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Assesing the Impact of Digital Technologies on Governance Policies for Food Security: A Case Study of Indonesia

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Abstract.
Food security has emerged as a crucial priority for the Indonesian government, as highlighted in Indonesia's ASEAN chairmanship in 2023. This study explores the implications of digital transformation on food security in Indonesia using a literature review method. Previous studies have shown the importance of technology adoption in agriculture and the potential benefits it offers to improve productivity and access to market information. The results showed a positive trend in food security in Indonesia, potentially influenced by the ongoing digital transformation of the agricultural and food sectors. Furthermore, this study analyzes the implications of the area of harvested land, productivity per hectare, and total production on food security. The data indicated that the harvested land area remained relatively stable over the years, with minor fluctuations. Total production showed consistent stability, whereas productivity per hectare steadily increased. This study also analyzed the food security index based on three aspects: availability, access, and consumption of food. Continuous monitoring and evaluation of digital initiatives are essential to track progress and inform evidence-based decision making.

Keywords: digital transformation, food security, food security index

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1. Introduction

The agricultural sector that produces food is an important aspect of global geopolitics. Indonesia has a high potential in the field of food. The concept of national resilience in Indonesia aligns with the concept of food security defined by the Food and Agriculture Organization (FAO) as a condition in which all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and preferences for an active and healthy life FAO, [1]. This concept allows the establishment of an agricultural system in a country, as long as the population has physical and economic access to food Ningrum et al., [2]. More broadly, food security refers to the sufficiency of food needs for the population. However, as times change, food security is not only concerned with meeting basic food needs. As stated by Armawi [3], food is

the most essential basic human need for survival and survival. Therefore, the availability of food resources is crucial to ensure an adequate supply of food of acceptable quality and medically safe for consumption.

Food security has emerged as a crucial priority for the Indonesian government, as highlighted by Indonesia's chairmanship of ASEAN in 2023 (Ministry of Communication and Information Technology, 2023a). The government recognized the significance of food security by prioritizing it a priority issue in the ASEAN-China Year of Agricultural Cooperation and Food Security, which was launched in Beijing. The initiative, initiated in November 2022, focuses on collaborating on green agriculture, agricultural digitization, and market access between ASEAN and China. It is part of the implementation of–China Joint Agreement on Food Security. The program aims to enhance market access for agricultural products, exchange information, and develop high-tech agricultural capabilities to meet the food needs of two billion people in ASEAN and China. Despite its agricultural potential, Indonesia's food security has lagged behind that of the other countries. According to the Global Food Security Index (GFSI) for 2021, Indonesia's food security index score was 59.2, lower than Singapore's score of 77.4, which was the highest in Southeast Asia. However, there was a slight improvement in Indonesia's Food Security Index in 2022, reaching 60.2, an increase of 1.7 from the previous year. Nevertheless, Indonesia's food security still fell below the global average of 62.2 and the Asia-Pacific average of 63.4, ranking 63rd out of 113 countries (Ministry of Communication and Information Technology, 2023b). However, Indonesia's food security remains relatively strong and ranks fourth in food security within ASEAN, trailing behind Singapore, Malaysia, and Vietnam.

The development of technological ecosystems in the era of the Fourth Industrial Revolution (Industry 4.0) is considered crucial for advancing the digital agricultural economy. This development is closely linked to the growth of the digital agricultural economy, which serves as a foundation for further national economic development. In other words, the growth of the national economy correlates with an improvement in food security. Despite advances in technology and its widespread adoption, the vital role of the agricultural sector in food production remains irreplaceable. Additionally, the increasing population of Indonesia must be accompanied by an increase in agricultural productivity. Until now, the focus of food security policies has been on increasing availability. However, there is a need for policy focus to shift towards improving affordability and quality of food nutrition. The COVID-19 crisis demanded a shift towards a digital food defense system. The role of digital transformation includes: (1) enhancing efficiency and accuracy in food distribution; (2) enabling more accurate and real-time data collection on

production, supply, and demand for food; (3) providing nutritional information, healthy food recommendations, and nutrition education to the public; and (4) direct involvement of farmers and food industry players through the use of technologies such as farming applications, agricultural sensors, or digital markets to improve farmers' productivity, production process efficiency, and access to wider markets Wibowo, [4].

Digital transformation has the potential to strengthen food security and reduce poverty. A key advantage of digital technologies is their quick access to communication and information. According to Biancone et al. [5], this accessibility enables an easier projection of the demand and supply of domestic food commodities. With improved information flow, domestic industries can better understand market needs and align their production. Additionally, this information can be utilized to ensure that the produced goods are efficiently consumed by the domestic community Elseidi, [6]. The development of technology has also stimulated new research studies aimed at optimizing the production of food commodities in Indonesia. Internet access plays a crucial role in this process. The availability of online resources and data allows researchers and policymakers to gather relevant information, analyze trends, and make informed decisions to improve food security. By analyzing the current state of food security, exploring the role of digital technologies in enhancing governance policies, and examining the effectiveness of these policies, this study aims to assess the impact of digital technologies on governance policies for food security in Indonesia.

