Assessment Report on Irrigation Strategy for Organic Rice Production

Ha-Ngan Nguyen and Dr. Jack O'Connor

United Nations University - Institute for Environment and Human Security (UNU-EHS)

For contact

ha-ngan.nguyen@outlook.com

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Organic rice production in the Mekong Delta: improving product safety, environmental sustainability, and livelihoods through better land and water management on multiple scales

Task 2.2 Development of Irrigation Strategies

Task 2.2.1 Development optimal irrigation strategies and irrigation zoning

Activity 2.2.1.1 Identify irrigation strategies to support organic rice production

Activity 2.2.1.2 Interview with authorities, farmers, and scientists to evaluate various identified irrigartion options

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Prepared by:

Ha-Ngan Nguyen

Dr. Jack O'Connor

United Nations University - Institute for Environment and Human Security (UNU-EHS)

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Key Findings and Gaps in The Report

This report investigates the intersection of irrigation strategies and organic rice production in the Mekong Delta, identifying key opportunities and persistent challenges. Our findings reveal critical gaps in existing policies and practices, while also highlighting successful strategies and potential pathways for future development.

❖ **Key Findings:**

- **Strengths and opportunities in current national policies:** Existing policies support sustainable agriculture and improved irrigation, creating a foundation for organic rice. Decree 109/2018/NĐ-CP provides a legal framework for organic agriculture. Decisions 1898/QĐ-BNN-TT and 555/QĐ-BNN-TT promote sustainable rice production and better irrigation. TCVN 11041-2:2017 sets standards for organic plant production, including water management. The Mekong Delta Regional Plan (Decision 287/QĐ-TTg) emphasizes sustainability and integrated water management. These policies offer opportunities for developing specific organic rice irrigation guidelines and leveraging existing infrastructure.
- **Lack of specific standards:** Despite these strengths and opportunities, a key finding is the lack of specific irrigation strategies and water quality standards tailored to organic rice production. While general water quality regulations exist (e.g. QCVN 08:2023/BTNMT), they lack the specificity required for organic certification, creating confusion and a lack of transparency. This contrasts with the stricter standards often applied by private companies such as Lotus Rice (a Vietnamese rice company), reinforcing the need for specific organic irrigation guidelines. This lack of clarity contributes to 'grey areas' in standard application and compliance, reducing the potential benefits of organic farming.
- **Optimal strategies identified:** This report proposes several optimal strategies for organic rice irrigation in the Mekong Delta. These strategies including (i) Prioritizing areas with clean water sources and upgrading existing infrastructure; (ii) Leveraging high-quality, low-emission rice areas with existing advanced irrigation systems; (iii) Implementing comprehensive farmer training programs focused on water management, organic cultivation techniques, and certification procedures; and (iv) An integrated, phased approach combining these strategies for long-term sustainability.
- **Future options and technological developments:** The report explores potential future options, such as the further development of smart sensor systems for water quality monitoring, smart pest traps, smart sluice gates, etc., and their integration into organic rice irrigation management. These advances can improve water use efficiency, monitor water quality in real time and contribute to more sustainable practices.

❖ **Gaps Identified and Addressed:**

- **This report fills several previously unfilled gaps:**
  - It compiles policy documents on irrigation and organic rice production that are not readily available online.
  - Assessed current irrigation infrastructure and organic farming practices in key provinces in the Mekong Delta (Vinh Long, Ca Mau, Tra Vinh, An Giang, Dong Thap).
  - Gathered insights from local authorities on proposed irrigation strategies to refine the development of optimal approaches.
  - The optimal strategies proposed in section 5.1 aim to address several of the gaps identified. The development of specific water quality standards for organic rice, the focus on upgrading existing infrastructure in areas with clean water sources, and the emphasis on farmer training all address these critical gaps. The integrated strategy also ensures a phased and comprehensive approach to implementation, promoting long-term sustainability.
- **Despite these advancements, critical gaps remain:**
  - **Analysis of standards:** A comparative study is essential to examine how the Vietnamese organic standards (TCVN 11041-2:2017) align with international standards and private company practices (e.g., Lotus Rice) in organic rice production, particularly regarding water quality. The purpose of this comparison is to identify gaps and opportunities for better integrating Vietnamese standards with on-the-ground farming practices. By synthesizing these insights, the study aims to enhance the relevance and applicability of the standards, ensuring they support effective organic farming procedures and improve outcomes for farmers.
  - **Implementation and enforcement of standards:** One of the things pointed out in the report is that there are 'grey areas' in how standards are used and adhered to. Further research is needed to understand the roles of different actors (companies, farmers, certification bodies) in the implementation and enforcement of organic standards. This includes investigating farmer awareness and the potential power imbalances in the certification process between local authorities and private companies. Clarifying these issues is essential to promote transparency and ensure the integrity of organic rice production.

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BỘ KHOA HỌC VÀ CÔNG NGHỆ

List of Acronyms

ARS	Aerobic Rice System
AWD	Alternate Wetting and Drying
DARD	Department of Agriculture and Rural Development
DIR	Drip Irrigated Rice
DONRE	Department of Natural Resources and Environment
DSR	Direct Seeded Rice
EC	Electrical Conductivity
GIS	Geographic Information Systems
I	Irrigation Rate
IC	Irrigation Center
IMZs	Irrigation Management Zones
IWRM	Integrated Water Resource Management
LXQ	Long Xuyen Quadrangle
MARD	Ministry of Agriculture and Rural Development
MONRE	Ministry of Natural Resources and Environment
PCA	Principal Component Analysis
PPP	Public-Private Partnerships
SI	Smart Irrigation
SRI	System of Rice Intensification
SSC	Saturated Soil Culture
WUA	Water User Association

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I. Introduction

1.1. Background

Often referred to as Vietnam's 'rice bowl', the Mekong Delta is vital to national and international food security. Its fertile lands and intricate waterways support extensive rice cultivation, making it a cornerstone of the regional economy and a vital source of livelihood for millions of people. However, the prevalence of conventional rice production, which relies on synthetic fertilisers and pesticides, has raised concerns about long-term environmental sustainability and potential impacts on human health and ecosystems (Khong & Loch, 2021; T. N. Nguyen & Tran, 2022). This has spurred a growing shift towards organic agriculture, with organic rice production emerging as a promising alternative that prioritises ecological balance and well-being (T. N. Nguyen & Tran, 2022).

The production of organic rice presents a number of advantages, including a reduced environmental impact, an improvement in soil health, an enhancement of biodiversity, and the potential for higher market prices (Panpakdee, 2023). However, the transition to organic practices presents a number of distinctive challenges, particularly in the context of irrigation management (Bui et al., 2018). The standards set out in the International Federation of Organic Agriculture Movements (IFOAM) guidelines prohibit the use of synthetic inputs, including fertilisers and pesticides (IFOAM, 2020). This necessitates the implementation of an effective water management strategy to prevent contamination from neighbouring conventional rice fields, where the use of synthetic inputs is prevalent. The potential for irrigation water to carry contaminants poses a significant risk to the organic integrity of the crop and the surrounding ecosystem.

Furthermore, the optimisation of growing conditions for organic rice requires the implementation of precise irrigation practices. In the absence of synthetic fertilisers, organic farmers are compelled to rely on natural methods to maintain soil fertility, including composting and cover cropping (AOI, 2023). Effective irrigation is a crucial element in supporting these practices and ensuring an adequate water and nutrient supply throughout the rice plant's life cycle (Bouman et al., 2007; FAO, 2014). This can be particularly challenging in the Mekong Delta's climate, which is characterised by distinct wet and dry seasons and fluctuating water availability (AOI, 2023).

The unique hydrological and topographical characteristics of the Mekong Delta, including a complex network of rivers, canals and floodplains, also require tailored approaches to irrigation. Irrigation systems must be designed to integrate with these natural features and accommodate seasonal variations in water flow. Successfully overcoming these challenges is critical to the long-term viability and scalability of organic rice production in the Mekong Delta.

This report, focusing on the OrganoRice project Task 2.2.1, examines suitable irrigation strategies for organic rice production in the Mekong Delta, specifically in Dong Thap, An Giang, and Vinh Long provinces. It explores the intersection of sustainable agriculture, effective water resource management, and the growing demand for organic food, aiming to provide practical guidance and policy recommendations to promote sustainable organic rice farming. The following section will detail the project's objectives and methodology for addressing these critical irrigation challenges.

1.2. Aim and Objectives of The Report

This report details the results of Task 2.2.1, which aims to develop optimal irrigation strategies and irrigation zoning for organic rice production. This task consists of two main activities:

- **Activity 2.2.1.1:** focuses on **identifying appropriate irrigation strategies** by reviewing existing planning documents, government policies and reports on organic rice production, and conducting in-depth interviews with local authorities and farmers.
- **Activity 2.2.1.2:** involves **evaluating identified irrigation strategies** through consultations with authorities, farmers and scientists, taking into account factors such as cost-benefit analysis, stakeholder preferences, potential risks and adaptability of farming systems.

We acknowledge the importance of stakeholder collaboration and aim to ensure that the strategies developed are practical, environmentally sound and equitable. This includes understanding current irrigation systems, identifying potential conflicts and synergies between organic and conventional rice farming, and developing strategies that can be integrated across the Delta. Ultimately, we aim to provide policy recommendations that support the growth of organic rice production while protecting the environment of the Mekong Delta.

1.3. Scope of Research

- **Geographical scope:** Provinces/cities in the Mekong Delta
- **Time scope:** Current situation and future projections (e.g., to 2030, 2050)
- **Content scope:** Focus on aspects related to irrigation in organic rice production (water sources, irrigation and drainage systems, water management, disaster response, etc.)

1.4. Methodology Used in The Report

- **Literature review:** We reviewed existing literature, government plans and reports on organic rice production and irrigation. This provided a basis for developing initial irrigation strategies based on established methodologies. This is in line with the first phase of Activity 2.2.1.1.
- **Stakeholder consultations:** We consulted with key stakeholders, including local authorities, cooperative managers and, importantly, organic rice farmers. These consultations, which included in-depth interviews, helped us to gather local knowledge, understand challenges and opportunities, and assess the feasibility of the proposed strategies. This corresponds to the latter part of activity 2.2.1.1 and the core of activity 2.2.1.2.
- **Data analysis:** We have refined our initial strategies based on the feedback received, ensuring that they are relevant, adaptable and appropriate for the Mekong Delta. This iterative process ensures that our recommendations are grounded in practical realities and address the specific needs of the region.

