minimizing the use of water in agricultural cultivation, and the ability to make various predictions that can provide benefits for farmers, (c) thus the opportunity to develop smart villages based on agriculture 4.0, can provide a great opportunity to be able to contribute to food security in Indonesia and can improve the welfare of rural communities.

5 Introduction

Smart Village is a program adopted from the Smart City program. Based on experience, many urban problems such as service, transportation, security, and others, can be overcome with the presence of Smart Cities. This successful experience is tried to be applied to address rural problems such as an increase in the elderly population, the departure of young populations to cities, rural population decline, digital inequality, and others [1,2]. Nevertheless, the same model cannot simply be applied to villages, as rural conditions may not work on the same principles as Smart Cities. Therefore, the use of Information Technology must be adjusted to the needs of the village through the concept of a "Smart Village". The Smart Village concept is based more on local conditions, infrastructure, resources available in rural areas and local demand, and the potential export of goods to urban areas [3].



In the long run, the impact of urbanization that occurs in rural areas has implications for the capabilities of the agricultural production sector. Though the rural position is very important as a production area that can supply national food needs. Based on the Inter-Census Agricultural Survey - SUTAS, until now as many as 45% of the workforce works in the service sector, while workers in the agricultural sector are only 33%, and it is expected to continue to decline. Even predicted, in the next ten years the number of farmers decreased by about 9.3 million. More than 70 percent of farmers today are over the age of 45 and there are about 9 million more who are over the age of 65 [4].

In overcoming this problem, it is necessary to accelerate rural development through the digitization of villages, referred to as Smart Villages. Based on a variety of experiences, the Smart Village program can cover various fields such as Smart Infrastructure, Smart Services, Smart Innovation, Smart Institutions, and others. Through the mobilization and utilization of available resources optimally, and through the support of digitalization, villages can experience faster and more inclusive growth, so that rural communities can achieve a high standard of living [3].

The European Commission for Smart Villages defines Smart Villages as rural areas and communities that are building on existing strengths and assets and developing new opportunities. In the Smart Villages program, traditional networks and services can be improved through digital technologies, telecommunications, and innovation, for business and social purposes. The Smart Village concept does not offer a one-size-fits-all solution but is based on the needs and potential of their respective regions [5]. Smart Village is a bundle of services delivered to its residents and businesses in an effective and efficient manner. The Smart Village ecosystem brings all the services of the village and its providers and users on a single platform [6,7].

The role of technology is very important in infrastructure investment, business development, human resources, capacity, and community development. Good governance and citizen engagement are decisive. Smart Villages will usually pay attention to things like e-literacy skills, access to e-health, other basic services, innovative solutions to environmental problems, application of circular economy to agricultural waste, promotion of local products supported by technology and ICT, implementation and full retrieval of benefits from smart specialties food farming projects, tourism, cultural activities, and others [8].

Three components are indicators of the development of Smart Village. First, is the economic component, which includes local administration and economic factors. It will include governance models, internet networks, mobility, cloud computing, entrepreneurship, and others. Second, is the environmental component, which includes issues related to resources and infrastructure available at the local level. This can include cleaner technologies, public and alternative transportation, green space, smart growth, climate change, and others. Third, is the social component which is a component that can deal with problems related to people's lives, participatory democracy, social innovation, services, and others [3].

Although many opportunities can be developed, smart village development strategies require priority programs. The Smart Village program should prioritize production interests that can generate income for the village community. In this case, the government can encourage the process of digitizing the agricultural sector based on Agriculture 4.0 technology. The main function of this technology is to increase crop production and improve tracking, harvesting, processing, and marketing in real-time [9]. In addition, it can also make the agricultural business a profitable investment, especially in low- and middle-income countries where population growth and pressure on the agricultural system will occur [10].

The concept of agricultural digitization based on the industrial revolution 4.0 is in line with the Presidential Regulation No. 7 of 2021 concerning the priority of using village funds in 2022. There are three focuses on the use of village funds, namely: 1) National economic recovery according to village authority, which consists of the formation, development, and revitalization of BUMDes / BUMDesma, provision of village electricity, and development of productive economic efforts, especially those managed by BUMDes/BUMDesma; 2) National priority programs according to village authority which includes village data collection, mapping potential and resources, and developing information

and communication technology, development of tourist villages, strengthening food security and stunting prevention in villages, and inclusive villages [11].

In line with the targets of information technology development and food security, digital-based agricultural resource management is the most important factor in supporting economic improvement. An important part of a farmer's income depends on direct support, market policies, and rural development policies. These measures target rural business development, including agricultural modernization, investment in small-scale local infrastructure and connectivity projects, village renewal, knowledge development, knowledge sharing, and bottom-up initiatives [5].

In accordance with village development targets in achieving village sustainable development goals (SDGs), this study tries to see the relationship between four main things, namely smart villages, food security, agricultural digitization (agriculture 4.0), and sustainability. This study will try to answer several important issues regarding these four things: 1) whether the concept of agriculture 4.0 can be an important part of the smart village program; 2) whether the concept of agriculture 4.0 can support the principle of sustainable agriculture; 3) Can the implementation of the smart village concept contribute to food security in Indonesia?

2. Methodology

The methodology used in this study is a qualitative method through a case study approach. A case study usually focuses on an event, whether it includes an individual, a cultural group, or a portrait of life. A case is an exploration of a case, it can be a program, an event, an activity, or an individual. Case studies can explore a specific phenomenon at a time and activity (program, event, process, institution, or social group) as well as collect information in detail and depth using various data collection procedures over a period of time [12]. This is in line with Robert K. Yin opinion that sees case studies as a research strategy. Case studies are used in many situations to contribute to our knowledge of individuals, groups, organizations, and social, political, and related phenomena [13].