2. Methods

This study employed a literature review method to assess the impact of digital technologies on governance policies for food security in Indonesia. Relevant sources were identified based on their relevance to the impact of digital technologies on food security governance policies. Journal articles, conference proceedings, reports, and governmental publications were included in this review. Data extraction was performed to collect relevant information from the selected studies. Key data elements include authors, publication year, research focus, methodology, findings, and implications. The extracted data were organized and analyzed thematically to identify patterns, trends, and gaps in the literature.

The synthesized findings are presented and discussed in a narrative format, highlighting the impact of digital technologies on governance policies for food security in Indonesia. The implications of these findings are interpreted in the context of existing theories, frameworks, and empirical evidence.

3. Results and Discussion

3.1. Previous Studies on Food Security in Digital Age

Research on agriculture and food security that focuses on the utilization of technology is limited. A study titled ”Strategies for Food Security Development” by Nurhadi [7] shows the development of food security through the analysis of an Internal-External Matrix, including the development and enhancement of cooperation networks, improvement of food distribution capacity, establishment of food reserve systems, enhancement of community empowerment and participation, and the development of diversification and food consumption. Similarly, Jaya [8] explains that the government tends to disagree and attempts to rapidly lower agricultural commodity prices in line with the policies adopted when agricultural commodity prices rise, aligning with the government's vision to improve farmers' welfare. This contradicts the perception of farmers regarding agricultural commodity price policies in Indonesia, as farmers feel that they have no hope of achieving economic prosperity. Furthermore, farmers perceive that the agricultural sector does not offer a favorable fate as a primary occupation. This continuous decline in the number of farmers has weakened food security at the regional level.

Fatchiya's research [9] titled ”The Application of Agricultural Innovation Technology and its Relation to Household Food Security of Farmers” demonstrates the efforts made by most farmers who own paddy fields through the intensive application of innovative technology, such as the system of intensive row planting (jajar legowo). Additionally, farmers with dry fields show intensive innovation through intercropping systems and processing of their agricultural produce.

Afifah's [10] research on the Implementation of Digital Marketing and its Influence on the Success of Micro, Small, and Medium Enterprises in the Creative Sector in Indonesia and Malaysia explains that knowledge of the implementation of digital marketing is the most essential and influential factor in the success of adopting digital marketing. They are also believed to provide greater benefits for the future of their businesses.

Previous studies on digital agricultural economics by Lubis [11] describe the effective integration of Information and Communication Technology (ICT) in the agricultural sector, which will lead to sustainable agriculture by providing timely and relevant agricultural information, enabling farmers to make informed decisions to improve productivity. ICT can greatly enhance farmers' accessibility to market information, commodity inputs, consumer trends, and relevant agricultural information, which positively affects the quality and quantity of their products. Information on marketing, new crop and livestock

management practices, pests and diseases, transportation availability, new marketing opportunities, and input and output prices in the agricultural sector is crucial for an efficient and productive economy.

In a scientific publication by Warr [12] titled ”Food Security vs. Food Self-Sufficiency: The Indonesian Case,” it was explained that food security is an important social goal and relies on the international food market to meet the needs of Indonesia’s growing population. The preferred strategy for increasing self-sufficiency is to improve agricultural productivity. This reduces imports by increasing agricultural yields but without raising domestic food prices and without creating conflicts between the higher self-sufficiency goals on one hand and food security and poverty reduction. Rahim et al. [13] wrote that in the field of agricultural economics, there is a price difference between the producer (farmers) and consumer levels. This difference is usually referred to as the marketing margin’. In economic terms, the marketing margin is the difference or gap between the purchase price paid by consumers and the selling price received by producers. This is influenced by the length of the market chain or the number of traders involved, resulting in higher marketing costs. Consequently, this leads to a larger marketing margin, causing the selling price received by farmers to become smaller, potentially affecting their income and welfare.

Subejo [14] wrote about the Access, Usage, and Determining Factors of Information and Communication Technology in Commercial Agricultural Areas to Support Food Security in Rural Yogyakarta. This explains that to support the sustainability of commercial agriculture, there needs to be speedy information services that can contribute to achieving high food security. The representation of farmers’ access to information and communication technology in rural areas can be seen through the ownership of ICT media, which reflects the capacity, flexibility, and alternatives available to communities in utilizing and accessing information through ICT. Consequently, there is a need to improve the content variety to be more comprehensive, covering all aspects, such as production techniques, marketing, policies, success stories, community interests, and agricultural financing using ICT media for agricultural activities in commercial agricultural areas. Additionally, collaboration between senior and young farmers can exchange information and complement each other based on their respective characteristics. Young farmers tend to focus on accessing new media that provides detailed information at high speeds, while senior farmers tend to access multiple media sources, necessitating collaboration between the two.