II. Overview of Current Policies related to Irrigation and Organic Rice

2.1. Explanation of Terms

- **High-quality rice** (Prime Minister, 2023)**:** The project *"Sustainable Development of One Million Hectares of High-Quality, Low-Emission Rice Production Linked to Green Growth in the Mekong Delta by 2030"* focuses on establishing specialized rice cultivation areas that meet high-quality standards and minimize emissions. Although a precise definition of "high-quality rice" could not be found at the time of writing this report, based on Decision No. 1490/QD-TTg of the Prime Minister approving this project, "high-quality rice" can be understood as rice that meets multiple criteria simultaneously, including:
    - **Scale of specialized production areas:** Increase from 180,000 hectares (2025) to 1 million hectares (2030).
    - **Sustainable farming practices:**
        - **Reduce seeding rate:** From 80-100 kg/ha (2025) to under 70 kg/ha (2030).
        - **Reduce chemical fertilizers and pesticides:** From a 20% reduction (2025) to a 30% reduction (2030).
        - **Reduce irrigation water:** 20% reduction for both years.
        - **100% of the area applies at least one sustainable farming practice** (One Must Do, Five Reductions, SRP, Alternate Wetting and Drying) and is granted a planting area code for both years.
    - **Value chain linkage:**
        - **100% of the production area linked with businesses for both years.**
        - **Increase the rate of synchronized mechanization:** From over 50% (2025) to over 70% (2030).
        - **Number of households applying sustainable farming practices:** From over 200,000 households (2025) to over 1 million households (2030).
    - **Environmental protection:**
        - **Reduce post-harvest losses:** From under 10% (2025) to under 8% (2030).
        - **Rate of straw collection and reuse:** From 70% (2025) to 100% (2030).
        - **Reduce greenhouse gas emissions:** Over 10% for both years.
    - **Productivity and economic efficiency:**
        - **Increase the added value of the rice value chain:** From 30% (2025) to 40% (2030).
        - **Profit margin for rice farmers:** From over 40% (2025) to over 50% (2030).
        - **Proportion of high-quality exported rice:** Over 20% of total rice exports for both years.

2.2. National Policies

National policies on irrigation and organic agriculture have a significant impact on organic rice production in Vietnam. While these policies aim for the common goal of sustainable agricultural development, their support for and obstacles to organic rice production manifest in different ways

2.2.1. Policies directly related to irrigation and organic farming:

Decree 109/2018/ND-CP on Organic Agriculture (Vietnam Government, 2018):

This decree is a significant step, establishing a legal framework for the development of organic agriculture in general and organic rice in particular. Clear definitions of principles, standards, certification processes, labeling, and product traceability have created favorable conditions for the production and consumption of organic rice. The decree also introduces specific support policies for businesses, cooperatives, and households engaged in organic production, including financial support for identifying production areas, certification costs, and training. This helps farmers access information, techniques, and markets, while also strengthening consumer confidence.

National Standards TCVN 11041-2:2017 on Organic agriculture - Part 2 (MOST, 2017):

National Standards TCVN 11041-2:2017 on Organic agriculture - Part 2 (MOST, 2017): This standard plays a key role in ensuring the quality and safety of organic rice products, meeting the demands of domestic and international markets. TCVN 11041-2:2017 provides detailed guidance on soil management (no synthetic fertilizers, prioritizing organic and microbial fertilizers), water management (meeting current regulations, avoiding pollution), and crop variety selection (non-genetically modified organisms-GMO, prioritizing organic varieties). Pest control is addressed specifically in section 5.1.10 of TCVN 11041-5:2018 (referenced within TCVN 11041-2:2017), which prioritizes preventative measures such as the "use of rice varieties resistant to pests and diseases… appropriate cultural practices such as ploughing or soaking…and biological measures." While chemical pesticides are generally prohibited, the standard acknowledges that intervention may be necessary. As stated in section 5.1.10, "If the measures…fail to protect rice against the outbreak of serious rice diseases and pests, substances may be used if they are listed in Table A.2 of TCVN 11041-2:2017." This table provides a list of approved substances for pest control in organic rice production, allowing farmers to work within the standards while addressing pest outbreaks. This approach aims to balance the need for pest control with the commitment to maintaining a chemical-free environment as much as possible. However, the application of TCVN, including these pest control measures, faces difficulties due to high conversion costs and stringent technical requirements, especially for smallholder farmers.

Decision 1898/QĐ-BNN-TT on Approved "Project on Restructuring Vietnam's Rice Industry to 2020 and Vision to 2030"(MARD, 2016b):

Decision 1898/QĐ-BNN-TT has laid a crucial foundation for the development of organic rice production. Within the context of industry restructuring, this decision emphasizes the adoption of sustainable farming practices, with organic standards being considered a key solution for enhancing the efficiency of rice production and business. The plan sets specific targets: by 2020, the area under sustainable cultivation must reach at least 50% of the total rice-growing area; and by 2030, this figure must exceed 75%. To achieve this goal, Decision 1898/QĐ-BNN-TT encourages the application of a range of sustainable rice production processes, including models such as "3 Reductions 3 Increases", "1 Must 5 Reductions", System of Rice Intensification (SRI), VietGAP, other GAP standards, and organic farming standards, in response to the growing market demand. For the Mekong Delta region, the plan specifically encourages the development of high-quality rice or organic rice production integrated with the rice-shrimp farming model in the coastal areas, capitalizing on the advantages of the specific ecosystem.

In terms of protecting water resources, Decision 1898/QĐ-BNN-TT outlines several key solutions. These include using international cooperation and citizen diplomacy to work with upstream Mekong countries to ensure that their activities do not negatively impact the natural flow of the river, the environment, agricultural production or the livelihoods of communities in the basin. The decision also emphasises the promotion of transparency in water use by upstream countries. It also calls for research and the proactive development of response strategies to ensure the availability of water for rice production and human consumption under all circumstances. The decision advocates rational planning and implementation of inter-provincial water management policies between upstream and downstream regions to regulate and optimise water use while minimising wastage from rice cultivation and aquaculture. Specifically, for the Mekong Delta, it emphasises the need for comprehensive regional irrigation planning and management policies to regulate inter-provincial water use, improve efficiency, and harmonise different water use objectives, particularly between rice production and aquaculture. The decision also promotes technical measures to improve water use efficiency, such as integrating field design with improved on-farm canal systems, electric pumping stations, land levelling, water-saving irrigation techniques, increasing field sizes, and modernising rice production systems and cropping patterns. Strengthening community-based water management in large fields and cooperatives is also highlighted. It also recommends the introduction of water user charges to encourage responsible use, and the redirection of irrigation subsidies towards the construction, maintenance, and repair of infrastructure. Finally, it recommends limiting the use of chemical fertilisers and pesticides and switching to bio-fertilisers and bio-pesticides to reduce water pollution from rice production.

Decision 555/QĐ-BNN-TT on Approving Scheme for Restructuring of Vietnam's Rice Industry by 2025 and 2030 (MARD, 2021):

This decision builds upon and develops Decision 1898/QĐ-BNN-TT, further promoting the restructuring of the rice sector towards 2025 and 2030. Decision 555/QĐ-BNN-TT sets more specific goals for sustainable, safe, and efficient rice production, including **reducing the use of pesticides, chemical (30% reduction by 2025 and 40% reduction by 2030)** increasing mechanization, applying high technology, and developing a high-quality rice market. These directions facilitate the expansion of organic rice production, meeting the increasing market demand.

Decision 555/QĐ-BNN-TT addresses organic rice within the context of restructuring the rice industry towards sustainability. Specifically, organic rice is mentioned in sections related to "Applying a system of good production practices" and "Selecting specific ecological regions for organic rice development." The decision encourages the adoption of advanced farming practices like SRI, and "1 Must 5 Reductions", along with good production practices including VietGAP, climate-smart rice cultivation, and **organic farming**. It also **identifies specific ecological zones suitable for organic rice production, such as the rice-shrimp farming areas in the coastal Mekong Delta and regions known for local specialty rice varieties.** Furthermore, the decision promotes certified rice production, including support for organic certification, as part of its quality control and food safety measures. It also mentions preferential policies for businesses investing in organic rice production and trade within its "Rice Export" section.

With regard to water management, Decision 555/QĐ-BNN-TT proposes several solutions. It calls for the continued implementation of Government Decree 77/2018/NĐ-CP of 16 May 2018, which supports small-scale irrigation, on-farm irrigation, and advanced water-saving irrigation techniques. It aims to upgrade on-farm irrigation systems in all rice-growing areas, integrated with land consolidation, plot expansion, use of electric pumps, and production mechanisation. The decision emphasises the strengthening of community-based water management in large fields and cooperatives. It promotes water-saving rice production techniques such as land levelling, alternating wet and dry irrigation, and shifting to crop rotation systems such as rice-shrimp or rice-upland models. The decision also advocates the use of drought-resistant rice varieties and adjusting planting schedules to minimise water use and avoid saltwater intrusion or late-season drought. Rational planning and implementation of inter-regional water management policies between upstream and downstream areas are essential to regulate, share and optimise water use, while reducing wastewater discharge from rice production. Specifically for the Mekong Delta, the decision calls for completing irrigation planning and implementing management policies to regulate water use between upstream and downstream areas. It also suggests constructing moderately sized freshwater reservoirs, combined with aquaculture in areas severely affected by drought and saltwater intrusion, to improve water use efficiency and harmonize different water use objectives, especially between rice production and aquaculture. Strengthening international cooperation is essential to mitigate the impacts of hydropower development in upstream Mekong countries on the environment, agricultural production, and livelihoods of downstream communities. The decision recommends implementing water usage fees to encourage water conservation and redirecting irrigation subsidies towards infrastructure construction, maintenance, and repair. It also encourages limiting the use of chemical fertilizers and pesticides, promoting organic fertilizers and bio-pesticides to reduce water pollution from rice production. Finally, the decision emphasizes ensuring forest planting and protection according to legal regulations for water resource conservation.

2.2.2. Policies undirectly related to irrigation and organic farming:

In addition to the above policies, the Vietnamese Prime Minister has approved the Mekong Delta Master Plan for the period 2021 - 2030 with a vision to 2050. This plan covers many areas but focuses on sustainable agricultural development and a modern irrigation system adapted to climate change. Below is a summary of the key points related to irrigation and agriculture:

Decision 287/QD-TTg on Approving Mekong River Delta Plan in a Period of 2021 - 2030 with a Vision to 2050 (Prime Minister, 2022):

- **In irrigation:**
    - **Irrigation system development:** The plan focuses on developing a comprehensive irrigation system that meets the requirements of agricultural production transformation adapted to climate change, ensures proactive flood prevention and response to extreme floods, and prevents erosion. Specifically, the plan proposes the following solutions:
        - Upgrading and completing the level I dike system, including sea dikes and dikes along major rivers.
        - Developing a system of dikes and sluices along the Tien, Hau, Co Chien, and north of Mang Thit rivers to control salinity, protecting fruit orchards.

- Researching and constructing a system of sluices and dikes south of the Cai Lon River to control saltwater intrusion.
- Constructing a system of sluices and dikes along the Hau River for the Quan Lo - Phung Hiep area to control salinity and enhance the ability to transfer water from the Hau River to the Ca Mau peninsula.
- Completing the irrigation system in coastal areas to proactively supply water and control salinity, constructing separate or circulating water supply and drainage canals for agricultural production and aquaculture.
- Controlling groundwater exploitation to limit subsidence.
- Developing an early warning and forecasting system for floods, droughts, and saltwater intrusion.

o **Water supply:** The plan divides water supply zones based on water source conditions and proposes the construction of inter-provincial water plants to supply water to areas affected by saltwater intrusion or facing water scarcity. It also encourages investment in the construction of raw water pumping stations, rainwater reservoirs, and the application of brackish and saline water treatment technologies to supply water to islands and coastal areas.

▪ **In agriculture:**

o **Agricultural production restructuring:** The plan guides the restructuring of agricultural production according to three ecological sub-regions:
- **Freshwater ecological zone:** Develop rice cultivation areas combined with flood-season livelihoods and freshwater aquaculture.
- **Freshwater - brackish transitional zone:** Develop specialized fruit and vegetable cultivation areas combined with seasonal brackish water aquaculture.
- **Brackish - saline coastal ecological zone:** Develop sustainable aquaculture areas.

o **Strategic product development:** Focus on developing strategic products in three key groups: Aquaculture, fruit, and rice, with a focus on increasing the proportion of aquaculture and fruit, and reducing the proportion of rice.

o **Science and technology application:** Encourage research, application, and transfer of biotechnology, provide high-quality seed systems, technical services, processing, and export of the region's key agricultural products; focus on research and application of high technology to enhance the value of agricultural products, **improve organic, sustainable, and environmentally friendly farming techniques**, adapting to extreme floods and saltwater intrusion.

o **High-quality agricultural development:** The plan aims to develop high-quality commercial agriculture, combined with trade, logistics services, ecotourism, and industry, focusing on processing industries, enhancing the value and competitiveness of agricultural products.

