

Realizing National Food Security Through Irrigation Infrastructure Development in the Context of Sustainable Development: A Review of Relevant Regulations

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ABSTRACT

Damage and suboptimal management of irrigation systems pose significant challenges to agricultural productivity and national food security. Although Government Regulation No. 20 of 2006 concerning Irrigation regulates irrigation infrastructure as a means of supporting agricultural productivity and food security, the integration of irrigation governance within the framework of Law No. 18 of 2012 concerning Food remains implicitly regulated, raising normative issues regarding regulatory coherence and the legal relationship between irrigation infrastructure and food security in achieving SDG 2 (Zero Hunger). Using normative legal research methods combined with legal and conceptual approaches, this study analyzes the role of irrigation infrastructure in supporting food security under Law No. 18 of 2012 and the function of irrigation infrastructure under Government Regulation No. 20 of 2006 in relation to food security objectives. The findings indicate that irrigation infrastructure is a crucial supporting element in the legal framework for food security under Law No. 18 of 2012, which supports agricultural productivity and food availability. In addition, the relationship between Government Regulation Number 20 of 2006 and Law Number 18 of 2012 shows the functional relationship between irrigation governance and food security in supporting sustainable development and SDGs 2 (Zero Hunger).

Keywords: Food, Food Security, Irrigation Infrastructure

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INTRODUCTION

Food remains a fundamental human necessity and a central issue in global development. Ensuring food availability is therefore essential to achieving food security, as it guarantees a sustainable supply capable of meeting the nutritional

needs of individuals and society (Farid et al., 2018). In the framework of the Sustainable Development Goals (SDGs), Goal 2 aims not only to end hunger, but also to strengthen food security, improve nutrition, and promote sustainable agriculture. The achievement of SDG 2 is closely linked to the ability of states to maintain sustainable food production systems capable of meeting the food demands of a growing global population projected to reach 9 billion by 2030 (Alisjahbana & Murniningtyas, 2018).

Sustainable agricultural development cannot be achieved without adequate irrigation infrastructure capable of ensuring a reliable water supply (Vitoria, 2020). Water constitutes a fundamental resource in agricultural production and plays a crucial role in maintaining food security. According to World Bank data, although irrigated agriculture covers only approximately 20 percent of cultivated land globally, it contributes nearly 40 percent of total food production. Irrigated land also demonstrates productivity levels that are generally twice as high as rain-fed agriculture (World Bank Group, 2026).

In response to these conditions, international policy frameworks, including those promoted by the World Bank, encourage states to strengthen sustainable agricultural intensification through investments in irrigation infrastructure and institutional reform. Such approaches are closely linked to global commitments under SDG 2, particularly in relation to sustainable resource governance and food security enhancement (World Bank Group, 2026).

Efficient and reliable irrigation systems are crucial for delivering water to agricultural areas, especially in states with high dependence on staple food commodities such as rice (Ministry of Public Works and Housing of the Republic of Indonesia, 2016). In Indonesia, food security is closely associated with rice as the primary staple food, within a context of demographic scale and spatial diversity (Erwandari, 2017). Accordingly, irrigation infrastructure is normatively positioned as a structural component in supporting national food security objectives.

National food security is highly dependent on the capacity of water infrastructure, particularly irrigation systems, to provide water reliably and efficiently. Irrigation therefore constitutes a strategic component in sustaining agricultural productivity and maintaining food availability. From a legal perspective, this structural dependence raises a normative question concerning the coherence and integration of irrigation governance within Indonesia's food security legal framework. According to the Ministry of Public Works, one of the major challenges in the water resources sector is the continuing deficit in irrigation infrastructure caused by widespread network damage and insufficient maintenance (Ministry of Public Works of the Republic of Indonesia, 2025).

Limited water availability and damaged irrigation networks continue to influence agricultural productivity in Indonesia. In several regions, irrigation dysfunction has been associated with fluctuations in rice production and planting intensity. For instance, conditions in North Aceh Regency have been reported to correlate with changes in rice production in recent years (Riani et al., 2025). Similar conditions have also been reported in Bali, where irrigation channel conditions have been linked to agricultural productivity issues (Maya, 2026). These conditions demonstrate that irrigation infrastructure plays a decisive role in sustaining agricultural production and national food security.

Irrigation plays an essential role in supporting agricultural productivity through water provision, soil fertility maintenance, pest control, and cultivation efficiency (Hayouni, 2025). Accordingly, the availability and proper management of irrigation systems constitute important factors in maintaining sustainable food production and achieving food security.

The urgency of irrigation governance is further reflected in the extent of irrigation infrastructure coverage and its administrative distribution in Indonesia. Of the total surface irrigation area in Indonesia, which covers 7.10 million hectares of which 78% of the total national irrigation area of 9.136 million hectares, approximately 46% or 3.3 million hectares is classified under varying conditions of infrastructure quality and management responsibility. Based on management authority, the distribution consists of 7.5% under the central government, 8.26% under provincial governments, and 30.40% under regency/city governments (Hardiman et al., 2020). Observations from existing studies indicate that irrigation systems constitute a structural element in agricultural production systems. Accordingly, irrigation governance is closely connected to the realization of food security objectives in Indonesia.

This condition does not fully reflect the objectives of Government Regulation No. 20 of 2006 concerning Irrigation and its amendments, which establish irrigation water management as a means to support agricultural productivity and national food security. In addition, Law No. 18 of 2012 concerning Food recognizes food security as a condition of food availability, accessibility, and utilization ensured by the State.

Normatively (*das sollen*), Law No. 18 of 2012 concerning Food establishes food security as the condition in which food needs are fulfilled, supported by availability, accessibility, and utilization of food. In this context, irrigation infrastructure is positioned as a supporting legal instrument for agricultural production. This is further reinforced by Government Regulation No. 20 of 2006 concerning Irrigation, which regulates irrigation as a means to support agricultural productivity and food security.

However, from a normative legal perspective, irrigation governance in Indonesia is characterized by a sectoral and multi-instrument regulatory structure in which irrigation regulation under Government Regulation No. 20 of 2006 concerning Irrigation and food security regulation under Law No. 18 of 2012 concerning Food are governed within separate legal frameworks. This condition indicates that the regulation has not yet been fully integrated into a coherent and unified legal framework for food security, thereby raising normative issues concerning regulatory coherence, coordination, and the legal relationship between irrigation governance and food security regulation.