3.2. Budget Policy for Food Security

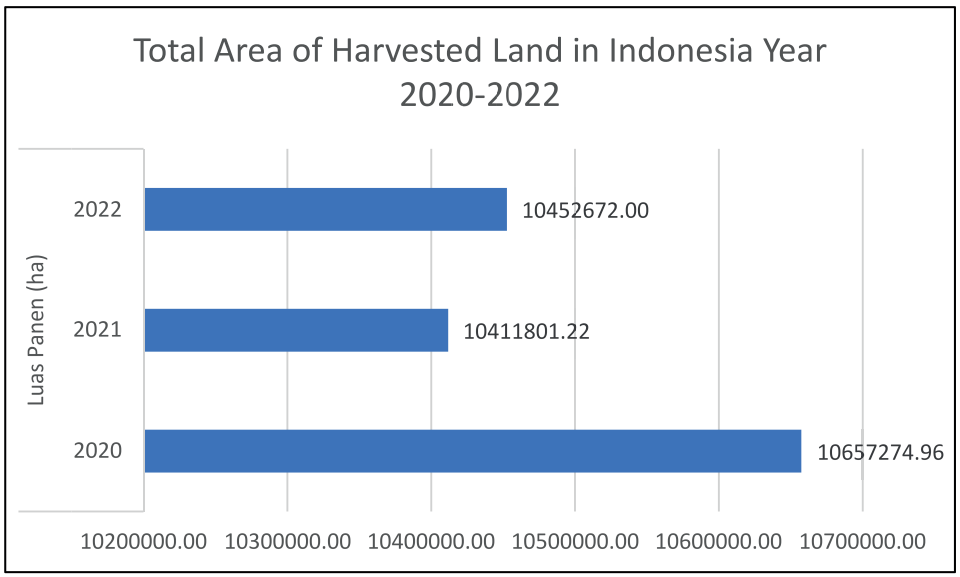
According to Portal Informasi Indonesia (2023), the government has allocated a food security budget amounting to IDR 104.2 trillion in 2023, with a focus on strengthening the agricultural sector and maintaining food reserves. Strengthening the agricultural sector includes the development of farming practices and infrastructure, including storage facilities, fertilizer subsidies, and low-interest credit. The mechanisms for disbursing these funds are as follows: For ministries and institutions, the Ministry of Agriculture has been allocated IDR 15.3 trillion for food security purposes, the Ministry of Maritime Affairs and Fisheries (KKP) IDR 6.8 trillion, the Ministry of Public Works and Housing IDR 23.9 trillion, and the National Food Agency IDR 100 billion. Additionally, IDR 25.3 trillion was allocated for fertilizer subsidies, IDR 1.8 trillion for government rice reserves, and IDR 2.6 trillion for other food price stabilization programs. Furthermore, transfers to regional areas include IDR 8.6 trillion for physical special allocation funds (DAK), IDR 0.3 trillion for non-physical DAK, and IDR 13.6 trillion for village funds. Moreover, the government will provide microcredit (KUR) for agricultural tools and machinery, ranging from IDR 500 million to IDR 200 billion, with an interest rate of 3 percent. To maintain the purchasing power of the population, the government will also distribute assistance to recipients of the Conditional Cash Transfer (PKH) program in the form of eggs and chicken meat for three months, starting in March, April, and May 2023.

3.3. Implication of Area of Harversted Land, Productivity, adn Production Towars Food Security

The data provided by BPS (2023) show trends in the area of harvested land, productivity per hectare, and total production over a three-year period (Figure 1, 2, and 3).

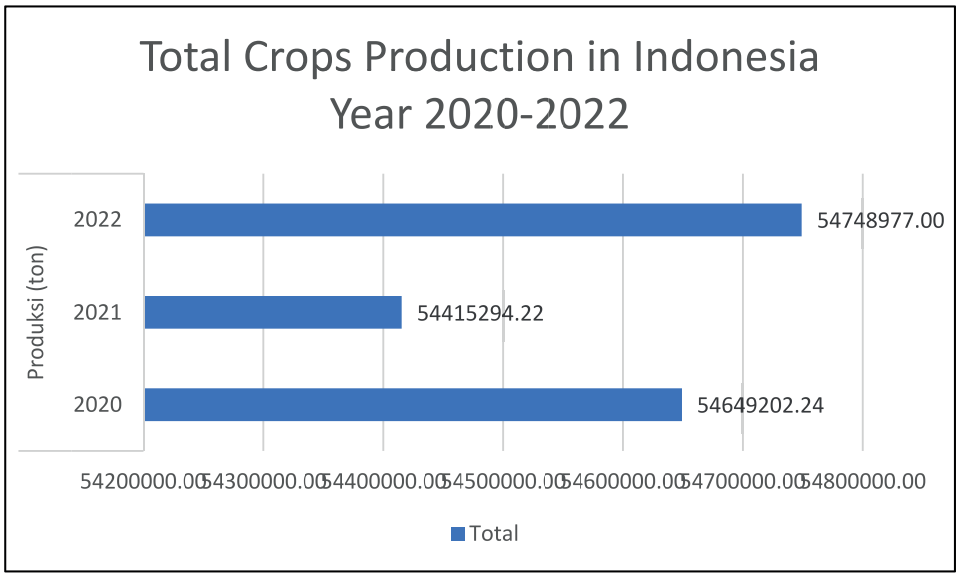
1. **Area of harvested land**
2. In 2020, the harvested land area was 10,657,274.96 hectares.
3. In 2021, the harvested land area was 10,411,801.22 hectares.
4. By 2022, the harvested land area was 10,452,672.00 hectares.