Case study methods allow researchers to maintain holistic and meaningful characteristics of real-life events such as individual cycles, organizational and managerial processes, environmental changes, international relations, and industrial maturation. The case study strategy rests on two questions in exploring a case, namely how and why. The focus of the case study is to examine events of a contemporary nature [13]. The case study is the government's policy on smart villages and their opportunities to support food security in Indonesia sustainably. Data collection methods are carried out by observing and studying the activities of actors both individuals and institutions, and their experiences in digital agriculture. Data is obtained through interviews and digital recording materials and existing written materials. The data was analyzed and produced a descriptive, comprehensive analysis of village digitization and agricultural digitization. His analysis can be a lesson in the development strategy of agriculture 4.0 going forward [14].

3. Smart village policy

Smart Village is a development acceleration concept that encourages villages to utilize digital technology to educate people and improve the village's ability as Independent Villages. The purpose of this concept is the transformation of the use of digital technology to encourage the improvement of basic service quality and village development based on inclusive and sustainable community empowerment. The basic principles of the Smart Village Program are: Participatory, Inclusive, Innovative, Collaborative, and Sustainable [15].

The basis of the Smart Village program is Law No. 6 of 2014 concerning Villages. The definition of Smart Village is by Article 78 of the Village Law, which states: (1) Village Development aims to improve the welfare of the village community and the quality of human life and poverty reduction through the fulfillment of basic needs, the development of village facilities and infrastructure, the development of local economic potential, and the sustainable use of natural resources and the environment. (2) Village Development includes planning, implementation, and supervision stages. (3)

Village Development as intended in paragraph (4) prioritizes ⁴⁸togetherness, kinship, and cooperation to realize the mainstreaming of peace and social justice.

Another basis is Article 86 states as follows: (1) Villages are entitled to access to information through the Village information system developed ⁵⁷by the District / City Government. (2) The Government and ³Local Government shall develop the Village information system and the development of Rural Areas. (3) Village information system as intended in paragraph (2) includes hardware and software facilities, networks, and human resources. (4) Village information system as intended in paragraph (2) includes Village data, Village Development data, Rural Areas, as well as other information related to Village Development and Rural Area development. (5) Village information system as intended in paragraph (2) is managed by the Village Government and can be accessed by the village community and all stakeholders. (6) District / City Government provides information on regency/city development ²⁵planning for villages.

There are six pillars of Smart Village: smart people, smart mobility, smart economy, smart government, smart living, and smart environment. The relationship of the 6 Pillars of Smart Villages with the National Long and Medium Term Development Plan (RPJMN) 2020-2024 is related to strengthening infrastructure and improving human resources (HR), as the following illustration:



Figure 1. The Six Pillars of Smart ⁵⁰villages through The National Long and Medium Term Development Plan (RPJMN) 2020-2024, of The Minister of Village Development of Disadvantaged Regions and Transmigration of Indonesia

²The six pillars are in line with the Regulation of the Minister of Village Development of Disadvantaged Regions and Transmigration (PERMENDES) No. 7 of 2021 concerning the Priority of The ⁶⁷Use of Village Funds in 2022, where Article 6 paragraph (2) is explained smart village activities ⁵³through the use of information and communication technology into one of the priority sectors in the use ⁶²of village funds, which is intended to encourage the achievement of village SDGs. As is known ⁷that the Village SDGs are derivatives of the 17 national SDGs which are made into 18 pillars as follows: 1. No Poverty); 2. Zero Hunger 3. Good Health and Wellbeing; 4. Quality Education; 5. Gender Equality; 6. Clean water and sanitation; 7. Affordable and clean energy; 8. decent work and economic growth; 9. Industry, innovation, and infrastructure; 10. Reduced inequalities); 11. Sustainable cities and communities; 12. Responsible consumption and production); 13. Climate action)

;14. Life below water) 15. Life on land); 16. Peace, justice, and strong institution); 17. Partnership for the goals); 18. Dynamic Village Institutions and Adaptive Village Culture.

Smart Village is a program to encourage the achievement of village SDGs through a measurement instrument called the Building Village Index (IDM). The Building Village Index (IDM) parameter is a composite index formed from three indices, namely the Social Resilience Index, the Economic Resilience Index, and the Ecological Resilience Index (Environment). The higher IDM value indicates the improved condition of the village in terms of social, economic, and ecological. IDM can determine the status of the village to be An Independent, Advanced, Lagging, and Very Lagging Village based on the value of these indices. Mandiri Village is a village that has availability and access to basic services, adequate infrastructure, and excellent public and government services. Desa Mandiri is a village that has a Building Village Index of more than 75 on a scale of 1 to 100. Using the size of the Building Village Index (IDM), currently, the number of independent villages reaches 3,269 villages or only 4% of the 74,961 villages throughout Indonesia.

Data from the Ministry of Villages, PDTT in 2021 showed that out of a total of 74,957 villages, there were still about 12,635 villages left behind and 5,649 villages were very left behind. And only 3,269 villages have the status of Mandiri Village. Through the smart village program, the Ministry of Kemendesa PDTT is optimistic that it can increase 12.21% of Developing Villages and 51.2% of Mandiri Villages by 2024 [16].