From a legal policy perspective, the Indonesian government has positioned irrigation development as an important instrument in supporting national food security. Various regulatory and development planning instruments emphasize the importance of irrigation infrastructure in sustaining agricultural productivity and ensuring food availability. This demonstrates that irrigation infrastructure is not merely a technical agricultural facility, but also forms part of the State's constitutional obligation to promote public welfare and guarantee the fulfilment of the right to food as mandated under Indonesian law.

The strategic role of irrigation infrastructure is further emphasized in Law Number 59 of 2024 concerning the 2025–2045 National Long-Term Development Plan and Presidential Regulation Number 12 of 2025 concerning the 2025–2029 National Medium-Term Development Plan, which establish irrigation development as a priority in strengthening agricultural resilience and food security. Furthermore, Presidential Instruction Number 2 of 2025 concerning the Acceleration of Development, Improvement, Rehabilitation, and Operation and Maintenance of Irrigation Networks to Support Food Self-Sufficiency and Regulation of the Minister of Public Works and Housing Number 4 of 2021 concerning Guidelines for the Implementation of the Irrigation Water Utilization Acceleration Program demonstrate the government's regulatory commitment to irrigation governance within the broader food security framework.

Despite the strategic relationship between irrigation and food security, limited legal scholarship has systematically addressed the normative coherence, regulatory alignment, and legal certainty in the interaction between irrigation regulation and food security law. Accordingly, a normative legal examination is necessary to analyse the legal relationship between irrigation regulation and food security regulation in supporting sustainable development policies and the achievement of SDGs Goal 2 (Zero Hunger). This study analyses the normative legal relationship between irrigation regulation and food security law based on two main research questions. First, what is the role of irrigation infrastructure in supporting food security within the framework of sustainable development under Law No. 18 of 2012 concerning Food? Second, how does the regulation of irrigation functions under Government Regulation No. 20 of 2006 concerning Irrigation contribute to the achievement of food security within the framework of sustainable development?

METHODOLOGY

This study employs a normative legal research method that examines legal norms and regulations governing irrigation infrastructure and food security in Indonesia (Fajar & Achmad, 2010). A statutory approach is applied to analyse legal instruments governing irrigation and national food security within the framework of Sustainable Development Goals (SDGs) Goal 2 (Zero Hunger) (Salim & Nurbani, 2013).

The legal materials examined include the 1945 Constitution of the Republic of Indonesia, Law No. 18 of 2012 concerning Food, and Government Regulation No. 20 of 2006 concerning Irrigation.

This study also adopts a conceptual approach to analyse key legal concepts, namely food security, irrigation governance, and sustainable development, with particular emphasis on the normative relationship and regulatory coherence between irrigation regulation and food security law. The analysis focuses on the interaction between these legal frameworks in supporting agricultural productivity and national food security.

This research is conducted through library-based legal research using primary, secondary, and tertiary legal materials (Soekanto & Mamudji, 2015). Primary legal materials consist of relevant statutory regulations, while secondary legal materials include legal literature, scholarly articles, and previous studies. Tertiary legal materials comprise legal dictionaries and encyclopedias (Ibrahim, 2006).

The collected legal materials are analysed through qualitative normative legal analysis using statutory interpretation to assess the consistency and harmonisation between irrigation regulation and food security regulation in supporting sustainable development policies and the achievement of SDGs Goal 2 (Zero Hunger).

RESULT AND DISCUSSION

Irrigation Infrastructure and Food Security

The definition of food security has evolved over time in response to changing economic and political conditions, as well as various food and hunger issues. The definition of food security based on the 1996 World Food Summit, which was subsequently updated in 2001, states that food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Termine, 2024). To achieve food security, there are four dimensions that must be met simultaneously, namely physical food availability, economic and physical food access, food utilization, and the stability of these three dimensions over time (World Bank Group, 2026).

These four dimensions have evolved over the past 50 years, and each dimension has varying degrees of relevance depending on the historical context of its time. Currently, these pillars are often viewed in stages: starting with food availability, then ensuring access to food for all, and continuing with appropriate food utilization. While stability is considered an integrated dimension, these dimensions are actually interrelated and equally important in achieving food security (Termine, 2024). Food availability reflects the availability of an adequate food supply, whether through production, distribution, or food reserves. Food access relates to a community's physical and economic ability to

obtain food, which is influenced by income, price, and infrastructure. Food utilization emphasizes the consumption of safe, nutritious, and nutritious food that meets the body's needs to support health. Food stability refers to the continuous maintenance of these three dimensions without disruption by crises, disasters, or economic turmoil.

As the modern concept of food security evolves, two new dimensions have been added to complement the previous four: sustainability and agency. The sustainability dimension emphasizes the relationship between food security, ecosystems, and food systems from a long-term perspective. Meanwhile, the agency dimension relates to the ability of individuals and communities to express their aspirations, make decisions, and act on those decisions to improve shared well-being (Termine, 2024). Therefore, food security is understood as a holistic concept encompassing food availability, distribution, and consumption (Rachman, 2010), with the main dimensions of food security including availability, utilization, socioeconomic and cultural access, and access to infrastructure (Rivani, 2012).

It should be highlighted that infrastructure and food security are closely interconnected, as adequate infrastructure contributes to improving community welfare through better access to sufficient and dependable food supplies (Supriyanto, 2024). According to Muller et al. (2015), infrastructure encompasses the physical facilities that support social and economic networks, including transportation, irrigation, drainage, buildings, and other public facilities essential for meeting basic human needs. Infrastructure is closely linked to environmental systems within broader social and economic contexts, and its presence directly influences current urban and rural socio-economic structures. Consequently, infrastructure must be recognized as a foundational element for effective decision-making (Mulyani & Putri, 2020).

In a similar perspective, Brett M. Frischmann, in his book "Infrastructure: The Value of Shared Resources", defines infrastructure as the fundamental framework of a system. Within this context, "traditional infrastructure" typically includes: (a) transportation networks, such as highways, railways, aviation systems, and seaports; (b) communication networks, including telephone and postal services; (c) governmental institutions, such as judicial systems; and (d) essential public facilities and services, including schools, water distribution systems, and irrigation networks (Frischmann, 2012). Sustainable infrastructure development, including roads, bridges, irrigation networks, and other critical connections, reflects the government's commitment to ensuring that progress in food security aligns with infrastructure development (Mulyani & Putri, 2020). Research by Hadi Santoso, Akhmad Makhfatih, and Hengki Purwoto on the impact of infrastructure on food security shows that infrastructure has a significant and positive influence on food security. Specifically, road, irrigation, and electricity infrastructure each have a positive and significant partial impact on food security (Santoso, 2019).