From these data, we can see that the harvested land area remained relatively stable over the three years, with minor fluctuations. Although there was a slight decrease from 2020 to 2021, the difference was not statistically significant. The harvested land area in 2022 increased slightly compared to that in 2021, indicating potential recovery or stabilization.



Source: BPS, 2023

Figure 1: Total Area of Harvested Land in Indonesia Year 2020-2022.

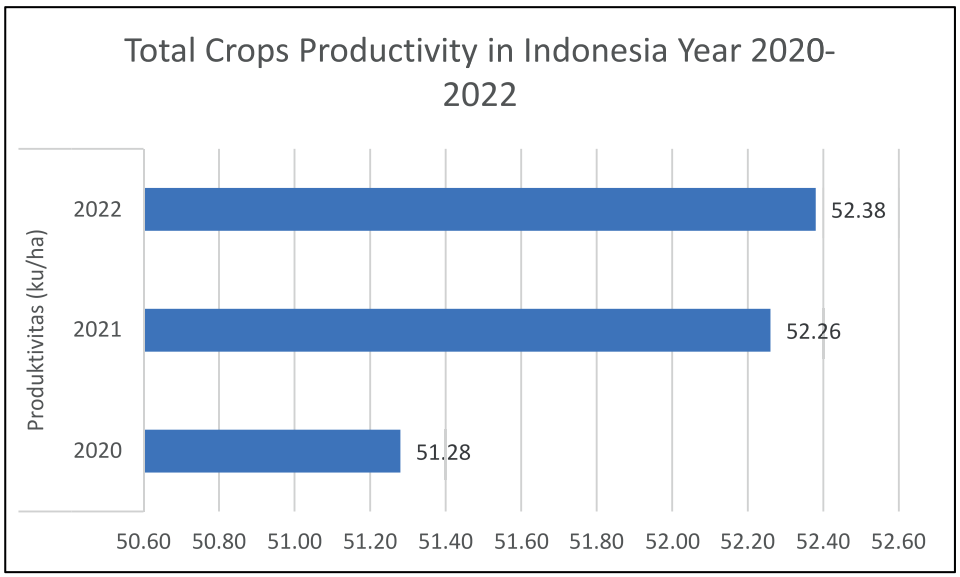


Source: BPS, 2023

Figure 2: Total Crops Production in Indonesia Year 2020-2022.

1. **Production**
2. In 2020, total production was 54,649,202.24 tons.
3. By 2021, the total production was 54,415,294.22 tons.
4. By 2022, the total production was 54,748,977.00 tons.

The production data showed that total production remained relatively stable across the three years, with small fluctuations. There were no significant variations in the total



Source: BPS, 2023

Figure 3: Total Crops Productivity in Indonesia Year 2020-2022.

production, indicating a consistent output. A slight increase in total production from 2021 to 2022 suggests a positive trend.

1. **Productivity per hectare**
2. In 2020, productivity per hectare was 51.28 units.
3. In 2021, productivity per hectare was 52.26 units.
4. In 2022, productivity per hectare was 52.38 units.

The data show that productivity per hectare consistently increased over the three years. There is a steady improvement in productivity, with the highest value recorded in 2022. Increasing productivity suggests advancements in agricultural practices, technology, and crop management techniques.

1. **Implications**

Based on the data analysis, the following implications can be drawn regarding Indonesian food security in the digital transformation era:

Potential for Enhanced Productivity: Digital transformation presents opportunities to improve agricultural productivity further. By leveraging digital technologies, such as precision agriculture, data analytics, and remote sensing, farmers can optimize resource utilization, monitor crop health, and make data-driven decisions. This can lead to increased productivity and improve food security.

Sustainable Resource Management: Digital technologies can help in efficient resource management, such as water, fertilizers, and pesticides, ensuring their optimal use. By employing sensor-based irrigation systems, AI-powered crop monitoring, and smart pest management, farmers can reduce resource wastage, minimize environmental impacts, and promote sustainable agricultural practices.