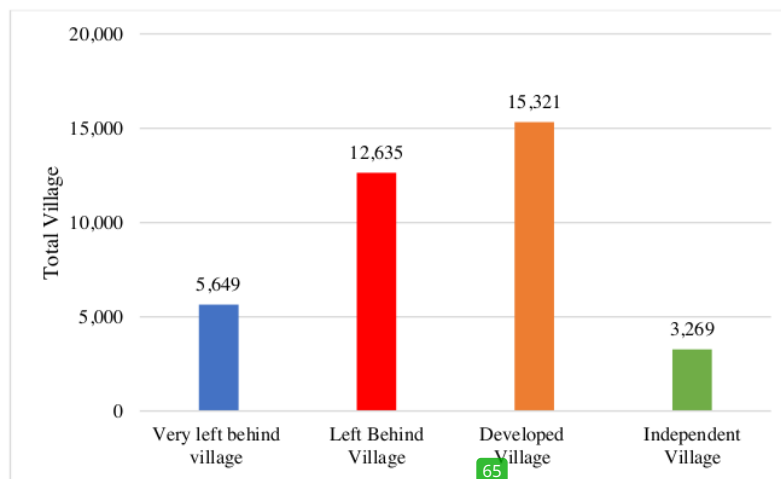


Figure 2. Status of Villages in Indonesia based on the Building Village Index

The development of the lagging village will be taken through a digital transformation process, which is packaged in the Smart Village program. [16]. This Smart Village policy is in line with the growth of users of the internet ecosystem and infrastructure today. In general, Indonesia is one of the countries with the largest population of internet users in the world. According to the We Are Social report, there are 204.7 million internet users or reaching 73.7% of the total population of Indonesia.

Currently, the availability of the internet, in general, is quite high, but the condition of the infrastructure is far from enough because the distribution of the internet has not been evenly distributed to the village, both in quantity and quality. There are still many villages that have not been reached by the internet network. Even if it is affordable quality, the quality is still low. Still limited to use for communication purposes, can not be used to manage data. Though the factors of network existence greatly influence the successful adoption of digital technology to realize a smart village [18].

Using this paradox, the rural community is the group that needs better digital connectivity the most to compensate for their remoteness, but in fact, they are least connected and included in the digital

work [19]. But the lack of internet networks has become a concern of the Indonesian government. The government issued a policy of accelerating the development of telecommunications infrastructure. As Press Release No. 168/HM/Kominfo /12/2020 concerning Indonesia's Digital Transformation Support states that the government is accelerating the development of telecommunications infrastructure to support Indonesia's digital transformation. The Indonesian Ministry of Information and Communication is working on the development of telecommunication infrastructure so that by the end of 2022 all villages and villages in Indonesia are affordable for 4G networks. For the remaining 3,435 villages and villages located in non-3T areas, mobile operator leaders have committed simultaneously to complete construction or present signals in the non-3T area no later than 2022, so that the remaining 9,113 villages and villages will be built by the Indonesian Ministry of Information and Communication [20,21].

The Government of Indonesia is committed to building a wide range of technology, information, and communication (ICT) infrastructure. The government built 348 thousand kilometers of fiber optic backbone broadband on land along 226 thousand KM and the seabed 123 thousand KM. It currently uses 9 telecommunication satellites including 5 national telecommunication satellites and 4 chartered foreign telecommunication satellites and will put multifunctional satellites with a capacity of 150 GB per second at 146 east longitudes of Indonesia's orbital slots. The Multifunctional Satellite of the Republic of Indonesia or SATRIA in the fourth quarter of 2023 will be able to be used [21].

4. Agriculture 4.0 development potential in smart village program

Agriculture is a very old profession and the main source of livelihood for rural people. But agricultural productivity is still mostly not optimally developed. Most farmers depend on natural conditions, such as the rainy season and old farming techniques. Smart farming can be a lifesaver for such people if applied in the right direction [22, 23].

The source of the rural economy generally comes from the management of natural resources, such as the agricultural sector. However, the rural agricultural sector has not been managed optimally, which in general is still conventional. Based on data from the 2018 Inter-Census Agriculture (SUTAS) survey, there is still about 87.59 percent of peasant households have not used technology. Only 7.28 households have mechanized and 3.26% use technology other than mechanization. This figure also illustrates the low productivity of Indonesian agriculture. Though the adoption of agricultural technology innovation is very important to improve the resilience of farmers' households. Technological innovation is needed in the production sector so that it can increase the productivity of quality agriculture at affordable prices [24].

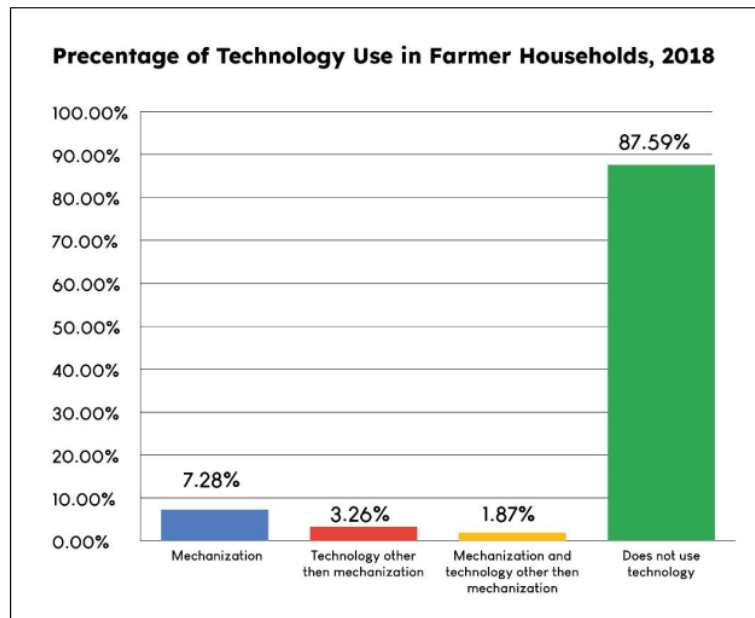
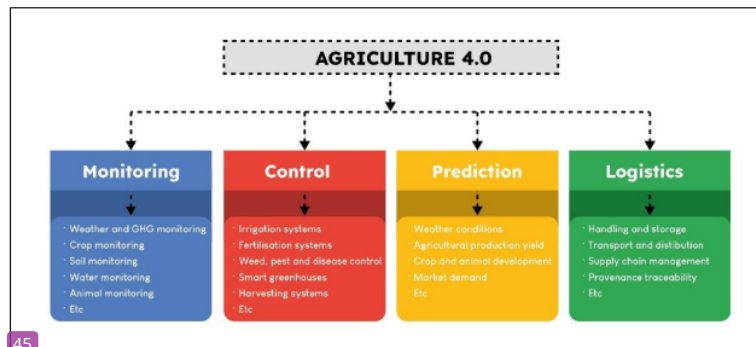