2.3. Regional Policies

This section examines specific irrigation policies and strategies whitin the Mekong Delta region and their relevance to organic farming.

2.3.1. Vinh Long Province

The article by Luu (2024), head of the Irrigation Center (IC) in Vinh Long Province, focuses on the irrigation policies and plans for agriculture in Vinh Long mentioned in the document. Although the document does not specifically mention organic agriculture, the modernization and development of the irrigation system as outlined in the document will indirectly support all forms of agriculture, including organic agriculture, by providing a stable water source, controlling salinity, and responding to climate change. However, to have specific support policies for organic agriculture, further research and proposals are needed.

- **Existing Policies and Plans:**

Law on Irrigation 2018:

This is the legal basis for irrigation development in Vinh Long, serving multiple purposes, including agriculture. The province has issued policies based on this law.

Vinh Long Provincial Planning for the period 2021-2030, with a vision to 2050:

Orients the development of a synchronous, gradually modern, and smart irrigation system to meet the requirements of sustainable agricultural production and serve the people's livelihood.

Plan "Modernizing the irrigation system to serve the transformation and development of sustainable agriculture in Vinh Long province in the period 2021-2050":

Details the modernization of irrigation, aiming for automation and connection with regional irrigation and transportation systems.

Scheme on arranging the organization and apparatus for managing and operating irrigation works in the province until 2025:

Aims to establish irrigation enterprises and grassroots organizations to manage and operate irrigation works according to the law.

- **Specific Investment Plans:**

  - **Period 2018-2023:** Investment of nearly 5.9 trillion VND for 481 irrigation works.
  - **Period 2021-2050:** An estimated 66.322 trillion VND is needed to modernize irrigation, including projects such as: completing irrigation in the South Mang Thit River area; upgrading and expanding the main canal; dredging the canal system; completing dykes, upgrading river embankments; investing in a large-scale sluice system.
  - **Modernizing management and operation:** Training and capacity building; modernizing the monitoring system; building an operational monitoring system, gradually automating.

- **Recommendations:**

Vinh Long province proposes that the Central Government support:

  - Reviewing, supplementing, and completing mechanisms and legal policies on irrigation.
  - Amending Decree No. 77/2018/ND-CP on subjects of support.

- Supporting research and application of new technologies, especially advanced and water-saving irrigation.
- Supporting human resource training in the management, operation, and protection of irrigation works and in disaster prevention and climate change response.
- Building a unified irrigation work management and operation model for the Mekong Delta region.
- Organizing training on management, operation, inspection, examination, and handling of violations.
- Completing the legal framework.

2.3.2. An Giang Province

Decision 1369/QĐ-TTg dated 15/11/2023 on approving the An Giang Provincial Planning for the period 2021-2030, with a vision to 2050:

- ***Link to the document:*** *https://cloud.organorice.org/f/191728*
- **Summary of Information:**

- **Irrigation:**
  - Develop a multi-purpose irrigation system ensuring food security, water security, and climate change adaptation.
  - Construct and upgrade reservoirs in the Bay Nui highlands and the Long Xuyen Quadrangle.
  - Renovate and upgrade canals, sluice gates, and pumping stations (especially Vinh Te Canal).
  - Invest in major irrigation projects: Climate-resilient upland irrigation systems, irrigation systems for agricultural and rural development in North Vam Nao, flood control in South Vam Nao, and enhanced water management capacity upstream of the Cuu Long River.
  - Upgrade dikes and embankments in the Long Xuyen Quadrangle and border areas.
  - Ensure water supply for domestic use, production, and services. Provide proactive irrigation for cultivated land, aquaculture, and commodity agricultural production areas. Construct and upgrade clean water plants.
  - Construct wastewater drainage systems and upgrade centralized wastewater treatment systems.
  - Zone disaster risks and construct dike systems and residential clusters for disaster prevention and control.
  - Zone and allocate water resources and protect water resources.

- **Rice production:**
  - Shift from "agricultural production" to "agricultural economic development," applying high technology and value chain production.
  - Rice is identified as a key product.
  - Develop specialized production areas for high-quality rice, glutinous rice, fragrant rice, specialty rice, floating rice, and organic rice.
  - Prioritize investment in projects related to irrigation, agriculture, and rural development.

- **Connection to Irrigation and/or Organic Rice Production:**

Decision 1369 creates an important foundation for organic rice development in An Giang by:

- **Ensuring clean water sources:** The planned, renovated, and upgraded irrigation system will provide a clean and stable water source for organic rice production.
- **Proactive irrigation:** The pumping station and canal system allows for proactive irrigation, especially crucial during the dry season, supporting effective organic rice cultivation.
- **Pest control:** Dikes and embankments help control floods, pests, and weeds, creating favorable conditions for organic farming.
- **Climate change adaptation:** Climate change adaptation irrigation projects help mitigate negative impacts (drought, saltwater intrusion) on organic rice production.
- **Supporting specialized production areas:** Planning specialized organic rice production areas creates conditions for applying production processes, quality control, and brand building.
- **Development orientation:** Shifting to "agricultural economic development," applying high technology, and value chain production are suitable directions for organic rice.

Decision 08/2023/QĐ-UBND dated 15/03/2023 on Promulgating Regulations on the Decentralization of Management, Exploitation, and Protection of Irrigation Works in An Giang Province:

- ***Link to the document:*** *https://cloud.organorice.org/f/191761*
- **Summary of Information:**

- Stipulates the decentralized responsibilities for managing, exploiting, and protecting irrigation works for various levels of government, organizations, and individuals.
- Management objects include canals, ditches, siphons, culverts, embankments, dams, pumping stations, reservoirs, and protective dikes.
- Emphasizes ensuring the safety, stability, and efficient operation of irrigation works to meet agricultural production and livelihood requirements.
- Clearly defines the protection scope of irrigation works.

- **Connection to Irrigation and/or Organic Rice Production:**

Although not directly addressed, the management, exploitation, and protection of irrigation works according to this decision indirectly support organic rice production:

- **Ensuring irrigation water sources:** Effective irrigation management ensures a stable and timely supply of irrigation water, especially during the dry season.
- **Controlling floods and droughts:** Managing irrigation works helps control floods and droughts, protecting organic rice production areas.
- **Preventing water pollution:** Protecting irrigation works also means protecting water sources from pollution, which is crucial for organic rice.
- **Supporting water-saving irrigation:** Decentralized management facilitates the application of water-saving irrigation methods, suitable for organic rice production.

Plan 421/KH-UBND dated 07/07/2020 on Implementing Decision No. 33/QD-TTg dated January 7, 2020 of the Prime Minister on "Approving Vietnam's Irrigation Strategy to 2030, with a vision to 2045" in An Giang province:

- ***Link to the document:*** *https://cloud.organorice.org/f/191758*

❖ **Summary of Information:**

- **Water supply:** Ensure water supply for domestic use, agricultural production (including rice), industry, and services. Prioritize water-scarce areas, urban areas, and industrial zones. Specific targets for rice: proactive irrigation for two crops, ensuring 95% irrigation coverage. By 2030, 85% of rice-growing areas will utilize advanced irrigation; by 2045, this will increase to 95%. Similar targets are set for upland crops, aquaculture, and high-tech industries.
- **Drainage:** Proactive drainage and increased mechanically drained areas. Ensure drainage for low-lying areas.
- **Disaster prevention and control:** Address various natural disasters such as drought, saltwater intrusion, and flooding. Combine structural and non-structural solutions. Ensure safety for urban areas, residential areas, and production activities.
- **Infrastructure development:** Focus investment on major irrigation works and projects related to agricultural restructuring and disaster prevention. Prioritize ethnic minority areas, mountainous areas, and disadvantaged areas.
- **Improving management and operation efficiency:** Enhance the operational efficiency of irrigation organizations and promote the role of local communities.
- Science and Technology: Research and apply technology in irrigation management, operation, and disaster prevention.
- **Solutions for specific regions:** Upstream areas: flood control, dike stabilization. Midstream areas: complete irrigation works, proactive water supply. Upland areas: multi-purpose reservoir exploitation.

❖ **Connection to Irrigation and/or Organic Rice Production:**

This plan directly supports organic rice production through:

- **Proactive irrigation and drainage:** Enable farmers to proactively manage water supply and drainage for organic rice fields, reducing crop failure risks and increasing yield and quality.
- **Irrigation water quality control:** Ensures clean water sources, meeting the stringent standards of organic production.
- **Mitigation of natural disaster impacts:** Protects organic rice production from drought, saltwater intrusion, and flooding.
- **Creating conditions for sustainable farming:** Application of advanced and water-saving irrigation technologies, environmental protection.

Operating Procedures for the Long Xuyen Quadrangle Irrigation System:

❖ ***Link to the document:*** *https://cloud.organorice.org/f/191770*

❖ **Summary of Information:**

- Describes the Long Xuyen Quadrangle irrigation system, serving irrigation, drainage, flood control, and desalinization.
- Analyzes topographical characteristics, soil properties, hydrological regime, saltwater intrusion, and water pollution.

- Provides operational guidelines for infrastructure components: border flood control structures, drainage systems, and aquaculture clusters.
- Specifies operating procedures in special circumstances (drought, major floods, storms).
- Requires monitoring of water levels, flow rates, salinity, and water quality.

❖ **Connection to Irrigation and/or Organic Rice Production:**

These operating procedures support organic rice production by:

- **Providing freshwater sources**: Strict control of sluice gate operation ensures a stable irrigation water supply, preventing waterlogging and saltwater intrusion.
- **Controlling salinity and floods:** The sluice gate system helps prevent saltwater intrusion and control floods, protecting organic rice.
- **Flushing acid sulfate soils and improving water quality:** Operating drainage sluice gates helps flush acid sulfate soils and improve water quality.
- **Pest management:** Appropriate irrigation and drainage control helps limit pest development.
- Monitoring: Tracks water quality and detects pollution risks early.

Report on Effective Water Management for Sustainable Development:

❖ ***Link to the document:*** *https://cloud.organorice.org/f/191767*

❖ **Summary of Information:**

The report describes the province's water infrastructure, including a dense canal network (7,421 km), a comprehensive dike system (5,806.2 km), 19 reservoirs (7,919,000 m^3 capacity), and 2,288 pumping stations. It analyzes the large rice cultivation area (612,699 ha) and its high-water demand (4.1 billion m^3 annually). The report also discusses traditional high-water-use rice farming practices, the shift towards other crops, and significant challenges like climate change, erosion, water pollution, and saltwater intrusion. It emphasizes the need for modern irrigation, water quality monitoring, and research into drought- and salt-tolerant rice varieties.