Supply Chain Optimization: Digital transformation can improve supply chain efficiency, reduce postharvest losses, and ensure timely delivery of produce. Technologies such as blockchains can enhance traceability and transparency, reduce food fraud, and improve consumer confidence. Efficient supply chains can contribute to food security by minimizing food loss and improving access to fresh and nutritious products.

Access to Information and Market Opportunities: Digital platforms and mobile applications can provide farmers access to market information, weather forecasts, and best practices. This enables farmers to make informed decisions, connect directly with buyers, and access fair prices for their produce. Enhanced access to information and market opportunities can empower farmers, especially smallholders, and contribute to improved livelihood and food security.

Data-driven decision-making: The availability of data through digital technologies enables policymakers and stakeholders to make informed decisions and develop evidence-based policies. Data analytics and predictive modeling can help identify trends, anticipate risks, and design targeted interventions to address food security challenges effectively.

Inclusive Digital Adoption: It essential to ensure inclusive digital adoption, addressing the digital divide between farmers and rural communities. Efforts should be made to provide training, technical support, and affordable access to digital technologies, particularly for smallholder farmers and marginalized groups. Inclusivity in digital transformation can contribute to equitable access to resources, opportunities, and information, thereby promoting overall food security.

Resilience and Adaptability: Digital technologies can improve the resilience of food systems by facilitating early warning systems, weather forecasting, and disaster response. By utilizing real-time data and predictive analytics, farmers and policymakers can better prepare for and mitigate the impacts of climate change, natural disasters, and other crises, thereby ensuring continued food production and security.

Strengthening Digital Infrastructure: To fully leverage the benefits of digital transformation, investments in robust digital infrastructure, such as reliable Internet connectivity and access to electricity, are essential. Improving infrastructure in rural areas can

enable the wider adoption of digital technologies and ensure that farmers and rural communities can fully participate in digital transformation.

Farmer empowerment and capacity building: Along with the adoption of digital technologies, it is important to provide training and capacity-building programs to farmers. Educating farmers on the use of digital tools, data interpretation, and decision-making processes can enhance their digital literacy and enable them to harness the full potential of digital technologies to improve their productivity and resilience.

Collaboration and Partnerships: Effective implementation of digital transformation in the agricultural sector requires collaboration among various stakeholders, including government agencies, technology providers, research institutions, and farmer organizations. Collaborative efforts can promote knowledge sharing, innovation, and the co-development of digital solutions tailored to the specific needs and challenges of Indonesian agriculture.

Policy and Regulatory Framework: It crucial to develop an enabling policy and regulatory framework that promotes innovation, protects data privacy and security, and supports responsible use of digital technologies in agriculture. Clear guidelines and standards can help ensure that digital transformation in the food sector is sustainable, equitable, and aligned with the national development goals.

Monitoring and Evaluation: Continuous monitoring and evaluation of the impact of digital transformation on food security is essential. Regular assessment of the effectiveness and efficiency of digital initiatives can provide insights into necessary adjustments, identify successful models, and scale up best practices. Monitoring also enables policymakers to track progress towards food security goals and make informed decisions based on data-driven evidence.

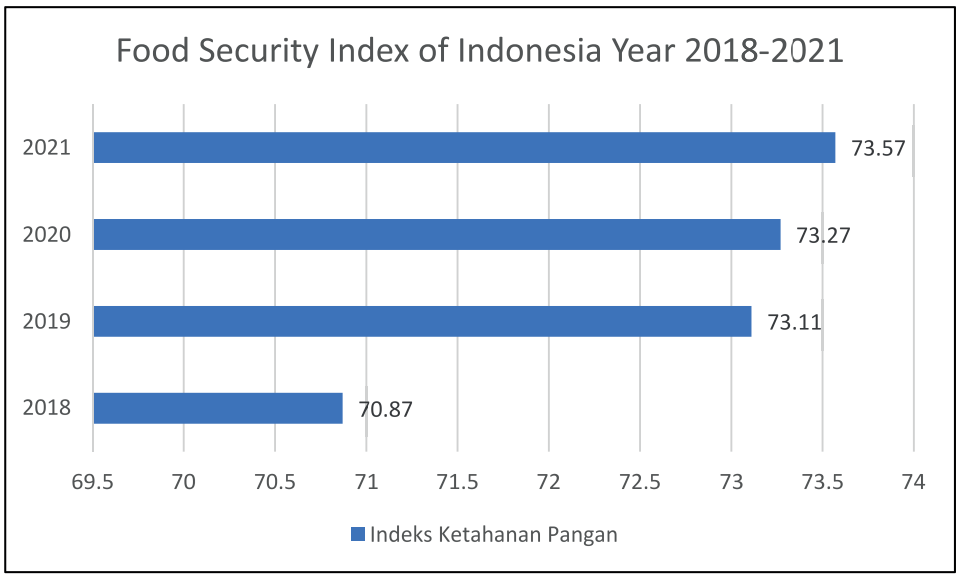
3.4. Food Security in Digital Era

Food security is a multidimensional concept that requires comprehensive assessment of a range of indicators. At the national level, the Central Statistics Agency (BPS) developed a Food Security Index based on three aspects: availability, access, and consumption of food. These indicators were combined to generate a composite value for food security, which was then used as a Food Security Index, Kementan, [15].