Figure 3. Percentage of technology used for farming households in Indonesia (2018) [24].

Following the development trend of [44](#) industrial revolution 4.0, currently, a digital transformation policy is a smart solution to increase agricultural [44](#) production. Currently, the application of agriculture 4.0 technology has been proven to increase agricultural [59](#) production. The core of agriculture 4.0 technology, is the use of Sensors and Robotics, the Internet of Things (IoT), Cloud Computing (Clouds), and Data Analytics in the form of Artificial Intelligence-Machine Learning, and Bigdata, and Decision Support System (DSS). This technology is used as an important instrument in agricultural digitization activities. [25,26,27]

Various kinds of technologies can be adopted to implement smart farming, such as weather forecasting technology that can monitor weather changes, various forms of smart applications, seed availability and cost information systems, fertilizers, pesticides, and other agricultural commodities, as well as various kinds of organic fertilizer training, and various other kinds [22]. Agriculture 4.0 technology can be operated on several forms of agricultural intelligent applications such as monitoring, control, prediction, and logistics in the agricultural sector [25], both upstream and downstream. For example, 1) monitoring applications that can be used to monitor weather, plants, soil, livestock, and others 2) Control Applications, in the form of remote control, against irrigation systems, fertilization, plant diseases, and harvesting. 3) Prediction applications, such as prediction of weather conditions, production, development of crops and livestock, and markets. 4) Logistics applications, such as warehousing systems, transportation and distribution, supply chain, and traceability aspects of a product.



45 **Figure 4.** Distribution of Agriculture 4.0 application domains and respective examples of applications (sub-domains) [25].

This technology can solve a variety of very complex problems and needs of the village, both agricultural, household, utility, and social [23]. In the world of agriculture, these applications are important instruments in the improvement of the production and value chains of agricultural products in the countryside. The digital application can overcome the main problems experienced by farmers in the field, such as the problem of climate change, the problem of low commodity selling prices, the problem of agricultural capital, environmental degradation problems, and so on. [25]. Through the intelligent application, it will eventually create a smart agricultural production process, as can be explained in the following several production chains:

4.1 Smart farming

Agricultural businesses today, have many obstacles, especially those related to the impacts of climate change, such as weather anomalies, crop diseases, low market prices, and so on. Under these conditions, farmers find it difficult to determine the right growing season, difficult to control crop pests, and so on. Through sensor technology, a tool can record weather conditions continuously and store them in storage called cloud computing (cloud servers). The way big data works is to bring data together from many different sources and applications. The data is converted into information that can help users to make strategic decisions. Information management focuses on transforming data into data information and can be useful information to rank the quality of agricultural production [28].

For example, the Indonesian Ministry of Agriculture has provided an application that provides information about the weather through the Planting Calendar (KATAM) application. The data on this application can be used to regulate when farmers can plant, and in which areas with what kind of land. (<http://katam.litbang.pertanian.go.id>). There is also an application of the Agricultural Land Monitoring Information System (SIPETANI). (<http://sipetani.pertanian.go.id>). To get high accuracy of weather data, the monitoring scale can be scaled down, weather monitoring technology can be installed on plantation sites or screen houses to record more microdata on a daily basis, over time. This tool serves to routinely monitor the microclimate around the location. The technology can observe weather, air and soil humidity, sunlight intensity, and wind speed. The technology is also able to store data for a long time, so it can be a reference in decision-making, such as planting time decisions, watering, spraying pests, and others.

With this data technology, a farmer can plant seasonally (off session), for example growing vegetables in the dry season, or planting tomatoes in the rainy season. For example, when temperature data is high, farmers may decide to use shade. To make this data more maximal, farmers can combine these monitoring devices with other platforms based on market price predictions that also use big data. With the combination of micro weather information systems and commodity market information systems, it is possible to make decisions about the planting calendar based on price predictions in the

market taken from data in the past. This will certainly maximize the income of farmers in the countryside.

In addition, through the Internet of Things (IoT) technology and remote sensing, farmers can use automated irrigation models to ease their work, which has been to transport water using human power. Not only that, through this digital tool farmers can monitor the condition of the garden from a smartphone application. It can even command watering remotely. So that farmers can focus on crop care. Irrigation using IoT proved successful in digital village programs in West Java [29].

15. Smart supply chain management

The value chain in the agricultural sector is an added value in agriculture that is formed when there is a change in the physical form or form of agricultural products or occurs due to the adoption of production methods, or a handling process that aims to increase the consumer base for the product so that producers get a larger portion of consumer spending. Agricultural product value chain management integrates the entire production process from processing, distribution, and marketing activities to products to the hands of consumers [30].