❖ **Connection to Irrigation and/or Organic Rice Production:**

The report highlights both the potential and challenges of organic rice production in An Giang:

- **Potential Benefits:**
  - **Stable irrigation:** The existing water infrastructure provides a reliable water source for organic rice cultivation, minimizing dependence on rainfall.
  - **Flood control:** The dike system protects organic rice fields from flood damage.
  - Supplementary Water Sources: Reservoirs provide additional water during dry periods, crucial for organic rice production.
  - **Precise irrigation control:** Pumping stations allow for efficient water use, reducing waste and minimizing the risk of waterlogging.
  - **Scalability:** The large existing rice cultivation area offers significant potential for expanding organic rice production.
- **Challenges and Solutions:**

- **Water quality:** Addressing erosion and pollution is crucial to ensure clean water for organic rice. Monitoring and management of water quality within the canal network are essential.
- **Water management:** Implementing efficient water management practices, including water storage solutions, is vital to meet the high water demands of rice while minimizing environmental impact.
- **Climate change adaptation:** Researching and implementing drought- and salt-tolerant organic rice varieties is crucial for adapting to changing climate conditions.
- **Sustainable land use:** Careful planning and management of land use are essential to ensure that diversification into other crops does not negatively impact water resources or land available for organic rice.
- **Public awareness:** Educating farmers and the public about the benefits of organic rice production and sustainable water management is key to widespread adoption.

2.3.3. Dong Thap Province

Decision 19/QĐ-UBND.HC dated 10/01/2022 on Approving the "Program for Development of Small-Scale Irrigation, On-Farm Irrigation, and Advanced, Water-Saving Irrigation in Dong Thap Province, 2021-2025":

❖ ***Link to the document:*** *https://cloud.organorice.org/f/191935*

❖ **Summary of Information:**

- **Current challenges:** Dong Thap's irrigation system faces challenges such as significant water loss, unlined canals, a lack of modern irrigation systems, and difficulties in water control.
- **Proposed solutions:**
  - **Infrastructure investment:** Constructing and upgrading advanced, water-saving irrigation systems (drip, sprinkler), electric pumping stations, sluice gates, and canal lining. Focus on integrated investment from primary to on-farm systems, especially those downstream of pumping stations.
  - **Technology application:** Promoting Industry 4.0 technologies and automation in irrigation control, developing databases for water resources and irrigation systems.
  - Capacity Building: Training management staff and farmers on irrigation system management, operation, and technology application. Strengthening grassroots irrigation organizations.
  - **Diversified funding:** Mobilizing funds from various sources: central and local budgets, ODA, concessional loans. Supporting farmers in investing in irrigation systems.
  - **Land management:** Surveying, locating, and protecting public land used for on-farm irrigation, ensuring proper land use.
  - **International cooperation:** Collaborating domestically and internationally to mobilize capital, share experiences, and apply advanced technologies.
  - **Stable power supply:** Investing in rural electrification combined with power supply for pumping stations to ensure efficient irrigation system operation.
- **Rice production goals:** The program aims to improve rice production efficiency, adapt to climate change, and contribute to agricultural restructuring towards a modern, efficient, and sustainable approach. This includes applying modern irrigation and technology, promoting advanced farming practices, developing pilot models (including integrated rice-fish farming), and supporting cooperatives.

❖ **Connection to Irrigation and/or Organic Rice Production:**

- **Effective water management and pollution reduction:** Modern, water-saving irrigation systems and lined canals improve water control, reduce water pollution (soil, water, and air), and create a more favorable environment for organic practices.
- **Reduced chemical fertilizer use:** Advanced irrigation technologies enable better control over fertilizer application, reducing the need for chemical fertilizers, which is a core principle of organic farming.
- **Biological pest control:** Improved irrigation and water management create a more controlled environment, reducing pest risks and supporting biological pest control methods.
- **Increased productivity and quality:** The application of technology and advanced farming practices contributes to higher yields and better quality of organic rice.
- **Biodiversity enhancement:** Promoting integrated rice-fish/shrimp models enhances biodiversity within the farming system.
- **Sustainable development:** The program supports the transition to sustainable organic rice production and climate change adaptation.
- **Market expansion:** Improved rice quality helps meet the growing demand for organic rice in the market.

Resolution 47/2021/NQ-HĐND dated 17/08/2021 on Regulating Support Levels for Small-Scale Irrigation, On-Farm Irrigation, and Advanced, Water-Saving Irrigation in Dong Thap Province:

- ***Link to the document:*** *https://cloud.organorice.org/f/191941*
- **Summary of Information:**

- Support for investment in water storage works (exemption from land rental fees, support for design and construction machinery).
- Support for advanced, water-saving irrigation (50% support for material costs, machinery, and laser land leveling).
- Support for investment in electric pumping stations, sluice gates, and canal lining (up to 70% support for sluice gates and canals, and 40% for pumping stations).
- Other specific support from the central government and the province.

- **Connection to Irrigation and/or Organic Rice Production:**

This resolution indirectly supports organic rice production by:

- **Improving the irrigation system:** Investment in water storage works, canals, and pumping stations helps ensure irrigation water sources.
- **Applying advanced irrigation:** Saves water, reduces production costs, and protects the environment.
- **Strengthening production linkages:** Creates conditions for the formation of concentrated organic rice production areas.

Design Proposal Report: Building a Pilot Model for Implementing the Project "Sustainable Development of 1 Million Hectares of High-Quality, Low-Emission Rice Specialization Linked to Green Growth in the Mekong Delta Region by 2030":

- ***Link to the document:*** *https://cloud.organorice.org/f/191944*
- **Summary of Information:**

- **Objectives:** Establish a specialized area for high-quality, low-emission rice production, following value chain production and sustainable farming practices.
- **Location:** Thang Loi Cooperative, Lang Bien Commune, Thap Muoi District, Dong Thap Province.
- Area: 215 hectares (50 hectares for the pilot model).
- **Proposed Investment:** Upgrade pumping stations, sluice gate systems, main canals, reinforce canal banks, low-voltage power lines, and level rice fields. Deploy smart water inlets, flood-dry sensors, and insect monitoring stations.

❖ **Connection to Irrigation and/or Organic Rice Production:**

This report supports organic rice production through:

- **Effective water management:** The improved and upgraded irrigation system allows for better control over irrigation, meeting the water needs of organic rice at each growth stage, minimizing water loss, and saving costs. Good water level control also helps suppress weed growth, reducing the need for herbicides.
- **Reduced emissions:** The model aims for low emissions, aligning with organic production principles and environmental protection.
- **Technology application:** Utilizing smart devices like automatic water inlets, wet-dry sensors, and insect monitoring stations improves management efficiency, reduces labor, enables early pest detection for timely intervention, and limits the use of chemical pesticides. Data collected from these devices also supports analysis, evaluation, and improvement of production processes.
- **Increased productivity and quality:** Investing in integrated infrastructure combined with advanced farming practices enhances both the yield and quality of organic rice.
- **Sustainable development:** The model promotes sustainable development, ensuring food safety, protecting the environment, and increasing farmers' income, consistent with the goals of organic rice production.

2.4. Gaps, Opportunities, and Recommendations

This analysis identifies gaps and opportunities for organic rice production based on national and regional policies related to irrigation and agriculture in Vietnam, specifically within the Mekong Delta.

2.4.1. National policy gaps and opportunities

❖ **Strengths:**

- **Decree 109/2018/NĐ-CP (Organic Agriculture):** This decree provides the legal basis for the development of organic agriculture. Articles 16 and 17 provide for support policies, including financial support for the identification of organic production areas (Article 17.1.a), certification support (Article 17.1.b), training (Article 17.1.c) and model development (Article 17.1.d). This demonstrates the State's commitment to the promotion of organic production.
- **Decision 1898/QĐ-BNN-TT (Rice Sector Restructuring Plan 2016):** This decision emphasises sustainable cultivation (II.1.d), reduction of greenhouse gas emissions and reduction of post-harvest losses. Section II.1.d.(i) mentions the upgrading and renovation of irrigation systems and the use of Alternate Wetting and Drying (AWD) irrigation. These measures can contribute to organic rice production.

- **Decision 555/QĐ-BNN-TT (Rice Sector Restructuring Plan 2021):** This decision updates Decision 1898 and places greater emphasis on sustainable production, climate change adaptation (II.4.a) and food safety (II.1.e). Section II.1.d mentions the application of good agricultural practices (VietGAP, GlobalGAP, organic, etc.), indicating attention to organic production.
- **TCVN 11041-2:2017 (Organic Plant Production):** This standard clearly defines the requirements for soil management (5.1.7) and water management (5.1.8) in organic crop production. Clause 5.1.8 states that water sources used must comply with current regulations and be protected from contamination.
- **Decision 287/QĐ-TTg (Mekong Delta Regional Plan 2021-2030):** This decision emphasises sustainable development (II.1.a, II.3.a, III.1.c), adaptation to climate change (II.3.a, VII.3) and integrated water resources management (VII.2). Section III.1.c mentions the development of organic farming. Section VI.3 deals with the development of irrigation systems and changes in operating regulations in line with the transformation of agricultural production.

❖ **Gaps:**

- **Irrigation system challenges:**
  - **Lack of specific irrigation planning for organic farming:** Despite the government's intention to expand organic agriculture to improve environmental conditions and promote sustainable development in the Mekong Delta, the documents reviewed lack specific plans or references to organic agriculture or irrigation planning. This lack of clear guidance on how to establish irrigation systems that meet the strict water/soil quality standards required for organic certification is a significant barrier to adoption.
  - **Lack of specific irrigation policies for organic rice:** Despite numerous policies that support organic agriculture and irrigation in general, there is a lack of policies that specifically support irrigation for organic rice production. Decree 109/2018/NĐ-CP does not address support for investments in water-saving irrigation systems or water treatment to meet organic standards. The decisions on the restructuring of the rice sector also lack specific guidance on the use of funds for irrigation for organic rice production. The risk of cross-contamination from shared irrigation systems between conventional and organic rice farms is a major challenge. The lack of specific provisions for dedicated organic irrigation systems or effective water treatment and quality control measures for shared systems is a significant policy gap.
  - **Lack of specific technical standard for organic rice production:** While TCVN 11041-5:2018 references QCVN 08-MT:2015/BTNMT and QCVN 09-MT:2015/BTNMT (technical regulations for surface water and groundwater quality, respectively) for water quality parameters in organic rice irrigation, these regulations are also applied to general water management. This dual application creates practical challenges for TCVN 11041-5:2018 because the standards, designed for broader water management, may not be entirely suitable or clearly defined enough to meet the specific clean water requirements of organic agriculture, particularly organic rice production. The lack of specific guidance tailored to organic farming within these general regulations makes it difficult to ensure that irrigation water meets the stricter standards necessary for organic certification.
  - **Lack of Effective Policy Integration:** While the policies all aim for sustainable agricultural development, the integration and linkage between policies on organic agriculture, irrigation, and rice sector

restructuring are not truly effective. This leads to a lack of specific programs and projects for investing in irrigation infrastructure for organic rice production.