1. **Trend in Food Security Index**

The Food Security Index scores gradually increased from 2018 to 2021.

1. In 2018, the score was 70.87.



Source: Satudata Polmankab

Figure 4: Food Security Index of Indonesia Year 2018-2021.

2. In 2019, the score had increased to 73.11.
3. By 2020, the score had increased to 73.27.
4. In 2021, the score will reach 73.57, indicating a continuing positive trend.
5. **Implications**

Based on the data analysis, the following implications can be drawn regarding Indonesia's food security in the context of digital transformation:

Positive Trends in Food Security: The increasing Trend in Food Security: The index scores indicates improvements in overall food security in Indonesia. This positive trend can be attributed to various factors including policy interventions, technological advancements, and sustainable agricultural practices.

Digital Transformation as a Potential Contributor: The rise in Food Security Index scores could be partially attributed to the ongoing digital transformation in the agricultural and food sectors. The adoption of digital technologies such as precision farming, smart irrigation systems, and supply chain management platforms can enhance productivity, efficiency, and transparency in the food system.

Access to Information and Knowledge: Digital transformation enables improved access to information and knowledge for farmers, policymakers, and consumers. Digital platforms and applications can provide farmers with real-time data on weather conditions, market prices, and best farming practices, thereby empowering them to make informed decisions. Consumers can also access information regarding food

safety, nutritional value, and sustainable sourcing, enabling them to make healthier and more conscious food choices.

Efficient Supply Chains: Digital technologies can optimize supply chains, reduce waste, and ensure timely delivery of produce from farmers to consumers. Improved logistics management, blockchain technology for traceability, and online marketplaces can enhance efficiency, reduce postharvest losses, and ensure fair prices for farmers.

Data-driven decision-making: Digital transformation enables the collection, analysis, and utilization of data in decision-making. By leveraging data analytics and predictive modeling, policymakers and stakeholders can identify patterns, anticipate market trends, and formulate evidence-based policies and interventions to effectively address food security challenges.

Inclusivity and Resilience: Digital transformation can contribute to the inclusivity and resilience of food systems. It can help small-scale farmers access markets, financial services, and knowledge resources, thereby reducing inequality. Additionally, digital tools can support climate-smart agricultural practices, improve resilience to climate change, and mitigate risks to food security.

Continuous Monitoring and Adaptation: The positive trend in the Food Security Index should be monitored continuously to identify any potential challenges or areas for improvement. Regular evaluation and adaptation of digital strategies and policies can ensure their effectiveness and address emerging food security issues effectively.

1. **Criteria for Food Security in the Digital Era**

   The development of the digital agricultural economy in relation to food security can be summarized into three aspects: food availability, food access, and food consumption.

2. **Ensuring Food Availability**

Food availability is a critical concern in Indonesia given the increasing population of the country. To achieve successful food provision, it is necessary to address the challenges posed by population growth. Projections indicate that Indonesia's population will rise from 238.5 million in 2010 to 305.6 million in 2035 (BPS, 2013). This study discusses the potential of digital agricultural economics to enhance food production and ensure its availability to meet growing demands.

Enhancing Production Capacity through Technological Advancements: The Technological development plays a crucial role in improving production capacity. By comprehensively analyzing a country's food requirements, it is possible to identify areas

where these requirements are adequately met or lacking. Digital agricultural economics enables the examination of data on potential food demand, empowering farmers to identify market opportunities and planning the cultivation of food crops accordingly. By strategically timing cultivation, farmers can reduce production shortfalls and estimate planting and harvesting times to avoid food shortages caused by simultaneous harvest. Continuous and consistent production helps to maintain food availability.

Ensuring Food Availability for Individuals and Households: Food availability must be guaranteed at all levels, from households to individuals, to support sustained access to food and to enable healthy living and productivity. Digital agricultural economics considers various factors such as quantity, quality, sustainability, and quantity in the concept of fulfilling food availability for each individual. Through the utilization of big data and comprehensive analysis, digital agricultural economics can summarize databases and provide insights into the fulfillment of food availability. The business community has already experienced the benefits of big data, enabling more accurate decision-making based on the acquired data. Additionally, sentiment analysis on social media helps businesses to understand consumer responses to marketed products. By leveraging big data, businesses can improve customer perceptions, identify market trends, and cater to consumer preferences. Technological advancements contribute to a comprehensive understanding of societal consumption patterns, facilitating producers' preparation for profitable food production and ensuring the fulfillment of food needs through digitalization.