A common fundamental problem faced by Indonesian farmers is the relatively low level of their welfare compared to the level of welfare of economic actors in other sectors. This is partly due to the relatively low selling price of agricultural commodities received by farmers. The low price received, among others, is caused by the low bargaining position of the farmer. Agricultural commodities produced, especially food, are quickly damaged if not sold quickly, so farmers want to sell the commodity as soon as possible. In addition, some farmers already owe it to loan sharks who at the same time act as traders. These circumstances are utilized on-site by buying agricultural commodities produced by farmers at low prices. The entry of Industry 4.0 into manufacturing has had a lot of impact on the entire supply chain management. Collaboration between suppliers, manufacturers, and customers is critical to increasing transparency, from the moment of ordering, and delivery, to the end of product life. Furthermore, due to the introduction of digitization and process automation, the entire structure of supply chain management [31].

Because the structure of rural agricultural commodity markets is often dominated by only one or a few buyers, farmers have fewer choices to sell their crops. The situation is getting worse during the harvest because production is abundant. As a result, although the volume of agricultural commodities sold by farmers is relatively large, farmers' incomes still do not increase, because the selling price of commodities is cheap. This situation hinders the welfare of farmers. If these obstacles can be overcome, then the welfare of farmers can increase.

The main issue in the supply chain is the level of traceability of a product. Consumers often question the origin, processing process, and safety assurance of a product. A product can be well received when the traceability aspect is high. For this reason, a collaboration between suppliers, industry, and consumers is needed to increase the transparency of all stages of the [32]. The supply chain from product of farmers to being delivered until the product is in the hands of consumers [32] distinguishes between the traditional supply chain model and the current digital supply chain model as follows:

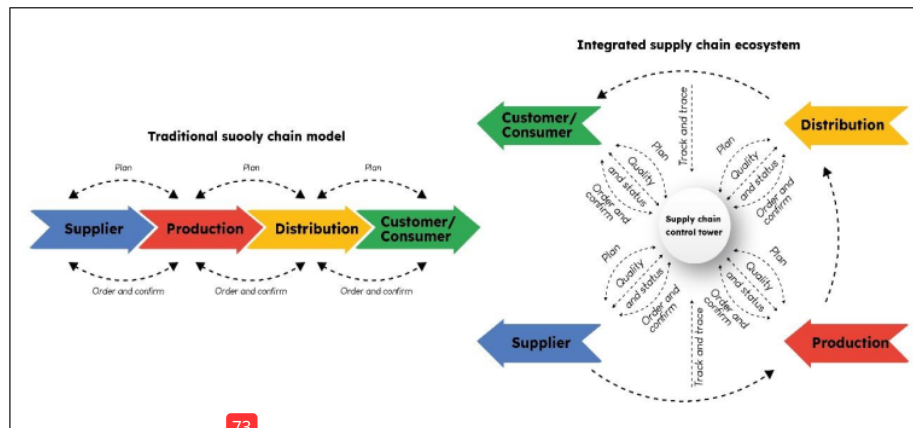


Figure 5. Differences between Traditional Supply Chain Systems (left) and Digital Supply Chain Systems (right) Source: [32]

To answer these challenges, digitization of every processing process and supply chain is one of the keys. The introduction of Industry 4.0 into manufacturing has many impacts on the whole supply chain. Collaboration between suppliers, manufacturers, and customers is crucial to increase the transparency of all the steps from when the order is dispatched until the end of the life of the product [31]. Internet of Things (IoT) applications, the use of robots and Artificial Intelligence (AI), the use of sensors in every process, process automation, and the application of big data analytics in the supply chain are devices that can improve consumer performance and satisfaction. The use of IoT logic and cloud computing can increase the depth of the system to monitor every movement of products and supply chain actors. The use of sensor applications in production, processes, and marketing environments offers detailed improvements in the accuracy of supply chain lines. Furthermore, big data analysis applications can create product-added value from the data obtained at each level. The level of traceability can also be increased through the use of the system blockchain [31,32,33].

The digitization of the supply chain allows companies to meet new customer requirements and increase efficiency. Digitization resulting in Supply Chain 4.0 makes the distribution and marketing process increase added value due to the following improvements: a) Supply chain becomes faster, as the new approach of product distribution reduces high delivery times. b) The supply chain is more detailed. Customer demand for increasingly individual products is on the rise. Customers are managed in a much more detailed group and a broad spectrum of suitable products will be offered; c) The chain is more accurate because the performance management system provides real-time, end-to-end transparency throughout the supply chain; d) Become more efficient, supply chains are driven by automation of physical tasks and planning [34].

In the future, this digital agrifood supply chain is a solution to increase the capacity of product traceability information systems that have various characteristics. All the information collected by digital supply chain systems can easily be found on the devices and mobile applications of manufacturers and consumers. The availability of this digital information can provide a guarantee of transparency and quality of food products. So that the supply chain ecosystem can be faster, more accurate, flexible, connected, and highly efficient.

In traditional supply chain systems, farmers often get losses during harvest, because agricultural products are often not accepted by the market. If accepted, sometimes at a very cheap price. With digital platforms in the form of e-commerce, supply chain systems are starting to change. Currently, there are thousands of farmers in West Java partnering with various e-commerce platforms, they sell tens to hundreds of tons of their garden products per day. As is known that West Java is the largest

supplier of capital city vegetable needs. Their supply chain system was shortened, that is, from the garden to the dining table, which used to be very long because it had to go through collecting merchants.

In this case, vegetable prices are also getting better, consumers are also satisfied because they can get fresh vegetables. The ordering system is pre-order or ordering upfront, thus minimizing the number of fresh materials wasted. After the consumer orders, then an order is placed to the partner farmer about the number of fresh ingredients that must be harvested. Several digital platforms are developing this model, such as Sayurbox, TaniHub, and others.