As mandated by Law Number 59 of 2024, which regulates the 2025–2045 National Long-Term Development Plan, key priorities are energy security, water security, and food self-sufficiency. Essentially, efficient and effective water resource utilization through conservation is essential to ensure sustainable water availability. These efforts are implemented through: 1) improving the quality of watersheds by rehabilitating forests and land and conserving lakes; 2) sustainable management of wetlands such as mangrove forests and peatlands; 3) strengthening integrated watershed management supported by non-vegetative conservation measures such as the construction of infiltration wells, retention ponds, and other water retention structures; 4) expanding water storage capacity; and 5) developing technologies for seawater utilization, particularly for coastal communities and small islands. From a utilization perspective, infrastructure development must be encouraged to achieve integrated and sustainable water resource management from upstream to downstream, including: 1) modernizing irrigation systems to improve water use efficiency; 2) development and implementation of technological solutions in water resource management such as the provision of water resource information systems to support water availability; and 3) application of water accounting principles to ensure environmental sustainability throughout the water supply chain.

As a key supporting factor in agricultural production, irrigation infrastructure is essential for ensuring water availability in farmland, particularly in rice paddies where it plays a decisive role in achieving optimal yields. Without an adequate water supply, most agricultural commodities cannot grow properly and reach harvest readiness, which highlights the importance of irrigation for Indonesia as an agrarian nation (Ministry of Public Works of the Republic of Indonesia, 2025). In this regard, irrigation infrastructure functions to sustain farm productivity and enhance agricultural output as part of efforts to strengthen national food security and improve community welfare, particularly for farmers. The primary objectives of irrigation are to ensure that available water is used effectively and efficiently; distributed fairly and equitably; delivered to tertiary plots in the right manner, at the right time, and in the right quantity according to crop needs; and managed in a way that prevents negative impacts caused by excess water. The benefits of irrigation include facilitating the flow of water to rice fields, improving soil fertility, providing a medium for plant cultivation, and regulating soil temperature (Ministry of Public Works and Housing of the Republic of Indonesia, 2019).

In this regard, irrigation infrastructure plays a vital role in supporting the entire crop production chain, from growth to harvest (Ministry of Public Works and Housing of the Republic of Indonesia, 2019). However, there are several things that need to be considered in terms of water provision through irrigation infrastructure, namely: 1) Area: because each irrigated area has different needs depending on soil type, climatic conditions such as evapotranspiration and effective rainfall, as well as water loss along the canal;

2) Quantity: the quantity of water varies according to the size and scale of agricultural activities; 3) Time: time is also very important because each stage of plant growth—land preparation, growth, and harvest—requires a different amount of water; 4) Quality: the quality of irrigation water must meet established standards, for example by maintaining very low salinity (Ministry of Public Works and Housing of the Republic of Indonesia, 2019).

Similarly, water availability in irrigation infrastructure is also affected by climate change. Molden (2007) states that shifts in rainfall distribution trigger droughts and floods, which directly impact irrigation systems. These disruptions affect the water balance in agricultural land, ultimately leading to decreased crop productivity. This decline in production poses a serious threat to efforts to achieve food security (Nurbaya, 2025). Various studies have shown that efficient irrigation technology can increase crop yields and water use efficiency compared to rain-fed agriculture, making it a crucial adaptation strategy in areas vulnerable to climate change. Therefore, developing and modernizing irrigation infrastructure is a strategic step to support food security, agricultural sustainability, and livelihood resilience. However, its effectiveness depends on proper irrigation system management and design to ensure its resilience to climate change (Rondhi, et al., 2026).

The development and management of optimal irrigation systems is very important to increase the productivity of irrigated agriculture to support national food security and community welfare (Ministry of Public Works and Housing of the Republic of Indonesia, 2020), therefore, the development and management of irrigation infrastructure is closely related to efforts to realize national food security (Pasandaran, 2007). Based on Government Regulation Number 20 of 2006 concerning Irrigation, the development and management of irrigation systems is a shared responsibility between the government and the community to maintain the sustainability of water availability for agriculture. Irrigation development is carried out through the construction, improvement, and rehabilitation of networks to support agricultural productivity and food security. Management includes operations, maintenance, security, and regulation of water distribution to ensure effective, efficient, and equitable operation. This regulation also emphasizes the importance of farmer and Water User Farmer Association (P3A) participation in irrigation network management. Furthermore, the central and regional governments are obliged to provide guidance, supervision, and funding according to their respective authorities. Thus, irrigation is seen not only as physical infrastructure, but also as a sustainable water resource management system to support community welfare and national food security.

The development and management of a prime irrigation system is one of the main requirements in increasing the productivity of irrigated agriculture in order to realize

national food security to achieve community welfare. The Indonesian government has implemented a breakthrough policy strategy by encouraging the renewal of irrigation management towards a more modern system through an irrigation modernization program, encompassing technical, managerial, and institutional aspects, including strengthening human resources. In this context, the development and management of irrigation systems in Indonesia is implemented using a five-pillar irrigation modernization approach, as stipulated in Circular Letter No. 01/SE/D/2018 of the Director General of Water Resources, Ministry of Public Works and Public Housing, concerning Technical Guidelines for Irrigation Modernization. These five pillars include: (1) water availability, (2) irrigation infrastructure, (3) irrigation management, (4) irrigation institutions, and (5) human resources or actors involved in irrigation management. This approach aims to create a more effective, efficient, and sustainable irrigation system capable of supporting improvements in irrigation services and optimal agricultural productivity (Ministry of Public Works and Housing of the Republic of Indonesia, 2020).