Case Study: Sleman Regency, Yogyakarta: A study conducted by Wibowo [4] in the Yogyakarta Department of Food focused on Sleman Regency. In 2018, the main food production from rice fields and dry fields in Sleman Regency amounted to 249,878 tons (milled rice), with a population of 1,206,714. The analysis reveals that the production of rice fields and dry fields equates to 200 kg (milled rice) per capita, or 125.48 kg of rice per person per year. According to the Ministry of Agriculture, rice consumption per person is 124 kg per year. These findings demonstrate that the primary food availability in the Sleman Regency is sufficient. In 2017, with a production of 290,627 tons (milled rice) and a population of 1,193,512, the calculation amounted to 150.57 kg of rice per person per year. Given the decrease in the population of the Sleman Regency to 1,075,575 in 2019, it can be assumed that primary food needs were adequately met in subsequent years. Furthermore, the availability of food has increased due to technological innovations, as evidenced by the continuous increase in chili production:43,626 quintals in 2016, 60,668 quintals in 2017, and 71,786 quintals in 2018. However, innovative marketing

strategies must accompany increasing production. Digital agricultural economics provides valuable information for cultivation processes, ensuring the fulfillment of food needs and preventing shortages.

1. **Food Accessibility**

   Food accessibility plays a crucial role in ensuring food prices and economic stability within a country. Political factors and food policies can influence the agricultural sector, which can lead to inflation in food prices. It is essential to establish policies that promote stable food prices and reduce inflationary pressures. Digital agricultural economics can contribute to price stability by facilitating direct access to food according to food policies, thereby reducing uncertainty for farmers and ensuring affordable prices for consumers.

   Challenges in the Agricultural Supply Chain: One of the challenges faced by farmers, as highlighted by Wibowo [4], is the role of intermediaries or secondary producers who dominate the capital and agricultural supply chains. As a result, primary farmers often receive lower profits or even incur losses. However, secondary producers benefit significantly from these arrangements. This imbalance in the supply chain can be addressed through digital agricultural economics, which enhances access to agricultural products, and provides a more efficient distribution system.

   Improving Efficiency and Consumer Satisfaction: Digital agricultural economics improve efficiency by enhancing consumers' access to agricultural products. Jain and Kumar (2011) defined efficiency as the dimension of electronic service quality that enables customers to access websites, search for products and related information, and leave the site with minimal effort. Efficiency and customer satisfaction are closely related because efficiency is one of the dimensions of electronic service quality that impacts customer satisfaction. By streamlining the access and purchase processes, digital agricultural economics enhances consumer satisfaction and ensures a more efficient agricultural market.

   Food Accessibility and Distribution: Food accessibility refers to households' ability to obtain sufficient food, whether through self-production, purchase, barter, gifts, loans, food assistance, or a combination of these methods. The availability of food in a region does not necessarily guarantee adequate access, in terms of both quantity and food diversity, for all households in that area Rachmaningsih and Priyarsono, [16]. Digital agricultural economics facilitates access to food through

the purchase process, enabling consumers to obtain desired agricultural products more easily.

Smooth Distribution and Inter-district Connectivity: In context of digital agricultural economics, smooth product distribution can be achieved by improving inter-district connectivity within a region. This requires adequate infrastructure and transportation support, as well as a technical understanding of digital agricultural economic processes. With the integration of digital agricultural economics, it has become easier to assess the availability of agricultural products and enable consumers and the community to access the required agricultural products.

2. **Food consumption**

Food consumption patterns play a crucial role in determining nutritional diversity within a population. In Indonesia, the dominant consumption pattern revolves around rice, leading to a lack of utilization of other nutritious food sources that could serve as staple food. To address this issue, the Indonesian government issued Presidential Regulation No. 22 in 2009 to accelerate the diversification of food consumption based on local resources. This regulation emphasizes the need for systematic and integrated efforts to promote diverse, nutritious, balanced, and safe food consumption practices in the population. The adoption of digital agricultural economics can contribute to enhancing dietary diversity by providing insights into consumption patterns and facilitating the fulfillment of nutritional requirements.

The Importance of Dietary Diversity: The concept of Balanced Nutritious and Diverse Food Consumption (B2SA) aims to increase public awareness regarding the importance of diverse, nutritious, balanced, and safe food consumption practices for a healthy, active, and productive life (Badan Pangan Nasional, 2023). Soekirman [17] explained that rising food prices can threaten the nutritional needs of families, particularly those who are unemployed or have insufficient income, jeopardizing food security. By leveraging the principles of Big Data discussed earlier, digital agricultural economics can generate data on consumption patterns, thus enabling the identification of commonly consumed food types. Analyzing these patterns can help determine the fulfillment of nutritional requirements and evaluate the dietary diversity.