Because the prospects are considered good, recently a conglomerate company in Indonesia, namely Astra, PT Astra International Tbk. invested about US \$ 5 million or equivalent to IDR 70 billion more invested into Sayurbox [35]. Meanwhile, through the Tani Fund, currently, more than 46,000 farmers are supported, with farmers' income increasing by more than 25%. TaniHub has operations in 12 cities with 2,000 product varieties. The agricultural e-commerce company also claims to contribute to an increase in farmers' production by about 20% and currently has 350,000 buyers who are served [36].

4.3 Smart Financing

One of the problems that require solutions for farmers in rural areas is the problem of capital. There are still many farmers who do not have working capital in farming. Many of these farmers are farmers. With the development of technology 4.0, it is possible to form a funding platform in the form of community fundraisers through financial technology, peer-to-peer lending methods, and crowdfunding.

Some examples of agricultural platforms 4.0 that run capital models like this are I-Grow, TaniFund, and others. In addition to doing business in vegetable and fruit food needs for consumers, this company is also engaged in Fintech. TaniFund issued a peer-to-peer lending platform with a funding system, as a farmer's operational financing solution. The company raises public funds with the permission of the OJK (Financial Services Authority), by promising various benefits. The development of TaniHub's performance can be seen in the total loans distributed amounting to IDR 309.58 billion, the total loans paid off are IDR 191.96 billion. The average return is 14.11 percent per year. Total outstanding loans amounted to IDR 117.61 billion. Total loans are currently 132.11 billion rupiahs [36].

Another example is the I-Grow platform. The company also implements capital cooperation for farmers. This platform distributes funds to farmers, then the financier benefits from this process. The platform distributes funding for farmers who want to make a profit while increasing environmental impact and benefiting agriculture. Opportunities to invest in agriculture, for those who do not have land and do not have the time and skills to farm. At the same time helping farmers who do not have capital. I-Grow brings together both sides to take advantage. This is done responsibly and through the permission of the Financial Services Authority (OJK).

Until now only with the Indonesian market, iGrow has managed to employ 7,500 more farmers in 2,500 hectares more land and obtain good and quality crops. Not only that, but I-grow has also become a source of income for farmers, landowners, and capital funders. I-grow's performance can be seen in the total outstanding loans of IDR 212.1 billion, the accumulated loans distributed amounting to IDR 347.1 billion, and the accumulation of loans in 2021 amounting to IDR 80.2 billion. Average Margin of 12-18%. Total Active Borrowers are as many as 114 people [37].

4.4 Smart institution

Village communities can be likened to small republics, have almost everything they want in themselves, and are almost independent of foreign relations. [3] Law No. 6 of 2014 concerning Villages is one of the regulations that successfully change the order at the village level. The birth of Law No. 6 of 2014 concerning Villages has brought villages to their autonomy that is within the framework of the Unitary State of the Republic of Indonesia. Villages that have broad authority get a

significant increase in budget supply. The challenge is how the institutional function of the village can run effectively and efficiently so that the large budget that has been issued by the government can provide community welfare.

One of the institutions mandated in the Law is Village-Owned Enterprises or BUMDes. Law No. 6 of 2014 concerning Villages mandates that villages have Village-Owned Enterprises. BUMDes activities can adjust to the potential of their respective villages so that BUMDes can run optimally. The role of BUMDes is very strategic in the management of the village economy [38].

Many things can be done through Bumdes, especially in ensuring the smooth supply chain of agricultural production. During this time agricultural production experienced obstacles in marketing and distribution. Prices are often toyed with by middlemen or steaming traders. This causes farmers to be in a disadvantaged position. In this case, BUMdes can overcome this problem by building an extensive market network through the use of digital technology. BUMdes can manage online or e-commerce stores that market local village products [39].

4.5 Smart Environment (Sustainability)

Sustainable agriculture standards can refer to 5 principles of FAO namely: Principle 1) Improving efficiency in the use of resources is essential for sustainable agriculture; Principle 2) Sustainability requires direct action to conserve, protect and improve natural resources; Principle 3) Agriculture that fails to protect and improve rural livelihoods, equality and unsustainable social welfare Principle 4) Improving the resilience of communities, communities and ecosystems is key to sustainable agriculture; Principle 5) Sustainable food and agriculture require a responsible and effective governance mechanism [39].

Therefore, sustainable agriculture should be defined not only in terms of its long-term economic productivity but also in terms of its environmental and social benefits and costs [40] Sustainable Agriculture is 1) Emphasizing methods and processes that increase soil productivity while minimizing harmful effects on climate, soil, water, air, biodiversity, and human health. 2) Aim to minimize the use of inputs from non-renewable sources and petroleum-based products and replace them with those derived from renewable resources. Focus on local communities and their needs, knowledge, skills, socio-cultural values, and institutional structures. 3) Ensure that the basic nutritional needs of current and future generations are met in both quantity and quality. 4) Provide long-term employment, adequate income, and dignified and equal working and living conditions for everyone involved in the agricultural value chain. 5) Reduce the vulnerability of the agricultural sector to adverse natural conditions (e.g. climate), socioeconomic factors (e.g. strong price fluctuations), and other risks. 6) Encourage sustainable rural institutions that encourage the participation of all shareholders and promote the reconciliation of interests

Precision farming or smart farming is considered to significantly increase agricultural production both in terms of productivity and sustainability. Although productivity seems to be the driving force of any technological advances in agriculture, the importance of sustainability should not be overlooked. Sustainability is emerging as a major issue across the spectrum of human activity so one of the goals of intelligent farming is the minimization of the environmental impact of agricultural activities [41].