Strengthening the institutional capacity of irrigation management and enhancing human resource capacity are crucial components of implementing the pillars of irrigation modernization. These efforts are developed through subcomponent activities within the government irrigation system covering an area exceeding 3,000 ha (Component A) and the strategic Jatiluhur irrigation system (Component B). Irrigation management institutions, including government institutions, water-using farmer organizations, and coordinating institutions such as the Irrigation Commission, need to develop institutional governance capable of addressing the various challenges in irrigation management and services. These institutions must have a strong foundation and be supported by competent human resources tailored to local characteristics, and be based on an appropriate reward management system (provision). This emphasizes that although the government is responsible for managing the primary network and farmers play a role in the tertiary network, government institutions remain obligated to provide services to farmers in accordance with mutually agreed management objectives. Furthermore, institutional development must also take into account advances in information, communication, and internet technology to enhance the knowledge and capabilities of actors in irrigation management (Ministry of Public Works and Housing of the Republic of Indonesia, 2020).

However, according to Purwantiny and Suheti (2017), in practice, the operational performance and maintenance of irrigation networks in Indonesia have not been managed optimally, so that the effectiveness of irrigation services and the sustainability of their management have not been fully achieved (Ramadhan, 2024). The condition of irrigation infrastructure, which is still experiencing a lot of damage and lack of maintenance, is one of the factors that hinders the optimization of irrigation management and services

(Ramadhan, 2024), in addition, the high level of damage to irrigation networks which is not balanced by the acceleration of repairs and rehabilitation has resulted in the performance of irrigation infrastructure in Indonesia not yet running optimally (Purwantini & Suhaeti, 2017), irrigation infrastructure that did not increase during the crisis (Sutrisno et al., 2022) and some irrigation infrastructure assets are experiencing functional degradation due to the suboptimal routine and ongoing maintenance activities (Taufiq, 2025). Studies show that budget constraints are one of the obstacles in managing and maintaining irrigation infrastructure (Dasril et al., 2024). Budget limitations mean that the operation and maintenance of irrigation networks cannot run optimally, resulting in a decline in the physical condition of irrigation infrastructure (Rahmadi et al., 2024).

The limited human resources who have competence in infrastructure management and maintenance is one of the main challenges in implementing the management and maintenance of irrigation networks (Taufiq, 2025), one example is the appointment of staff who do not have the experience or competencies appropriate to their field and position (Kalesaran et al., 2016). Therefore, in facing the challenges of irrigation development and effective resource management, it is necessary to be supported by professional human resources (Putri & Sudiarta, 2024). The role of human resources in managing irrigation modernization is crucial to supporting food security. To achieve food security, the quality and quantity of human resources must be qualified and competent (Ernawati, 2025).

Another challenge in the management and maintenance of irrigation infrastructure that can occur is problems caused by the unclear division of authority between related parties, thus triggering a shift in responsibility in its implementation (Oktarina, 2022). Authority for the development and management of irrigation areas is divided among three levels: the central government, provincial governments, and district/city governments. This division of authority potentially poses challenges for the central government in providing guidance, oversight, and ensuring effective coordination regarding the development and management of irrigation areas at the provincial and district/city levels. Therefore, synergistic coordination among stakeholders, including the central and regional governments, communities, and the private sector, is needed to achieve inclusive and sustainable food security (Ulya & Hafsari, 2025).

Food Security within the Framework of Sustainable Development Goals (SDGs)

The declaration of the Sustainable Development Goals (SDGs) in 2015 marked a turning point, as societies in all countries began to recognize the importance of implementing sustainable development (Alisjahbana & Murniningtyas, 2018). SDGs is increasingly recognised as a global imperative that applies equally to take place across all nations, regardless of their level of development. Every country, without exception, must implement the SDGs while ensuring that no citizen is left behind (*No One Left Behind*) (Brodjonegoro,

2021). Fundamentally, the SDGs focus on people as the heart of development, with the ultimate aim of improving human well-being (Alisjahbana & Murniningtyas, 2018).

The SDGs are a shared commitment with a broader scope than the Milenium Development Goals (MDGs). The focus of the goals lies not only in development outcomes that lead to increased well-being, but also encompasses aspects of justice, inclusivity, and the process of achieving these goals (Alisjahbana & Murniningtyas, 2018). Improving food security policies has been one of the unresolved agendas during the 15 years of implementation of the Millennium Development Goals (MDGs) and was then continued as part of the development agenda in the SDGs.

Therefore, food security has a direct relationship with the SDGs in global development (Ayyi et al., 2026). Food security is a concern and a development agenda for all countries. The SDGs call for increased food availability, affordability, and quality worldwide (Nugroho, 2020). The implementation of food security, as stated in Goal 2 of SDGs, aims to achieve zero hunger. Therefore, every country is required to implement various programs and policies to ensure that no one continues to experience hunger. This goal is crucial because hunger can hinder the achievement of sustainable development in a country (Ayyi et al., 2026). As the essence of the SDGs as contained in the United Nations Outcome Document on Sustainable Development Goals, namely

“Alongside continuing development priorities such as poverty eradication, health, education and food security and nutrition, it sets out a wide range of economic, social and environmental objectives. It also promises more peaceful and inclusive societies. It also, crucially defines means of implementation”

Strengthening food security at the individual level, improving public nutrition and health, and moving agricultural systems towards a more resilient and sustainable system are strategic steps in supporting the achievement of Goal 2 of the SDGs (Zero Hunger) (Food Security Agency of the Republic of Indonesia, 2025). Goal 2 of the SDGs focuses on efforts to eradicate hunger, achieve food security and improve nutritional status, and encourage sustainable agricultural development. To achieve the Zero Hunger target by 2030, a number of targets have been set that are measured through various achievement indicators. Overall, this goal includes 8 targets and is measured using 14 global indicators used to broadcast achievements in the aspects of food security, agricultural productivity, food system sustainability, and food market stability (United Nations, n.d.)

Studies show that increasing agricultural productivity and implementing sustainable agricultural practices make a positive contribution to achieving food security (Bahari et al., 2024). Increasing agricultural productivity plays a role in strengthening the availability of nutritious food and expanding public access to food more equitably, thereby contributing

to improving nutritional status. Furthermore, increased productivity that occurs evenly across various regions can strengthen national food security by providing stable, high-quality, and easily accessible food (Patria et al., 2026), and there is also research showing that sustainable agriculture is an effective approach to increasing food security while supporting the improvement of farmer welfare (Bahari et al., 2024).