❖ **Opportunities:**

- **Established legal and regulatory framework:** Decree 109/2018/ND-CP and TCVN 11041-2:2017 provide a solid legal and regulatory foundation for organic agriculture, including specific standards for rice production. This framework promotes quality control, traceability, and consumer confidence.
- **Awareness of sustainable farming and water management:** Both Decision 1898/QĐ-BNN-TT and Decision 555/QĐ-BNN-TT emphasise the importance of sustainable agriculture, climate change adaptation and food security. In particular, they emphasise investment in and improvement of irrigation systems, especially on-farm irrigation, to ensure proactive, economical and efficient irrigation water sources. Improving the general irrigation system also helps to create favourable conditions for the development of dedicated irrigation for organic rice production. These decisions encourage the use of water-saving irrigation techniques such as drip, sprinkler and furrow irrigation, which are suitable for organic production requirements.
- **Integration of programs and projects:** Clause 2, Article 17 of Decree 109/2018/NĐ-CP creates opportunities to integrate irrigation projects into organic agriculture support programs. Similarly, the objectives of water resource protection in Decision 1898/QĐ-BNN-TT and production certification support in Decision 555/QĐ-BNN-TT also open up opportunities to integrate sustainable water management solutions suitable for organic rice production.
- **Technical standard for organic agriculture production:** TCVN 11041-2:2017 provides specific regulations on soil and water management in organic crop production, ensuring product quality and environmental protection. This standard requires that water sources used must meet current regulations on water quality and that measures must be taken to protect water sources from pollution. This sets a requirement for strict water resource management, contributing to the development of irrigation systems suitable for organic rice production. Furthermore, TCVN 11041-2:2017 addresses specific issues regarding the risk of external water contamination:
  - **Bio-pesticide utilization:** The table A2 mentioned in the TCVN11041-2:2017 provides a list of approved substances for pest control in organic rice production, allowing farmers to consult this when facing pest outbreaks.
  - **Production area:** Requires organic production areas to be clearly demarcated, with buffer zones or physical barriers separating them from conventional production areas. These buffer zones must be clearly defined and easily identifiable. The width and height of plants in the buffer zone depend on the height of the plants in the conventional production area, the source of pollution to be addressed, the local topography, and climatic conditions.
  - **Water contamination prevention:** If there is a risk of external contamination* from water sources, the standard requires the creation of an earth embankment or drainage ditch outside the buffer zone to prevent water intrusion and contamination into the organic production area.

    ** External contaminations: Runoff contaminated with chemical fertilizers and pesticides, organic and microbial pollutants, improperly disposed pesticide packaging, pesticide residues from rinsing* *equipment, plastic waste (microplastics), runoff from deteriorated pesticide storage facilities (VAAS, 2021)*

- **Long-term vision for the mekong deltafrom Decision 287/QĐ-TTg:** The Mekong Delta Master Plan (Decision 287/QD-TTg) provides a long-term vision for sustainable regional development which can support organic rice farming by:
  - **Controlling saltwater intrusion and providing freshwater:** Investing in irrigation systems, dikes, and sluices helps control saltwater intrusion, ensuring a freshwater source for organic rice production, especially in coastal areas.
  - **Restructuring agricultural production:** Prioritizing aquaculture and fruit creates an ideal entry point for expanding organic production, as organic methods are particularly well-suited to sustainable aquaculture growth.
  - **Applying science and technology:** Encouraging research and application of high technology in agriculture, including organic farming techniques, helps improve the productivity and quality of organic rice.
  - **Developing high-quality agriculture:** The direction of developing high-quality commercial agriculture aligns with the goal of organic rice production, meeting the increasing market demand for clean and safe products.

The development of organic rice production requires synchronized coordination between policies on organic agriculture and irrigation. It is necessary to improve the legal framework, financial and technical support policies for farmers, invest in developing suitable irrigation systems, strengthen trade promotion, and raise consumer awareness. Decision 555/QĐ-BNN-TT is an opportunity to concretize support policies and address obstacles, creating momentum for the sustainable development of the organic rice sector in Vietnam.

2.4.2. Regional policy gaps and opportunities (Mekong Delta)

❖ **Gaps:**

- **Lack of specific organic rice focus:** Regional policies often address general agricultural and irrigation improvements without specifically targeting organic rice, leading to missed opportunities for tailored support.
- **Coordination challenges:** Implementing national policies at the regional level requires effective coordination between different provinces and agencies to avoid inconsistencies and maximize impact.

❖ **Opportunities:**

- **An Giang province:**
  - **Provincial Planning (Decision 1369/QĐ-TTg):** Focus on multi-purpose irrigation, upgraded infrastructure, and specialized organic rice production areas provides a strong foundation for organic rice development.
  - **Decentralized Irrigation Management (Decision 08/QĐ-UBND):** Improved management of irrigation works indirectly supports organic rice by ensuring water availability and quality.

- **Irrigation Strategy Implementation (Plan 421/KH-UBND):** Targets for proactive irrigation, drainage, and disaster prevention directly benefit organic rice.
- **Long Xuyen Quadrangle Irrigation System Operating Procedures:** Detailed procedures for water management support organic rice by controlling salinity, floods, and ensuring freshwater availability.
- **"Effective Water Management" Report:** Identifies both potential and challenges, offering valuable insights for targeted interventions.

▪ **Dong Thap province:**
  - **Irrigation Development Program (Decision 19/QĐ-UBND.HC):** Focus on small-scale, on-farm, and advanced irrigation directly benefits organic rice by improving water management and efficiency.
  - **Support for Irrigation Investments (Resolution 47/2021/NQ-HĐND):** Financial incentives for irrigation upgrades indirectly support organic rice farmers by reducing investment costs.
  - **Pilot Model for Sustainable Rice Production:** This initiative demonstrates practical solutions for water management, technology application, and sustainable practices in organic rice farming.

▪ **Vinh Long province (limited information):** While the focus on irrigation modernization indirectly supports agriculture, including organic farming, specific policies targeting organic rice are needed.

2.4.3. Overall recommendations:

▪ **Developing specific policies for organic irrigation:** Vietnam has an opportunity to become a leader in sustainable agriculture by developing specific policies for organic irrigation. This could include setting water quality standards for organic agriculture, promoting water-efficient technologies, and providing financial incentives for organic irrigation practices.

▪ **Integrate irrigation with organic certification**: Streamlining the relationship between irrigation policies and organic certification processes can simplify compliance for farmers and enhance the credibility of Vietnamese organic products.

▪ **Supporting research and innovation:** Investing in research on organic irrigation can lead to more efficient and sustainable practices tailored to the specific conditions in Vietnam. This could include investigating the effectiveness of different irrigation techniques, developing water-saving technologies, and exploring ways to improve water quality.

▪ **Capacity building and training**: Providing training and technical assistance to farmers on organic irrigation practices can help them improve water management, reduce water consumption and improve the quality of their products.

▪ **Promoting market access for organic products:** By supporting organic irrigation, Vietnam can improve the quality and marketability of its organic rice and other organic products, potentially accessing premium markets and increasing farmers' incomes.

III. Potential Irrigation Strategies for Organic Rice Production

This section presents the initial irrigation strategies reviewed by UNU researchers, based on scientific literature, best practices, and consideration of the context of the Mekong Delta. These strategies address key challenges related to water management, cross-contamination prevention, and sustainable intensification of organic rice production.

3.1. Guiding Principles

The proposed strategies are guided by the principles of sustainability, equity, climate resilience, and compatibility with organic farming practices. This subsection details these principles and how they inform the specific strategies. Based on the documents from FAO (2014) *at section Strategic Objectives, page 9*

The proposed irrigation strategies for organic rice production in the Mekong Delta are guided by the following core principles:

- **Principle 1 (P1) - Sustainability**: Irrigation strategies must ensure the long-term viability of organic rice production by minimising environmental impacts and conserving natural resources. This includes using water efficiently, preventing water pollution from agrochemical run-off from conventional farms, maintaining soil health and promoting biodiversity. Strategies will consider the entire water cycle and aim to minimise water withdrawals, optimise water use efficiency and prevent salinisation and other forms of land degradation.
- **Principle 2 (P2) - Equity:** Irrigation strategies should promote equitable access to water resources for all stakeholders, including smallholder farmers, and ensure that the benefits of organic rice production are shared equitably. This requires careful consideration of water allocation mechanisms, community participation in water management and support for vulnerable groups. Strategies will aim to avoid exacerbating existing inequalities and promote social justice in the context of organic rice production.
- **Principle 3 (P3) - Climate Resilience:** Irrigation strategies shall enhance the resilience of organic rice production systems to the impacts of climate change, such as increased frequency and intensity of droughts, sea-level rise and extreme weather events. This includes promoting drought-resistant rice varieties, implementing water-efficient irrigation techniques, and developing climate-smart infrastructure. Strategies will include climate change projections and adaptation measures to ensure the long-term sustainability of organic rice production in the face of a changing climate.
- **Principle 4 (P4) - Compatibility with Organic Farming Practices**: Irrigation strategies shall be fully compatible with the principles of organic agriculture, which prohibit the use of synthetic fertilisers, pesticides and genetically modified organisms. This includes ensuring that irrigation water is free of contaminants and promoting practices that enhance soil fertility and biodiversity. Strategies will prioritise organic principles and ensure alignment with organic certification standards. This includes considering the potential to use treated wastewater for irrigation, provided it meets organic standards.
- **Principle 5 (P5) - Cross-Contamination Prevention**: Given the proximity of conventional and organic rice farms in the Mekong Delta, a key principle guiding irrigation strategies is the prevention of cross-contamination. This will require careful management of water flows, buffer zones, and possibly separate irrigation infrastructure for organic and conventional farms. Strategies will take into account the specific

hydrological conditions of the region and implement measures to minimise the risk of contamination from adjacent conventional farms.

- **Principle 6 (P6) - Economic Viability:** Irrigation strategies should contribute to the economic viability of organic rice production by improving yields, reducing production costs and improving market access for organic products. This requires considering the costs and benefits of different irrigation options and promoting market-based incentives for organic rice production.

3.2. Provincial Scale: Localized Irrigation Systems for Organic Rice

The provincial level is critical for managing irrigation systems that directly support organic rice production. As provincial authorities are responsible for local water management and agricultural planning, strategies at this level can be fine-tuned to meet the geographical, environmental, and social needs of organic rice producers.

At the provincial level, irrigation management can be closely tailored to the specific needs of local organic rice farmers, considering local water resources, farming practices and environmental conditions. The aim is to develop irrigation strategies that support organic farming principles, minimise cross-contamination and improve water use efficiency, while ensuring social equity and climate resilience.

3.2.1. Irrigation zoning and water source separation

(Furihata et al., 2019; Gilles et al., 2007; Hou et al., 2020; Irham et al., 2024; OFFER, 2008; Trinh et al., 2017; Vahedi et al., 2023)

<u>Overview:</u> Creating distinct irrigation zones for organic and conventional rice farms prevents cross-contamination from synthetic agrochemicals. This involves separate irrigation channels, reservoirs, or piping systems for organic farms, ensuring a clean, uncontaminated water supply.