Precision farming, in combination with more productive crop/livestock varieties and the use of decision support systems to encourage evidence-based decision-making, can lead to smarter use of inputs in exchange for greater rewards. In addition, robotic technology can provide benefits to agricultural communities as compensation for labor loss, which is becoming a serious problem in developing countries as populations migrate to urban centers. Smart farming can enhance social sustainability by supporting the profitability of agricultural businesses, and by providing a wide range of high-tech jobs [42].

In practice, there are several that can be supported by the existence of Agriculture 4.0. For example, overcoming climate change, producing water use, avoiding lost crops, and excessive use of fertilizer can be avoided, and can also support the improvement of the welfare of smallholder farmers.

Thus, the development of the agriculture 4.0 model in smart village program activities is in line with the sustainability principles that exist in the sustainable development goals (SDGs) of the Village.

5. Digital transformation for the smart village in agricultural 4.0 based

Agricultural-Based Digital Transformation in Indonesia the Smart Village Program carried out by the Ministry of Village PDTT is a digital transformation process based on five strategic steps, as follows: 1) Accelerate the expansion access and improvement of digital infrastructure and the provision of internet services; 2) Prepare a digital transformation roadmap around strategic sectors. Whether in the government sector, public services, social assistance, education, health, trade, industry, and broadcasting; 3) acceleration of national data center integration; 4) Preparing the needs of digital talents; 5) Prepare regulations as soon as possible regulation of funding and financing schemes [15].

The main objectives of the digital transformation process are: 1) forming and improving internet connectivity in rural areas; 2) spur and increase the growth of the digital economy / increasing the growth of the digital economy through BUMDesa Bersama; 3) Capacity building by carrying out capacity building activities in the framework of technical training of human resources in order to develop digital / internet facilities and infrastructure.

Digital transformation is a strategic priority project in the RPJMN 2020-2024 on integrated villages. One of the important parts of the village concept is the development of the village economy which includes: the development of tourist villages, digital villages, superior products of villages and rural areas, and the development of BUMdesa / BUMDes Bersama. The achievement of digital transformation is carried out through various activities, mainly through Piloting and Real Living Lab.

5.1 Pilot project villages

Smart Village Nusantara (SVN), in its presentation, is projected to be 1,000 which will be implemented in 2020-2024 through the collaboration of various stakeholders, both from programs and budget allocations. A number of villages in various districts and provinces have been initiated into Smart Villages. In fact, this program is an implementation of the Smart City Nusantara Concept. The essence of the Smart City program is the use of Information and Communication Technology to improve comfort, security, efficiency, and workability in providing sustainable services and can improve people's lives by prioritizing local wisdom in the area. The Smart Village Nusantara program is the implementation of Smart City in the village scope. As a derivative of the concept, initiative and implementation of a Smart City, Smart Village adopts a smart city approach that is adapted to the conditions, needs and problems of the village and is one of the supporting factors for the use of digital aspects in its daily life.

The real form of this Smart Village pilot project is the training of village digital cadres, the development of smart village networks, and the formation of piloting villages. To accelerate the Smart Village program, Smart Village Nusantara piloting has been carried out in collaboration with Telkom. This activity is focused on three main aspects, namely government administration, economic and social. Several districts have initiated cooperation with Telkom [43].

Smart Village Nusantara (SVN) is a collaboration program between PT. Telkom Indonesia with the Ministry of Village PDTT and local government. In this program, Telkom is committed to playing an active role in developing 5 pilot projects called Smart Village Nusantara. The objectives of this program are a) Incubation of Solution: Incubation of Telkom Group Product/ Solution to support the development of the digital village ecosystem; b) Real Living Lab: collaboration tools and benchmark for villages or other stakeholders (related Ministries / Institutions); c) Digital Village Transformation: Experience for piloting villages for empowering and sustainable improvement of the village economy.

The pilot project location consists of several selected villages that have different characteristics and potentials. Various applications supporting the digitization of the village are provided according to the needs and characteristics of the village and are encouraged by optimizing its use for sustainable development. So that the process of community assistance is also part of the digital village piloting

agenda so that people become skilled in using and become accustomed to utilizing digital technology in everyday life.

There are several villages that are the object of the Smart Village Nusantara pilot. 1) Palasari Subang Village, West Java, with a population of 6,747 people, about 55 percent of whom are working as entrepreneurs. The potential of the village is the agricultural sector, animal husbandry, and SMEs. 2) Pangandaran Village, Pangandaran Regency, West Java, has a population of 11,057 people, 50 percent of whom are fishermen and entrepreneurs. The potential of the village is tourism, fisheries, and SMEs. 3) Kemuning Village, Karanganyar Regency, Central Java, which has a population of 6,800 thousand with a profession of about 50 percent of farmers and 20 percent of entrepreneurs. The potential of the village is Tourism, Culture, and Agriculture; 4) Sambirejo Village, Yogyakarta with a population of 5,677 people, 25 percent farmers and daysmen. The potential of the village is tourism, MSMEs, and Culture; 5) Ranupani, Lumajang East Java with a population of 1,487 people, and 95 farmers, the potential of the village is agriculture and culture.

These villages intervene with different activities and are facilitated with different equipment, such as connectivity and infrastructure, support devices, applications, and socialization. All facilities are provided based on the potential and needs of each village.