Increasing agricultural productivity and implementing sustainable agriculture are closely linked to the strategic role of irrigation infrastructure. Various studies have shown that the availability of irrigation infrastructure contributes to increased agricultural productivity (Wenggol et al., 2024). Conversely, various constraints on irrigation infrastructure can also have a direct impact on decreasing agricultural productivity (Nainggolan et al., 2025). In the context of sustainable agricultural development, irrigation infrastructure is a crucial component supporting both productivity and sustainability in the agricultural sector (FAO, n.d.). Therefore, proper irrigation water management is a crucial aspect in supporting sustainable development. One necessary effort is to accurately calculate irrigation water requirements to optimize water use, maintain environmental sustainability, and increase agricultural productivity (Zebua & Harita, 2026). In this regard, irrigation infrastructure plays an important role in providing the water needed to support the achievement of food security (Nugroho, 2020), meanwhile, food security is a primary focus of Goal 2 of the SDGs (Zero Hunger). Therefore, irrigation infrastructure plays a strategic role in supporting the achievement of food security within the SDG framework.

Irrigation infrastructure significantly contributes to achieving target 2.3 of the SDGs, which is to increase agricultural productivity and the income of small-scale food producers. Through more stable and secure water availability, irrigation systems can increase crop yields, cropping intensity, and agricultural production efficiency. This impact is directly related to indicator 2.3.1 concerning production volume per unit of labor and indicator 2.3.2 concerning the average income of small-scale food producers. Furthermore, irrigation infrastructure also supports target 2.4 of the SDGs, which focuses on realizing a sustainable and climate-resilient food production system. This support is reflected in indicator 2.4.1 concerning the proportion of productive and sustainable agricultural land. Irrigation systems help improve water management efficiency, maintain soil fertility, and reduce the risk of crop failure due to drought and climate change. In addition to these direct contributions, irrigation infrastructure also supports target 2.1 of the SDGs, which aims to end hunger and ensure people's access to sufficient and safe food. Increasing water availability for agriculture plays a role in maintaining stable food production, thus ensuring food availability.

The Role of Irrigation Infrastructure in Supporting Food Security within the Framework of Sustainable Development Under Law No. 18 of 2012 Concerning Food

Indonesia is a country with a population of more than 260 million people and is one of the four most populous countries in the world after the United States, China, and India. (Sulaiman, et al., 2018), This condition makes the issue of food security a top priority, even a non-negotiable need (Sulaiman, et al., 2025).

National food security, which is also a major issue, also depends heavily on the ability of water resource infrastructure in the form of irrigation systems to provide water reliably and efficiently (Ministry of Public Works of the Republic of Indonesia, 2025), therefore, one of the facilities that has an important role in supporting food security is irrigation (Riani et al., 2025). Good irrigation infrastructure serves as an essential component in increasing agricultural production, as the agricultural sector relies heavily on adequate and sustainable water availability. In tropical countries like Indonesia, an effective irrigation system can help farmers overcome various challenges caused by seasonal changes, both during prolonged dry seasons and heavy rainfall (Indranika & Kurniasih, 2025).

In an effort to achieve food security, the government has implemented several strategies, including those related to irrigation (Limanseto, 2021). In light of this, the government needs to pay closer attention to the comprehensive development and rehabilitation of water management infrastructure, including irrigation networks, to ensure they function optimally, given their highly strategic role in supporting sustainable increases in land productivity (Sulaiman, et al., 2025).

The irrigation network revitalization program is a crucial factor in efforts to boost national agricultural productivity. During the 2015–2024 period, the government has implemented the development of new irrigation areas covering 1.27 million hectares as part of irrigation network expansion. During the same period, the government also carried out the rehabilitation of irrigation networks covering 4.61 million hectares, or approximately 86.33% of the total network requiring repairs due to moderate and severe damage. Furthermore, the rehabilitation achievement, which has reached 52%, demonstrates the government's priority in improving the quality of existing irrigation infrastructure to support national food security (Ministry of Public Works of the Republic of Indonesia, 2025).

The increase in the capacity of irrigation network service areas during the 2015–2024 period shows a fluctuating pattern. In 2015, the highest achievement was achieved, namely 155,382 hectares from the target of 182,017 hectares. However, in 2016 there was a significant decline to 52,518 hectares. Subsequently, in 2017 showed an increase again with the achievement of 63,223 hectares from the target of 78,867.30 hectares, although

the trend decreased again in 2018. In 2019, the achievement increased to around 42,599 hectares, but experienced a drastic decline in 2020, possibly influenced by the COVID-19 pandemic and the national budget refocusing policy. In that year, the achievement only reached 13,685 hectares from the target of 45,000 hectares. 2022 saw a significant increase, achieving approximately 35,099 hectares of land, out of a target of 135,000 hectares. Furthermore, in 2023, the figure increased to 50,477 hectares, surpassing the target of approximately 50,000 hectares. Meanwhile, in 2024, the target was 10,052 hectares, out of a target of 10,000 hectares (Ministry of Public Works of the Republic of Indonesia, 2025).

The Ministry of Public Works has also carried out the construction and rehabilitation of irrigation networks covering an area of 589,605.80 hectares in the 2025 fiscal year as part of efforts to strengthen national food security. Similarly, in 2026, the government aims to expand the coverage of irrigation network construction and rehabilitation to 750,000 hectares to ensure that agricultural productivity continues to rise and food availability remains guaranteed (Ministry of Public Works of the Republic of Indonesia, 2026). These revitalization efforts—which focus on irrigation as a strategic infrastructure that plays a vital role in enhancing national agricultural productivity—reflect the government’s commitment to achieving national food security (Ministry of Public Works of the Republic of Indonesia, 2025).

Indonesia’s food security condition in 2025 shows improvement compared to 2024, which is reflected in the increase in the number of food secure districts/cities from 422 (82.10%) to 433 (84.24%) and a decrease in the number of food vulnerable districts/cities from 92 (17.90%) to 81 (15.76%). This progress is further supported by the National Food Security Index (Indeks Ketahanan Pangan/IKP) in 2025, which reached a score of 73.00, consisting of 61.47 for food availability, 82.70 for food affordability, and 74.99 for food utilization. (Food Security Agency of the Republic of Indonesia, 2025).