Promoting Dietary Diversity for Improved Health: Increasing the availability of diverse food options that adhere to the principles of B2SA is essential to enhance nutritional intake. From a health perspective, the fulfillment of nutritional needs through diverse food consumption positively affects overall well-being. Digital agricultural economics can support this by providing information and access to a wider range of nutritious food

products, thereby encouraging individuals to make healthier choices and to improve their overall health.

Effectiveness of Digital Agricultural Economics in Ensuring Food Security: While digital agricultural economics has proven beneficial in supporting the production and distribution processes of agricultural products, its effectiveness in achieving food security is still being evaluated. Users experience the advantages of digital agricultural economics in enhancing food security. In terms of production and distribution, the use of digital agricultural economics has shown promising results. However, distribution and access play crucial roles in ensuring food security, especially in a globally competitive environment with rapid technological advancements. Despite these advantages, the utilization of social media platforms or applications in digital agricultural economics still faces limitations and inefficiencies. When assessing the utilization of digital agricultural economics in terms of food security, the consumption aspect emerges as the least effective because of users' lack of awareness of the importance of diverse and nutritious food consumption. The consumption aspect encompasses nutritional needs that support human health, and it is essential for individuals to recognize the significance of consuming diverse, nutritious, balanced, and safe foods (B2SA).

Based on the above description, the main problems and solutions related to digital agricultural economics in supporting food security are presented in Table 1.

Table 1: Challenges and Solutions related to Food Security in the Digital Transformation.

Food Security Aspect	Challenges in Digital Agricultural Economics	Solution/Strategy
Production/Availability	1. Limited availability of information about agricultural products and their quality	1. Collaboration with Agricultural Agencies, Ministry of Agriculture, and involving youth farmers
	2. Insufficient production facilities	2. Partnerships with Agencies, Ministry, and private companies
	3. Inaccurate cultivation calculations and harvest timing	3. Human Resource Development
Distribution/Access	1. Slow response to agricultural products	1. Strengthening Human Resources
	2. Infrastructure constraints such as network availability	2. Partnerships with the Ministry of Communication and Informatics
	3. Inaccessible applications/ websites	3. Involvement of youth farmers and developers
Consumption	1. Lack of public awareness about nutritional value of food	1. Human Resource Development
	2. Limited applications regarding nutritional content of agricultural products	2. Partnerships with developers, private companies, Agricultural Agencies, and Ministry of Health.

Source: Wibowo, 2020

4. Conclusion

Previous research has indicated the potential of digital technologies to enhance food security through improved productivity, access to information, supply chain optimization, and sustainable resource management. The government has allocated a substantial budget for food security, focusing on strengthening the agricultural sector, maintaining food reserves, and implementing programs, such as fertilizer subsidies and low-interest credit. These budget allocations indicate the government's commitment to address food security challenges and support the agricultural sector. The data analysis revealed relatively stable trends in the area of harvested land and total production over the three-year period. Although there were minor fluctuations, the overall production remained consistent. Notably, there was a consistent increase in productivity per hectare, which suggests advancements in agricultural practices and technology adoption. Meanwhile, the Food Security Index scores showed a positive trend, indicating improvements in overall food security in Indonesia. The increasing scores can be attributed, at least in part, to the ongoing digital transformation of the agricultural and food sectors, which has contributed to enhanced productivity, efficiency, and transparency.

The findings suggest that digital transformation has the potential to contribute significantly to food security in Indonesia by improving agricultural productivity, resource management, supply chains, access to information, and data-driven decision-making. However, it is crucial to ensure inclusive digital adoption, strengthen the digital infrastructure, provide farmer empowerment and capacity building, foster collaboration and partnerships, and develop a supportive policy and regulatory framework. Continuous monitoring and evaluation are necessary to track progress and make informed decisions to effectively address food security challenges in the digital era.

Further research is needed to support the development of a digital agricultural economy. This research should aim to establish relationships with companies, governments, or private institutions, facilitating growth and collaboration in the development of the digital agricultural economy.

Collaboration between various stakeholders, including farmers, technology companies, government agencies, and research institutions, should be encouraged. These partnerships can help drive the development of a digital agricultural economy by combining expertise and resources.

Investment in digital infrastructure, such as improving Internet connectivity and access to technology in rural areas, is crucial. This will ensure that farmers and rural communities fully participate in the digital agricultural economy and benefit from their potential.

Education and training programs should be implemented to enhance the digital literacy of farmers and rural communities. Providing them with the necessary skills and knowledge will empower them to effectively leverage digital tools and platforms.

Policymakers should create an enabling environment for the digital agricultural economy, including the establishment of supportive regulations and incentives. This will encourage innovation, investment, and adoption of digital technologies in the agricultural sector

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