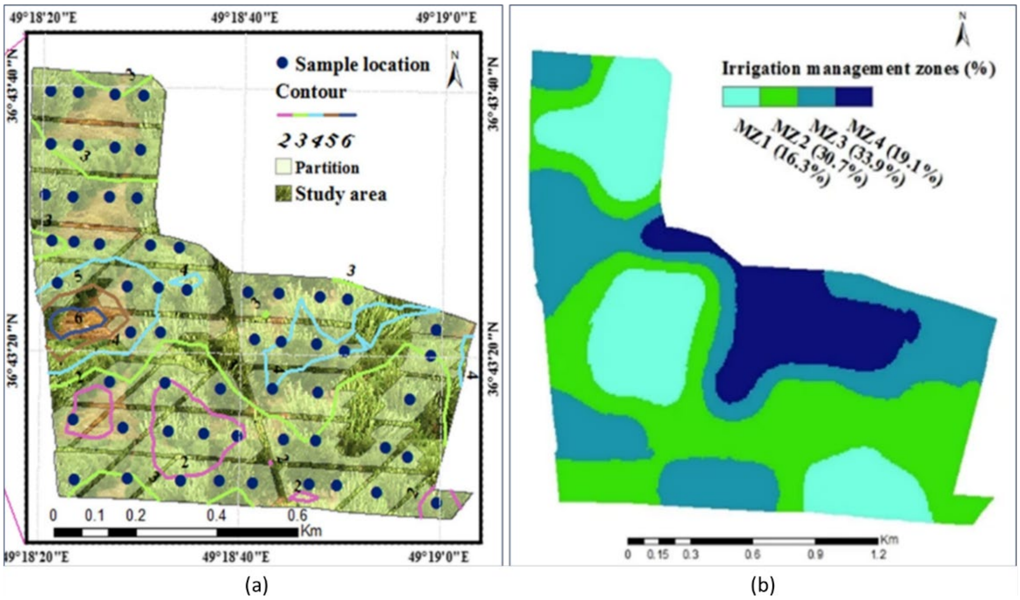

Figure 1. Modelling spatial distribution patterns to delineate irrigation zoning

Source: (Vahedi et al., 2023)

Vahedi et al. (2023) investigated the delineation of irrigation management zones (IMZs) in a 120-hectare super-high-density olive orchard. Soil and leaf samples were collected at 57 georeferenced points distributed across the orchard in a 50m x 50m grid pattern, as depicted in Figure 1-a. These samples were analyzed for various physical and chemical properties, which were then used as input for geostatistical analysis and principal component analysis (PCA). Co-kriging was employed to create spatially continuous maps of the key soil properties, and PCA was used to reduce the dimensionality of the data and identify the most influential variables. These principal components, along with irrigation rate (I) and electrical conductivity (EC), were then used as input for a fuzzy k-means clustering algorithm to delineate four distinct IMZs, as shown in Figure 1-b. These zones represent areas within the orchard with similar soil characteristics and irrigation requirements, enabling targeted irrigation management strategies for each zone to optimize water use efficiency and potentially improve yield. The spatial distribution of the IMZs reflects the underlying variability in soil properties observed in the sample locations (Figure 1-a), particularly the influence of salinity (EC) and soil physical properties like sand content, bulk density, and available water capacity.

Rationale: Organic rice production prohibits the use of synthetic fertilisers, pesticides, and genetically modified organisms (GMOs). Preventing contamination of irrigation water is therefore crucial to maintaining organic certification. The proximity of conventional and organic farms in the Mekong Delta poses a significant risk of agrochemical run-off into organic fields through shared irrigation systems.

Implementation steps:

- **(i) Mapping and classification:** Identify and map out the locations of organic and conventional rice farms within the province. This can be done using geographic information systems (GIS) to create detailed land-use maps that highlight areas at risk of contamination.
- **(ii) Water resource assessment:** Conduct an assessment of available water resources in the province, including rivers, canals, groundwater, and reservoirs. Determine which water sources are suitable for organic farming based on water quality standards (e.g., free from chemical pollutants).
- **(iii) Infrastructure development:** Build or modify existing irrigation infrastructure to provide separate water supply channels for organic farms. This may involve constructing new canals or reservoirs specifically for organic farms or installing piping systems to deliver clean water from uncontaminated sources.
- **(iv) Monitoring and enforcement:** Establish a monitoring system to ensure that water quality remains within acceptable limits for organic farming. This can involve regular water testing and enforcement measures to prevent accidental or intentional contamination.

Principles addressed:

- **P1 (Sustainability):** Proper zoning and dedicated infrastructure minimize the environmental impact of conventional farming on organic systems, promoting long-term ecological balance. This reduces the need for remediation and conserves water resources.
- **P4 (Compatibility with organic farming practices):** This solution directly addresses P4 by ensuring the irrigation water used for organic rice is free from synthetic agrochemicals, a fundamental requirement for organic certification. This safeguards the integrity of organic production and maintains consumer trust.

- **P5 (Cross-contamination prevention):** By physical separating water sources, the risk of contamination from conventional farms is minimized.

Detailed strategy: Irrigation zoning involves physically separating organic and conventional rice production areas to prevent contamination. This zoning is based on water sources, land use patterns, and hydrological conditions. The strategy can be broken down into key actions:

(i) Conducting a comprehensive land use survey:

- Use GIS technology to map out organic and conventional rice farms within the province. This mapping should include:
  - **Water sources:** Identify water sources (rivers, canals, reservoirs) used by farmers, ensuring that water quality data (e.g., chemical content, salinity) is collected.
  - **Topography:** Understand the flow of water, especially in relation to the risk of runoff from conventional to organic farms.

Example: GIS mapping could reveal areas where conventional rice farms are located upstream of organic farms, necessitating new irrigation channels or reservoirs to avoid contamination.

(ii) Developing separate water supply systems:

- Physical separation of irrigation systems might involve:
  - **Constructing new irrigation canals** for organic rice farms that draw water directly from unpolluted sources.
  - **Installing filtration systems** at the water intake points to remove contaminants before the water reaches organic farms.
  - **Establishing small reservoirs** that collect rainwater for organic farms, ensuring a clean and self-contained water supply.

Example: The local government could build a reservoir solely for organic farming, ensuring that water is free from agrochemical residues. This reservoir could be fed by rainwater or groundwater sources that are tested for purity.

(iii) Monitoring and enforcement:

- Set up a provincial monitoring system where water quality is regularly tested at critical points in the irrigation network (e.g., at the head of irrigation canals and at farm-level intake points).
- Enforce zoning regulations by imposing penalties for farms or industrial activities that cause contamination of water sources designated for organic farming.

Example: Local authorities can develop a water quality monitoring framework using mobile testing units to check for contaminants like nitrates and pesticides.

Benefits:

- **Prevents cross-contamination**: By separating water sources for organic and conventional farms, the risk of contamination from chemical fertilizers and pesticides used in conventional farming is minimized, which is crucial for maintaining organic certification.

- **Increases water quality:** Organic farms receive cleaner water, which contributes to healthier soil and crop systems, reducing the need for costly remediation or soil recovery efforts due to contamination.
- **Supports organic certification:** Proper zoning helps farms maintain their organic status by adhering to water quality standards required for organic certification.

Trade-offs:

- **Infrastructure costs:** Building or modifying irrigation infrastructure to separate water sources can be expensive, particularly in areas with limited budgets. This includes the costs of constructing new canals, reservoirs, or filtration systems.
- **Land use restrictions:** Zoning may require reallocation of land use, potentially limiting the expansion of conventional farming or other productive uses in the region. This could affect local economic interests or lead to conflicts over land use.
- **Coordination challenges:** Implementing and enforcing zoning requires strong coordination between local authorities, farmers, and other stakeholders. Without proper governance, there could be gaps in enforcement that may lead to contamination.

Feasibility:

- **Technical feasibility:** Zoning and water source separation are technically feasible but require initial investments in infrastructure and monitoring systems. Provinces with existing irrigation systems that can be modified are more likely to succeed.
- **Financial feasibility:** High up-front costs can be a barrier, especially in provinces that don't yet have a dedicated budget. However, financial support from government programs or international donors (e.g., World Bank, FAO) can make this more feasible.
- **Social feasibility:** This strategy may face resistance from conventional farmers who could see zoning as a limitation on their practices. Strong community engagement and education about the benefits of organic farming can help ease this transition.

3.2.2. Buffer zones between farms

Overview: Establish buffer zones between organic and conventional farms to mitigate the risk of agrochemical drift (e.g., pesticides or herbicides) and runoff from conventional farms contaminating organic fields. These buffer zones can serve as natural barriers, such as hedgerows, tree lines, or designated fallow land. There are two types of buffer zones can be established:

- **Buffer zones by planting native vegetation on land** (Bouagnimbeck et al., 2009; CAFTCenter, 2017; Coleman, 2012; LoginEKO, 2024; OFC-FBC, 2024; USDA, 2024)

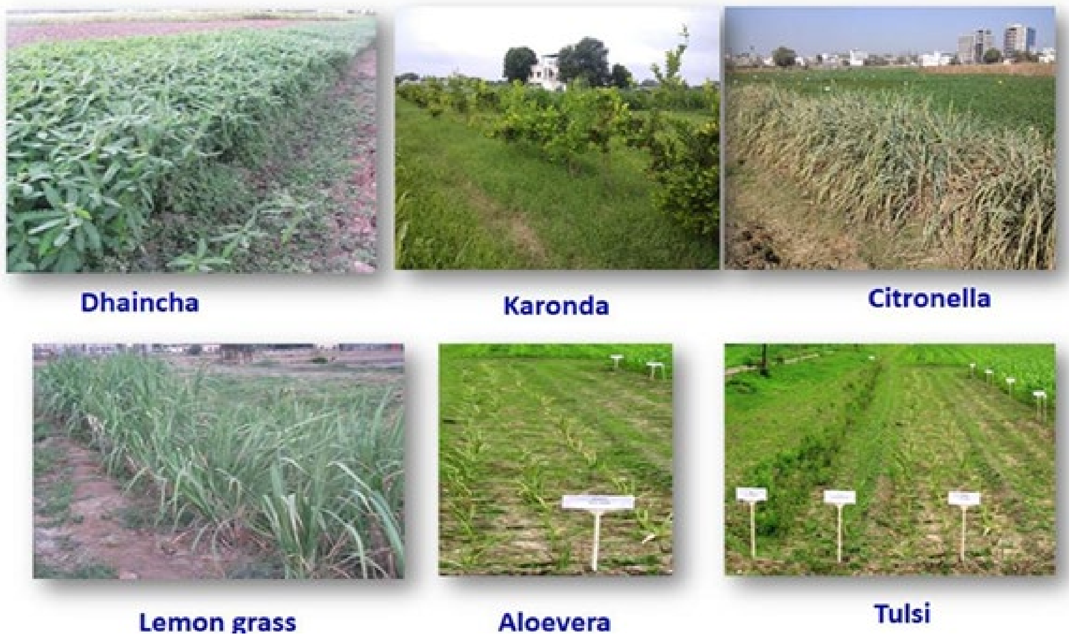

Figure 2. Different types of vegetation species for the buffer zone on land in organic rice farming

Source: (CAFTCenter, 2017)

- **Buffer zones by planting native vegetation in irrigation systems** (Abonyi et al., 2024; LandscapeDNA, 2024)

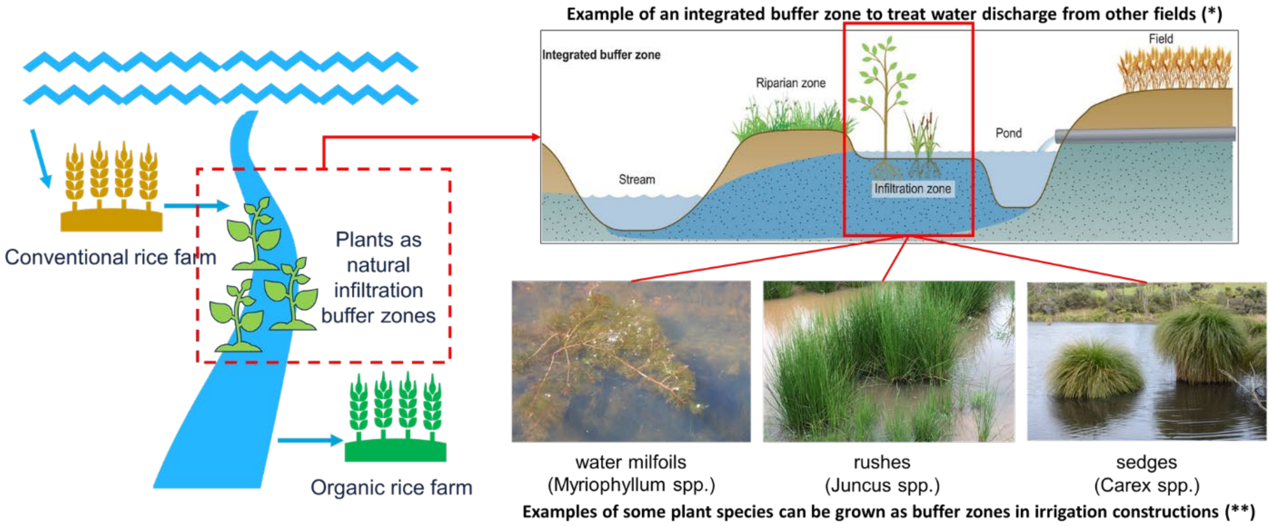

Figure 3. Example of planting vegetation in irrigation systems as a buffer zone to treat water discharge from other fieldss

Source: (**Abonyi et al., 2024; *LandscapeDNA, 2024)

<u>Rationale:</u> Buffer zones act as a physical and ecological barrier that reduces the movement of chemicals and pollutants from conventional farms to organic farms. They also promote biodiversity by providing habitats for beneficial organisms such as pollinators and natural pest predators. In some cases, buffer zones can be used for agroforestry or other sustainable land uses that contribute to environmental health.