The IKP was prepared by the Food Security Agency of the Republic of Indonesia, where the IKP plays a strategic role in measuring the achievement of food security development in a region, measuring regional performance in fulfilling mandatory government duties, and is a tool for determining regional development priorities and program intervention priorities (Food Security Agency of the Republic of Indonesia, 2000). IKP is a composite index that measures regional food security and vulnerability from three aspects: availability, affordability, and utilization (Food Security Agency of the Republic of Indonesia, 2025). The higher the Food Security Index (IKP) of a region, the better its food security (Food Security Agency of the Republic of Indonesia, 2000). This condition reflects the country’s success in guaranteeing the community’s basic right to food.

Explicitly, the considerations of letters a and b of Law No. 18 of 2012 concerning Food emphasize that food is the most important basic human need, and its fulfillment is part of the human rights guaranteed in the 1945 Constitution of the Republic of Indonesia. Fulfillment of the right to food is seen as a fundamental element in the development of quality human resources. Therefore, the state has an obligation to guarantee the availability, affordability, and fulfillment of sufficient, safe, quality, and balanced nutritional food consumption evenly, both at the national, regional, and individual levels throughout the territory of the Unitary State of the Republic of Indonesia in a sustainable manner by utilizing local resources, institutions, and culture.

In relation to the considerations set forth in letters a and b of Law No. 18 of 2012 concerning Food, the state bears the obligation to realize food security through the dimensions of food availability, accessibility, and the fulfillment of food consumption needs for the community. This obligation is consistent with the theory of the modern rule of law. According to Sjahran Basah, Indonesia has adopted the concept of a modern rule of law, or welfare state, aimed at establishing a just and prosperous society, both materially and spiritually, in accordance with Pancasila and the 1945 Constitution (Basah, 1983).

The Republic of Indonesia was established as a welfare state in which the government bears responsibility for ensuring a minimum standard of living for all citizens (Chandrawulan, 2014), including through efforts to achieve and maintain food security. Food security is achieved when food is available for the nation and individuals, as reflected in the availability of sufficient food, both in quantity and quality, that is safe, diverse, nutritious, evenly distributed, and affordable, and does not conflict with the religion, beliefs, and culture of the community, so that people can live healthy, active, and productive lives sustainably. This is as stated in Article 1 number 4 of Law No. 18 of 2012 concerning Food.

In the context of Law No. 18 of 2012 concerning Food, the State's obligation to guarantee food security cannot be separated from its responsibility to ensure the availability of supporting agricultural infrastructure. Irrigation infrastructure therefore possesses not merely a technical or economic function, but also a legal function as an instrument through which the State fulfils its constitutional and statutory obligations in ensuring food availability and supporting the realization of the right to food. The sustainability of food production is closely dependent upon the State's capacity to maintain water availability for agricultural activities through adequate irrigation governance and infrastructure development.

As part of efforts to achieve food security, irrigation infrastructure plays a strategic role in the implementation of Law No. 18 of 2012 because it is a determining factor in the food production stage. Irrigation infrastructure functions to ensure the availability of water for agricultural land so that the food production process can take place optimally, thereby increasing the productivity of agricultural land to meet food availability. Law Number 18 of 2012 concerning Food implicitly regulates irrigation infrastructure. The law only provides explanatory provisions in Article 7 letter e, which states that food infrastructure is a key supporting element in increasing food production, where irrigation is included as part of this infrastructure. However, several provisions are substantially directly related to the role of irrigation infrastructure in realizing food security, particularly in terms of food production, including those contained in Article 4 letter a, Article 7 letter e, Article 12 paragraph (4), Article 12 paragraph (5), Article 16 paragraph (2) letter e, Article 18 letter a, and Article 20.

Table 1
Relevance of irrigation infrastructure to articles in Law No. 18 of 2012 concerning Food

Description of Articles in Law No. 18 of 2012 concerning Food	Relevance of Irrigation Infrastructure to Articles in Law No. 18 of 2012 concerning Food
Article 4 letter a Food administration aims to improve food production capacity.	Irrigation infrastructure plays an important role in increasing food production capacity through the provision and management of water for agricultural activities.
Article 7 letter e Food planning must take into account the need for facilities and infrastructure for food administration.	Irrigation infrastructure is one of the important infrastructures in food administration that must be considered in national and regional food planning.
Article 12 paragraph (4) To realize domestic food availability, efforts are made by developing facilities, infrastructure, and technology for production, post-harvest handling, processing, and storage.	Irrigation infrastructure is part of the infrastructure developed to support food production in order to achieve domestic food availability.
Article 12 paragraph (5) letter d To realize food availability through domestic food production, efforts are made by building, rehabilitating, and developing food production infrastructure.	Irrigation infrastructure is built, rehabilitated, and developed as part of food production infrastructure to support national food availability.
Article 16 paragraph (2) letter e The development of food production potential is carried out by utilizing food facilities and infrastructure.	Irrigation infrastructure is food-related infrastructure that supports the development of food production potential through adequate water supply for agriculture.

Description of Articles in Law No. 18 of 2012 concerning Food	Relevance of Irrigation Infrastructure to Articles in Law No. 18 of 2012 concerning Food
Article 18 letter a The government and regional governments, in fulfilling food needs, are obliged to regulate, develop, and allocate agricultural land and water resources.	Irrigation infrastructure is closely related to the management and distribution of water resources to agricultural land; therefore, its regulation, development, and allocation are the responsibility of the government and regional governments.
Article 20 The government and regional governments facilitate the use and development of facilities and infrastructure in efforts to increase agricultural production.	Irrigation infrastructure supports increased agricultural production; therefore, the government and regional governments need to facilitate its use and development.

Based on the table, irrigation infrastructure holds a strategic function in supporting national food security as mandated by Law No. 18 of 2012 concerning food. Irrigation not only serves as a supporting infrastructure for agricultural production, but also plays a key role in increasing food production capacity, maintaining domestic food availability, and developing sustainable food production potential. Furthermore, the construction, rehabilitation, and development of irrigation infrastructure are part of the responsibility of the central and regional governments in managing water resources and agricultural land to meet the community’s food needs.

Normatively, the provisions contained in Law No. 18 of 2012 concerning Food demonstrate that irrigation infrastructure forms an integral component of the legal framework governing national food security. Although the law does not regulate irrigation in a specific and comprehensive manner, several provisions substantively place irrigation within the broader framework of food production support systems. These provisions collectively indicate that the fulfilment of food security is not solely oriented toward food distribution and consumption, but also toward the legal and institutional support necessary to sustain food production capacity. In this regard, irrigation infrastructure constitutes a supporting legal instrument for achieving the objectives of food availability and agricultural sustainability as mandated by the Food Law.