5.2 Smart farming for food security

One of the main potential villages in Indonesia is the agricultural sector, including villages that have been included in the SVN pilot project. This is certainly in line with the program to improve food security by the message from Permendes No. 7 of 2021 concerning the priority of the Use of Village Funds in 2022, especially in article 6 paragraph 2 which includes: a) strengthening food security, which can be done through the use of agricultural digital technology b) the establishment, development, and revitalization of BUMDes / BUMDesma, which can be done to improve the supply chain system of agricultural production; c) the development of productive economic businesses, such as processing raw materials from agricultural production, especially those managed by BUMDes / BUMDesma, which can be done to support the downstream agricultural sector. d) development of information and communication technologies, which serve to support digitization in all production links.

The method to realize sustainable food security is through digital transformation in the agricultural sector commonly called Agriculture 4.0, namely the digitization of integrated agriculture both upstream and downstream, such as Smart Farming, Smart Supply Chain Management, Smart Financing, and others. The implementation of Agriculture 4.0 makes agricultural cultivation activities more efficient, measurable, and integrated.

To support food security, the Ministry of PDTT encourages the use of Smart Farming technology. Kemendes PDTT plays an important role in helping farmers increase productivity. Currently, pilot projects have been built to implement smart farming in several areas that have the potential of largely agricultural land. In 2021, the implementation of the Smart Village program is at the stage of human resource development. This program is targeted to run effectively in the future. Kemendes PDTT built a pilot project applied on an area of 250 hectares by involving other stakeholders who have the capability for smart farming development. Some of the areas that will be the location of the smart farming pilot project are a) Garut, West Java, b) West Pasaman, West Sumatra; c) Sukabumi, West Java; d) Situbondo, East Java; e) Dairi, West Sumatra; f) Brebes, Central Java; g) Banyuwangi, East Java; h) Badung, Bali; i) Ponorogo, East Java; j) East Lombok, NTB; k) Cianjur, West Java; l) Malang, East Java. [44].

By 2022, a pilot village will be established in Central Sulawesi and will be developed into other villages. The Ministry of PDTT with the Central Sulawesi Provincial Government has signed a Memorandum of Understanding (MoU) on December 6, 2021. There are three districts whose villages are used as Smart Village pilot villages including there are 20 villages in Parigi Moutong regency, 20 villages in Sigi district, and 20 district villages in Banggai. Consideration of the selection of Central Sulawesi Province to be the location of the Smart Village pilot project, because the Central Sulawesi Provincial Government happens to also be implementing the Smart Village program. Through this

Smart Village, Central Sulawesi is targeted to be equipped with information technology facilities and infrastructure. If the scenario goes, then in the next 10 years the people of Central Sulawesi already can use information technology, to improve their welfare [45].

With the Smart Village program, village communities will benefit from technology, the community will get assistance in identifying innovative solutions to develop basic services and local economic development. The community will also benefit from the opening of opportunities to collaborate directly with various parties. The Kemendes PDTT Ministry aims to print 3,000 Smart Villages by 2024. Kemendes PDTT cooperates with the Telecommunication and Information Accessibility Agency (BAKTI) of the Ministry of Communication and Information Technology (Kominfo) as a facility for telecommunication infrastructure needs [45].

For the funding of the Smart Village program, funds in the Ministry of Kemendes PDTT managed by the Center for The Development of Village Competitiveness, Disadvantaged Regions, and Transmigration, The Development and Information Agency, specifically for the Smart Village program, reached hundreds of billions for two years. The budget value is IDR 326 billion until 2024. In addition, the government has also agreed on cooperation support from the World Bank to improve the system and strengthen institutions to improve the implementation of the Village Law, through the Strengthening Government and Village Development Program (P3PD).

For example, the Ministry of PDTT and the Regional Government of Situbondo Regency, East Java, have collaborated with the private sector, to conduct a trial of smart agriculture 4.0 in Battal Village, Panji District. With the implementation of the agricultural system agriculture 4.0 like this, it is believed to attract young people to farm. The increase in agricultural productivity is expected to increase the potential of the area. For this reason, the Ministry of PDTT has created a smart farming 4.0 roadmap as follows: (i) trial of the use of drone sprayer devices on cornfields in Sleman Regency and the review of soil and weather sensor equipment in rice fields in Wonogiri Regency; (ii) Sumbawa Regency has conducted trials of the use of drone sprayers and soil and weather sensors in rice fields; (iii) East Sumbawa Regency has conducted trials of the use of drone sprayer and soil and weather sensors in rice fields; (iv) Situbondo Regency has carried out the launch of smart farming 4.0 and trials of the use of tools (drone sprayer, soil and weather sensor, and water discharge sensor), (v) Tabanan Regency has conducted trials of the use of tools (drone sprayer, soil and weather sensor, and drone surveillance) [46].

All of these techniques can help create precision agriculture and intelligent farming by using satellite imagery, and other technologies (such as sensors), to observe and record data to minimize costs and save resources while increasing production output. Central Java Post, 2019) [46].

6. Conclusions

From the existing data, it can be seen that: (a) The concept of agriculture 4.0 is very likely to be part of the implementation of the Smart Village program, considering that Indonesian villages are generally agricultural villages, and farmers are generally still conventional. There is still about 87.59 percent of farming families have not been touched by technology today. Rural areas and agrarian communities can be directed to support food security programs through agricultural digitization programs. If these farmers intervene with the digitalization program, of course, it is very potential to support food security. (b) Agricultural technology 4.0 has characterization as a sustainable activity, such as its ability to minimize input use, minimize water use in agricultural cultivation, and the ability to make various predictions that are beneficial for farmers; (c) thus, the agriculture-based smart village program 4.0, will provide a great opportunity to be able to contribute to food security in Indonesia in a sustain; (d) Through this activity, the government hopes to increase the Village Development Index (IDM), from a lagging and very disadvantaged village to a developed village and an independent village, while achieving the village's Sustainable Development Goals (SDGs) goals, through the digitization of the service sector and the production sector.

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