Implementation steps:

(i) **Design of buffer zones:** Determine the appropriate width and composition of buffer zones based on local conditions (e.g., soil type, slope, hydrology). For example, wider buffer zones may be required in areas with higher risk of runoff, while narrower zones may suffice in flat areas with low risk.

(ii) **Vegetative barriers:** Plant native trees, shrubs, or grasses in the buffer zones. These plants help trap pollutants, reduce soil erosion, and improve water infiltration, thereby reducing the risk of contamination of nearby organic fields.

(iii) **Policy support:** Work with local agricultural authorities to establish guidelines and financial incentives for farmers to maintain buffer zones. This could include subsidies for planting native species or compensating farmers for land set aside for buffer zones.

(iv) **Monitoring:** Monitor the effectiveness of buffer zones in preventing contamination, using soil and water testing to track the movement of chemicals from conventional farms.

Principles addressed:

- **P1 (Sustainability):** Buffer zones enhance biodiversity, improve soil health, and protect water quality by filtering runoff and reducing erosion. This contributes to a more sustainable and resilient agricultural landscape.
- **P4 (Compatibility with organic farming practices):** Buffer zones create a physical barrier against drift and runoff contamination from conventional farms, ensuring compliance with organic standards. This is crucial for maintaining the integrity of organic produce.
- **P5 (Cross-contamination prevention):** Buffer zones act as a first line of defense against cross-contamination, reducing the risk of prohibited substances reaching organic fields.

Detailed strategy: Creating buffer zones between organic and conventional farms is essential to prevent cross-contamination from pesticide drift, chemical runoff, or water contamination. These zones can also serve as ecological corridors, improving biodiversity and environmental sustainability.

(i) Establishing appropriate buffer widths:

- The width of buffer zones should be determined based on:
  - **Topography:** Steeper areas with higher runoff potential may require wider buffers (e.g., 10–30 meters).
  - **Hydrological conditions:** Areas with high rainfall or proximity to water bodies may need wider buffers to manage water flow and filtration.
  - **Prevailing winds:** In areas where wind drift is a concern, wider buffers comprising tall vegetation (e.g., trees) can help block agrochemical drift.

Example: Buffer zones between conventional and organic fields could be established using a combination of bamboo and native trees, which are effective at reducing wind and runoff.

(ii) Planting vegetative barriers:

- Plant diverse, native species in the buffer zones to:
  - **Trap runoff pollutants:** Root systems of deep-rooted plants can filter out contaminants.

- **Prevent soil erosion:** Vegetation stabilizes soil, reducing the amount of sediment and chemicals entering water systems.
- **Promote biodiversity:** Buffer zones can serve as habitats for beneficial insects and wildlife, which in turn support organic farming through natural pest control.

Example: Local authorities could promote the use of vetiver grass (cỏ hương lau) in buffer zones, which is known for its deep roots and ability to trap pollutants.

(iii) Encouraging farmers to maintain buffers:

- Introduce financial incentives or subsidies for farmers to maintain buffer zones. This could include:
  - **Direct payments** for maintaining ecological buffers.
  - **Tax reductions or grants** for farmers who comply with buffer zone regulations.
  - **Certification benefits:** Organic certification agencies could offer reduced certification fees for farms that implement and maintain buffer zones.

Example: farmers could receive subsidies through the provincial authoritie's fund for planting and maintaining buffer zones, improving environmental outcomes while supporting organic certification.

(iv) Monitoring effectiveness:

- Implement a monitoring program to track the effectiveness of buffer zones in reducing contamination. This could include:
  - **Soil and water testing** to measure pollutants at the edges of buffer zones.
  - **Biodiversity assessments** to gauge the ecological value of the buffer zones.

Benefits:

- **Reduces chemical drift and runoff:** Buffer zones act as physical barriers that reduce the movement of pesticides, fertilizers, and other pollutants from conventional to organic farms, protecting soil and water quality
- **Promotes biodiversity:** Buffer zones can be planted with native vegetation, creating habitats for beneficial organisms such as pollinators, natural pest predators, and birds. This can also enhance ecosystem services that benefit organic farming
- **Soil and water conservation:** Vegetative barriers help to reduce soil erosion and improve water infiltration, which is beneficial for long-term soil health and water conservation.

Trade-offs:

- **Loss of arable land:** Setting aside land for buffer zones can reduce the amount of land available for cultivation, which may be a significant trade-off in densely farmed regions.
- **Maintenance costs:** Buffer zones require ongoing maintenance, such as managing vegetation, preventing invasive species, and ensuring that the buffer remains effective at trapping pollutants.
- **Initial setup costs:** Establishing buffer zones, including planting and preparing the land, can involve initial costs that may deter farmers, especially if they do not receive financial incentives.

Feasibility:

- **Technical feasibility:** Establishing buffer zones is relatively straightforward, though the exact width and type of vegetation used will depend on local conditions (e.g., soil, topography, climate). Buffer zones are highly feasible in areas with adequate land availability.
- **Financial feasibility:** Financially, buffer zones can be implemented at a relatively low cost compared to more infrastructure-heavy solutions like reservoirs or new irrigation systems. However, subsidies or incentives may be needed to encourage farmers to set aside land.
- **Social feasibility:** Social feasibility is high if buffer zones are coupled with incentives such as compensation for lost land or tax breaks. However, without incentives, farmers may resist losing productive land.

3.2.3. Community-based water management

(Aarnoudse et al., 2018; ADB, 2017; DAI Global LLC, 2018; Schmidt et al., 2023)

Overview: Form community-based Water User Associations (WUAs) that involve local farmers, irrigation managers, and other stakeholders in the management of irrigation systems. These associations can help ensure equitable water distribution, resolve conflicts, and promote sustainable water use practices.

Rationale: Community-based water management is essential for ensuring that smallholder farmers, who often make up the majority of organic rice producers in the Mekong Delta, have equitable access to water resources. WUAs provide a platform for participatory decision-making, allowing farmers to have a say in how water is allocated and used. This approach is particularly important in areas where water is scarce or where competition for water resources is high. The WUA method has been recognized in sub-Saharan Africa (Aarnoudse et al., 2018), six Chinese provinces including Anhui, Heilongjiang, Henan, Jilin, and Yunnan provinces, and the Ningxia Hui Autonomous Region (ADB, 2017), Haiti's Northern Corridor (DAI Global LLC, 2018), and in some countries such as Tajikistan, Kyrgyzstan, Pakistan, Madagascar, and Myanmar (Schmidt et al., 2023).

Implementation steps:

(i) **Formation of WUAs**: Organize local farmers and other stakeholders into water user associations. These groups can be based on geographic regions (e.g., villages or irrigation zones) or the types of crops being grown (e.g., organic vs. conventional).

(ii) **Capacity building:** Provide training to WUA members on water management techniques, conflict resolution, and sustainable farming practices. This training can be facilitated by local agricultural extension services or NGOs working in the region.

(iii) **Water allocation rules:** Develop clear rules for water allocation that prioritize fair distribution, particularly during periods of water scarcity. These rules should be developed through a participatory process to ensure buy-in from all stakeholders.

(iv) **Conflict resolution mechanisms:** Establish mechanisms within the WUA for resolving disputes over water use. This could include mediation services or a designated conflict resolution committee within the association.

Principles addressed:

- **P2 (Equity):** WUAs ensure fair access to water resources, especially for smallholder farmers who may be marginalized in traditional water management systems. This empowers local communities and fosters collaborative resource governance.
- **P4 (Compatibility with organic farming practices):** WUAs can promote a common understanding and enforcement of practices that prevent contamination, thereby fostering an environment that supports organic farming. This community-level commitment to responsible water use indirectly supports the needs of organic farming by reducing the overall risk of contamination.
- **P6 (Economic viability):** Improved water access and reduced conflicts over resources contribute to the economic stability of organic rice farming. This strengthens local livelihoods and encourages sustainable agricultural practices.

Detailed strategy: WUAs play a crucial role in managing water resources at the provincial level. These associations empower local farmers to take part in decision-making processes and ensure equitable access to irrigation water.

(i) Formation of WUAs:

- Organize farmers into WUAs based on geographic proximity (e.g., by irrigation canal or watershed). Each association should include:
  - **Smallholder farmers** (especially organic rice producers).
  - **Irrigation officials** from the provincial authorities (e.g. DARDs, ICs)
  - **Local stakeholders**, such as cooperative managers or community leaders.

Example: A WUA could be formed with representatives from different villages who rely on the same irrigation canal, ensuring that organic farms have a say in water management decisions.

(ii) Training and capacity building:

- Provide training programs for WUA members on:
  - **Water management:** Techniques for equitable water allocation and conflict resolution.
  - **Sustainable irrigation practices:** Including water-saving techniques such as AWD. *See more details in section 3.2.4*
  - **Environmental stewardship:** Education on protecting water quality and managing fertilizers and pesticides in conventional farms to reduce contamination risks.

Example: Department of Agriculture and Rural Development of province could partner with local universities to offer workshops on water management and irrigation technologies for WUA members.

(iii) Developing water allocation rules:

- Establish clear rules for water allocation that prioritize:
  - **Organic farms** in terms of access to clean water.
  - **Equitable distribution** during periods of water scarcity, such as droughts or during critical growth phases for rice.

Example: A WUA could establish a rotating schedule for water distribution, with organic farms receiving priority for clean water sources during the early planting season.

(iv) Conflict resolution mechanisms:

- Implement dispute-resolution mechanisms within the WUA to address conflicts over water use. This could include:
  - **Mediation** by a neutral party (e.g., a local government representative).
  - **Voting systems** where all WUA members have an equal vote on key decisions.

Example: The WUA could resolve conflicts over water use by holding monthly meetings where members discuss water allocation and vote on any proposed changes to the irrigation schedule

Benefits:

- **Equitable water distribution:** WUAs ensure that irrigation water is distributed fairly among all farmers, including smallholder organic rice farmers. This promotes social equity and reduces conflicts over water use.
- **Local decision-making:** Community-based management empowers local farmers to take part in decision-making processes, making water management more responsive to local needs and conditions. This can increase farmer buy-in and the sustainability of water management practices.
- **Improved efficiency:** WUAs can promote efficient water use by introducing water-saving practices and technologies, leading to better resource management at the local level.