The normative construction contained in Law No. 18 of 2012 demonstrates that food security is not merely interpreted as the availability of food commodities, but also encompasses the institutional and infrastructural mechanisms necessary to sustain food production. Within this framework, irrigation infrastructure may be understood as part of the legal instruments supporting the realization of national food sovereignty and sustainable agricultural development.

The normative relationship between irrigation infrastructure and food security under Law No. 18 of 2012 also reflects the interdependence between agricultural resource

management and the fulfilment of socio-economic rights. In this regard, irrigation governance may be interpreted as part of the State's legal responsibility to ensure the continuity of food production systems capable of supporting national food availability. Consequently, deficiencies in irrigation infrastructure may indirectly affect the State's capacity to fulfil its obligations relating to food security and the right to food.

From a sustainable development perspective, the regulation and development of irrigation infrastructure also reflect the integration between national food law and global development commitments. Food security policies under Indonesian law are not implemented in isolation, but are closely connected with international development frameworks, particularly the Sustainable Development Goals (SDGs). Consequently, irrigation governance may also be interpreted as part of the State's broader legal and policy efforts to achieve sustainable agricultural development and long-term food resilience.

As a food infrastructure in realizing food security as mandated by Law No. 18 of 2012 concerning Food, irrigation infrastructure plays a role in achieving Goal 2 of the Sustainable Development Goals (SDGs). Infrastructure contributes to achieving target 2.3 of the SDGs by increasing agricultural productivity and the income of small-scale food producers. More stable water availability helps increase crop yields, cropping intensity, and agricultural production efficiency, which are related to indicators 2.3.1 and 2.3.2. In addition, irrigation infrastructure also supports target 2.4 of the SDGs by encouraging sustainable and climate-resilient agricultural systems through more efficient water management, maintaining soil fertility, and reducing the risk of crop failure. On the other hand, irrigation also supports target 2.1 of the SDGs by maintaining stable production and food availability for the community.

The Regulation of Irrigation Functions Under Government Regulation No. 20 of 2006 Concerning Irrigation Contribute to the Achievement of National Food Security within the Framework of Sustainable Development

Government Regulation No. 20 of 2006 concerning Irrigation was enacted as an implementing regulation of Law No. 7 of 2004 concerning Water Resources, particularly in relation to the development and management of irrigation systems and irrigation infrastructure.

Article 1 number 3 of Government Regulation No. 20 of 2006 defines irrigation as an effort "to provide, regulate, and dispose of irrigation water to support agriculture," including surface irrigation, swamp irrigation, groundwater irrigation, pump irrigation, and pond irrigation. The phrase "irrigation water to support agriculture" contained in Article 1 number 3 of Government Regulation No. 20 of 2006 concerning Irrigation indicates that irrigation governance in Indonesia is primarily directed toward supporting agricultural activities. Normatively, this provision establishes a functional legal relationship between water resource management and agricultural development objectives.

The general explanation of Government Regulation Number 20 of 2006 concerning irrigation emphasizes the crucial role of irrigation infrastructure in the agricultural sector. The agricultural sector is strategically important in the Indonesian economy and highly dependent on water availability. In this context, irrigation infrastructure is a key component supporting successful agricultural development and plays a crucial role. This is consistent with previous studies showing that irrigation infrastructure increases cropping intensity, which subsequently contributes to higher harvest frequency and agricultural production yields (Afwan, 2021). Another study further explains that irrigation supports the productivity of agricultural activities, thereby increasing agricultural production in order to realize national food security and farmers' welfare through the sustainability of irrigation systems (Hidayat, 2019).

The provisions of Article 2 of Government Regulation Number 20 of 2006 concerning Irrigation explicitly position irrigation infrastructure as a means to support increased agricultural productivity in order to increase production output within the framework of national food security. From this provision, it can be understood that irrigation is positioned as a strategic instrument that directly contributes to increasing agricultural sector productivity, thus having a crucial role in achieving food security goals.

Normatively, Article 2 of Government Regulation No. 20 of 2006 demonstrates that irrigation regulation in Indonesia is not merely administrative in nature, but is also directed toward achieving broader socio-economic objectives, particularly national food security. The provision reflects the State's legal policy in positioning irrigation infrastructure as an essential component of agricultural sustainability and food production systems.

Law No. 18 of 2012 concerning Food defines food security as the condition of fulfilling food needs for the country down to the individual level, which is reflected in the aspects of food availability, affordability, and utilization. Within this framework, food availability is highly dependent on the production capacity of the agricultural sector, which in turn is directly influenced by the existence and effectiveness of irrigation infrastructure. This is in line with Government Regulation No. 20 of 2006 concerning Irrigation which positions irrigation as a strategic infrastructure in supporting increased agricultural productivity. Accordingly, from a normative legal perspective, the irrigation function regulated under Government Regulation No. 20 of 2006 forms an integral part of the legal framework supporting the realization of food security under Law No. 18 of 2012 concerning Food.

The relationship between the regulation of irrigation infrastructure functions based on Article 2 of Government Regulation Number 20 of 2006 and the regulation of food security based on Law Number 18 of 2012 concerning Food has legal implications, including:

The regulation of irrigation functions under Government Regulation No. 20 of 2006 on Irrigation implies the affirmation of irrigation infrastructure as an important instrument in efforts to achieve national food security. Irrigation infrastructure has a direct impact on increasing agricultural land productivity in order to ensure food availability, where food availability constitutes one of the aspects of food security as regulated in Law No. 18 of 2012 on Food.

The regulation of irrigation functions under Government Regulation No. 20 of 2006 on Irrigation and the regulation of food security under Law No. 18 of 2012 on Food indicate an integrated regulatory approach between water resource management through irrigation infrastructure and food governance. This demonstrates that efforts to realize national food security cannot be separated from the management of agricultural infrastructure, particularly irrigation as part of the food production system. In this context, irrigation infrastructure plays an essential role in the management and utilization of water resources for agriculture.

The regulation of irrigation functions under Government Regulation No. 20 of 2006 on Irrigation and the regulation of food security under Law No. 18 of 2012 on Food imply that irrigation infrastructure is positioned as a determinant factor influencing the success of national food security. In this regard, irrigation infrastructure plays a crucial role in the food production aspect as the initial stage in the national food supply chain.

The regulation of irrigation functions under Government Regulation No. 20 of 2006 on Irrigation and the regulation of food security under Law No. 18 of 2012 on Food further strengthen the State's commitment to achieving national food security through the fulfillment of people's food availability in accordance with its obligations by providing and managing irrigation infrastructure. In this context, irrigation infrastructure plays an important role in fulfilling the people's food needs, which constitutionally constitute a state obligation.

The regulation of irrigation functions under Government Regulation No. 20 of 2006 on Irrigation and the regulation of food security under Law No. 18 of 2012 on Food demonstrate the existence of interrelated and mutually supportive policies between the water resources sector and the food sector in order to achieve national food security. These interlinked and mutually reinforcing policies between irrigation infrastructure and food security form an integrated legal system aimed at realizing national food security.

The regulation of irrigation under Government Regulation No. 20 of 2006 on Irrigation and the regulation of food security under Law No. 18 of 2012 on Food reflects the interconnected roles of stakeholders in irrigation and food governance, including central and regional governments, irrigation institutions, and Water User Farmer Associations

(P3A), in supporting agricultural productivity and national food security. This coordinated governance also reflects the distribution of governmental responsibilities between central and regional authorities in the management of irrigation and food security affairs within Indonesia's decentralized administrative system.

These six points demonstrate that the regulation of irrigation functions in Government Regulation No. 20 of 2006 concerning Irrigation and the regulation of food security in Law No. 18 of 2012 concerning Food, which are interrelated, have positioned irrigation infrastructure as strategic infrastructure that plays a direct role in increasing agricultural productivity. This condition contributes to the fulfillment of the aspect of food availability which is a key element in achieving national food security.

The integration between irrigation regulation and food security policy reflects the incorporation of sustainable development principles into national regulatory frameworks governing agriculture and water resources. Such integration is further demonstrated through the alignment of national regulatory policies with global development commitments, particularly Sustainable Development Goals (SDGs) Goal 2 (Zero Hunger), especially in target 2.1 which relates to the eradication of hunger and access to safe and nutritious food, target 2.3 which emphasizes increasing farmer productivity and income through access to production resources, and target 2.4 which focuses on the implementation of sustainable food production systems and agricultural practices that are resilient to climate change and environmental conditions. Thus, the irrigation function as regulated in Article 2 of Government Regulation Number 20 of 2006 concerning Irrigation has strategic relevance in supporting the achievement of Sustainable Development Goals (SDGs), particularly through its role in increasing agricultural productivity and realizing national food security. This demonstrates that irrigation regulation is not a standalone technical policy, but forms part of the broader legal architecture governing national food security. Nevertheless, the sectoral and multi-instrument nature of irrigation and food security regulation in Indonesia demonstrates the need for stronger legal harmonisation and institutional coordination, which subsequently necessitates further policy reinforcement and cross-sectoral governance mechanisms.

The regulation of irrigation functions under Government Regulation No. 20 of 2006 concerning Irrigation contributes significantly to the achievement of food security within the framework of sustainable development by establishing a legal framework for the integrated and sustainable management of water resources to support agricultural productivity and national food availability. Through the regulation of irrigation development, operation, rehabilitation, and maintenance, irrigation infrastructure is legally positioned as a strategic instrument for sustaining food production and supporting national food security. This regulatory framework is further strengthened through

Presidential Instruction No. 2 of 2025 concerning the Acceleration of Development, Improvement, Rehabilitation, and Operation and Maintenance of Irrigation Networks, which serves as an implementation mechanism to enhance irrigation governance through cross-sectoral coordination and a whole-of-government approach. From a legal and policy perspective, these regulations reflect the State's commitment to strengthening irrigation management, promoting sustainable agricultural development, and supporting food self-sufficiency as part of the *Asta Cita* agenda, particularly in achieving food independence and strengthening rural development. Furthermore, these policies are aligned with the vision of *Indonesia Emas 2045*, which positions food security, sustainable resource management, and public welfare as fundamental pillars of Indonesia's long-term national development strategy.

CONCLUSION

Irrigation infrastructure has a strategic role in supporting national food security under Law No. 18 of 2012 concerning Food. Irrigation infrastructure forms part of the framework supporting food production and domestic food availability, while also reflecting the State's responsibility to guarantee food availability and the right to food. Furthermore, the regulation and development of irrigation infrastructure reflect the implementation of the welfare state concept and sustainable development principles, particularly in supporting Sustainable Development Goals (SDGs) Goal 2 concerning Zero Hunger. Therefore, irrigation infrastructure possesses important significance in realizing sustainable national food security in Indonesia.

Government Regulation No. 20 of 2006 concerning Irrigation and Law No. 18 of 2012 concerning Food have an interconnected role in realizing national food security. Government Regulation No. 20 of 2006 concerning Irrigation regulates the function of irrigation infrastructure in supporting water availability and increasing agricultural productivity, while Law No. 18 of 2012 concerning Food establishes food availability as a fundamental element of food security. The relationship between these two regulations demonstrates that sustainable food security can be achieved through the integration of irrigation management and food governance policies. Through this regulatory framework, irrigation infrastructure plays an important role in supporting agricultural production, maintaining domestic food availability, and fulfilling the State's responsibility to ensure community food needs. Furthermore, the integration of these regulations also reflects the implementation of sustainable development principles, particularly in supporting the achievement of Sustainable Development Goals (SDGs) Goal 2 concerning Zero Hunger.

However, this study has several limitations. This research focuses primarily on the normative relationship between irrigation regulation and food security law, particularly Law No. 18 of 2012 concerning Food and Government Regulation No. 20

of 2006 concerning Irrigation, without examining the practical implementation and inter-institutional coordination in irrigation and food governance. In addition, the study is limited to a normative legal approach and does not incorporate broader empirical, technical, or socio-economic perspectives concerning irrigation management and sustainable food security. Accordingly, further research is needed to analyse the effectiveness of regulatory harmonisation, institutional coordination, and irrigation governance through a more interdisciplinary and comprehensive approach in supporting sustainable food security and the achievement of SDGs Goal 2 (Zero Hunger).

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