Trade-offs:

- **Coordination challenges:** Organizing and managing WUAs can be complex, particularly in regions with diverse stakeholder interests (e.g., organic vs. conventional farmers). Conflicts may arise, especially during times of water scarcity.
- **Capacity building requirements:** WUAs require ongoing training and capacity building to function effectively. Without proper training, water distribution might remain inefficient or prone to conflicts.
- **Time-intensive:** Participating in a WUA requires a time commitment from farmers, which may be a burden during peak farming seasons. Additionally, decision-making through consensus can be slower than top-down approaches.

Feasibility:

- **Technical feasibility:** WUAs are relatively easy to establish but require governance structures and capacity-building efforts. The success of WUAs depends on the willingness of farmers and local authorities to collaborate.
- **Financial feasibility:** WUAs are financially feasible as they rely more on human resources and institutional support rather than costly infrastructure. Government or NGO support for training and facilitation may be necessary, but overall costs are low.
- **Social feasibility:** Social feasibility is high if farmers are involved early in the planning process. WUAs provide a platform for smallholder and marginalized farmers to have a voice, which can increase community cohesion and trust.

3.2.4. Farmer training for water-efficient practices

(Beforest, 2023; Biosillico, 2024; European Commission, 2012; IRRI, 2016; Johannes et al., 2019; Leon & Izumi, 2022; Mallareddy et al., 2023; Spanu et al., 2024; Tabbal et al., 2002; Yamaguchi et al., 2019)

Overview: Provide training to organic rice farmers on water saving irrigation techniques such as AWD, SRI, Aerobic Rice System (ARS), Saturated Soil Culture (SSC), Direct Seeded Rice (DSR), Drip Irrigated Rice (DIR), Smart Irrigation (SI), In this sub-section, AWD has been selected as an example of how to introduce a water saving irrigation technique in organic rice farming. AWD involves intermittent irrigation, allowing fields to dry out between waterings, reducing water usage while maintaining yields.

Rationale: Water-efficient practices are critical for reducing water withdrawals, especially in areas facing water scarcity due to climate change or competition for resources. AWD has been shown to reduce water use by up to 30% in rice farming while maintaining or improving yields. Additionally, AWD can reduce the emission of methane, a potent greenhouse gas, from rice paddies, making it a climate-friendly practice.

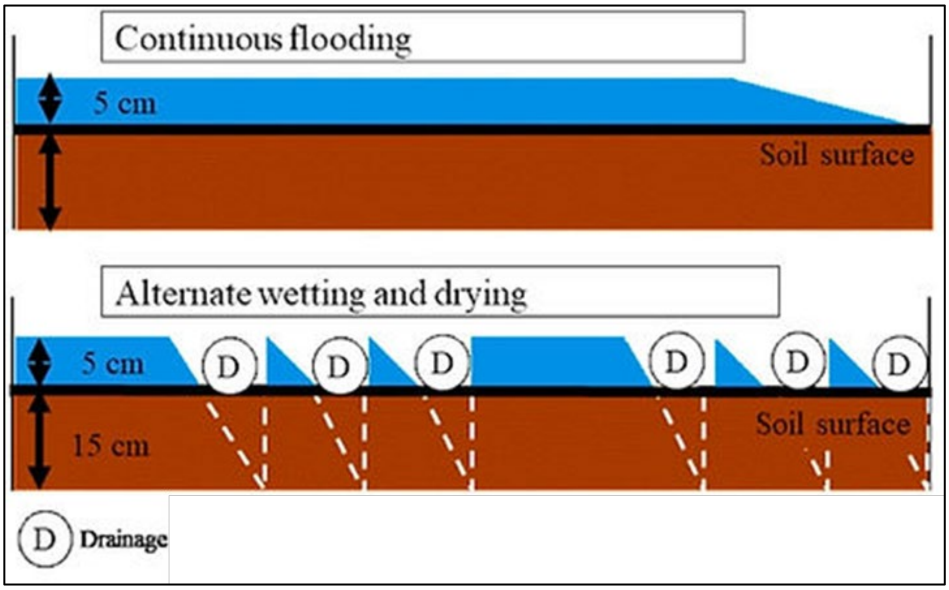

Figure 4. Illustration of AWD technique
Source: (Nguyen et al., 2022)

Implementation steps:

- **(i) Training programs:** Organize training workshops for farmers, conducted by agricultural extension officers or NGOs. These workshops should focus on the principles of AWD, water management practices, and the benefits of water conservation.
- **(ii) Demonstration farms:** Establish demonstration farms where farmers can observe the benefits of water-efficient practices in action. These farms can showcase the use of AWD and other techniques, such as drip irrigation or rainwater harvesting.
- **(iii) Monitoring and feedback:** After training, provide ongoing support to farmers through regular monitoring visits. Farmers can receive feedback on their irrigation practices and make adjustments as needed.
- **(iv) Incentives for adoption:** Provide incentives, such as subsidies for water-saving equipment or recognition programs for farmers who adopt water-efficient practices.

Principles addressed:

- **P1 (Sustainability):** Water-efficient practices like AWD reduce water consumption, minimizing environmental impact and conserving this precious resource.
- **P3 (Climate resilience):** Water-efficient practices improves drought resilience by optimizing water use and reducing reliance on consistent rainfall. This helps farmers adapt to changing climate conditions.
- **P4 (Compatibility with organic farming practices):** Training can include education on the importance of avoiding contaminated water sources and using approved irrigation methods that minimize the risk of contamination. This reinforces the principles of organic farming and helps farmers understand the specific requirements for maintaining certification.

Detailed strategy: Training on water-efficient irrigation techniques is a crucial component of provincial irrigation strategies. Organic rice farmers need to be equipped with the knowledge and tools to conserve water while maintaining productivity.

(i) Organizing training programs:

- Develop training workshops for farmers, conducted by agricultural extension officers or local NGOs. The focus should be on:
  - **AWD:** A technique where rice paddies are allowed to dry out between irrigations, reducing water use by 30% or more while maintaining yields.
  - **Rainwater harvesting:** Techniques for capturing and storing rainwater in small on-farm reservoirs for irrigation during dry periods.
  - **Drip irrigation:** Though less common in rice, drip systems can be used for vegetable crops grown in rotation with rice, further improving water use efficiency.

Example: The provincial agricultural extension service could offer AWD training sessions, demonstrating the technique on model farms that use both organic and conventional methods.

(ii) Establishing demonstration farms:

- Set up demonstration farms where farmers can see firsthand how water-saving irrigation practices work. These farms could be run by local extension services or progressive farmers who have successfully adopted AWD or other conservation techniques:

Example: A demonstration farm in province could showcase the use of AWD in organic rice farming, allowing farmers to observe the benefits in terms of water savings and crop yields.

(iii) Providing incentives for adoption:

- Offer incentives to farmers who adopt water-efficient practices, such as:
  - **Subsidies** for purchasing irrigation equipment (e.g., pumps, drip irrigation kits).
  - **Recognition programs** for farmers who successfully implement water-saving techniques (e.g., environmental stewardship awards).
  - **Access to premium markets:** Farmers who adopt sustainable practices may gain access to organic certification or other premium markets, improving their economic viability.

Example: Farmers who implement AWD could be eligible for subsidies to purchase pumps that help with managing water levels in their fields.

(iv) Ongoing support and monitoring:

- Provide ongoing technical support to farmers as they implement new irrigation practices. Regular field visits by extension officers can help farmers troubleshoot problems and fine-tune their irrigation schedules.
- Monitor adoption rates and the effectiveness of training programs through periodic surveys and field assessments.

Benefits:

- **Water conservation:** Techniques like AWD can reduce water usage by up to 30%, making irrigation more sustainable, particularly in areas prone to water scarcity.
- **Cost savings:** By using less water, farmers can save on irrigation costs (e.g., paying for water or pumping costs), making farming more economically viable.
- **Climate resilience:** Water-efficient practices also make farms more resilient to droughts and other climate-related stresses, ensuring food security during challenging growing seasons.
- **Methane emission reduction:** AWD can reduce methane emissions from rice paddies, contributing to climate change mitigation efforts.

Trade-offs:

- **Initial learning curve:** Farmers may initially struggle to adopt new practices like AWD due to lack of familiarity or fear of reduced yields. Transitioning to new methods requires time and confidence in the techniques.
- **Variable results:** In some cases, water-efficient techniques may result in slightly lower yields, particularly when not implemented correctly. This can deter farmers from adopting these methods.
- **Upfront costs for equipment:** Some water-efficient practices, such as installing drip irrigation or water management systems, may require initial investments in equipment, which could be a barrier for smallholder farmers.

Feasibility:

- **Technical feasibility:** Training in water-efficient practices is highly feasible, especially with the support of agricultural extension services. Demonstration farms and pilot projects can help farmers see the benefits firsthand.
- **Financial feasibility:** While some practices (e.g., AWD) have low costs, others (e.g., drip irrigation) may require financial support for equipment. Government programs or donor funding can help alleviate the burden of these initial costs.
- **Social feasibility:** Social feasibility is generally high, especially when farmers are shown the economic and environmental benefits of water-efficient practices. Demonstration farms and peer-to-peer learning can help accelerate adoption.

Summary for section 3.2:

Table 1 gives a summary of the irrigation strategies derived based on the Guiding Principles:

Table 1. Mapping of guiding principles and proposed irrigation strategies at provincial scale

Strategy	P1 (Susintainability)	P2 (Equity)	P3 (Climate Resilience)	P4 (Compatibility with Organic Farming)	P5 (Cross-Contamination Prevention)	P6 (Economic Viability)
Irrigation Zoning and Water Source Separation	✓			✓	✓	
Buffer Zones Between Farms	✓			✓	✓	
Community-Based Water Management		✓		✓		✓
Farmer Training for Water-Efficient Practices	✓		✓	✓		

The provincial level plays a pivotal role in designing and implementing localized irrigation systems that cater to the unique needs of organic rice farming. By focusing on strategies such as irrigation zoning, buffer zones, community-based water management, and farmer training in water-efficient practices, the provincial authorities can ensure that organic rice farmers have access to clean, uncontaminated water while promoting sustainability, social equity, and climate resilience.

❖ **Key takeaways:**

- **Irrigation zoning and water source separation:** The creation of distinct irrigation zones for organic and conventional farms is essential to prevent cross-contamination from agrochemicals. By mapping farms, assessing water resources, and developing separate infrastructure, provinces can secure a clean water supply for organic rice farmers. This approach directly supports organic certification, enhances water quality, and safeguards the long-term sustainability of organic farming in the region. However, the strategy requires significant investment in infrastructure and ongoing monitoring to ensure compliance.
- **Buffer zones between farms:** Establishing buffer zones between organic and conventional farms acts as a physical barrier to mitigate the risk of agrochemical drift and runoff. These zones not only protect organic farms from contamination but also promote biodiversity and soil conservation. Despite the loss of arable land and maintenance costs associated with buffer zones, the benefits in terms of environmental health, biodiversity, and protection of organic status are substantial. The feasibility of this strategy is high, particularly with financial incentives and policy support to encourage farmer participation.
- **Community-based water management:** Forming Water User Associations -WUAs empowers local farmers to manage water resources in a participatory and equitable manner, ensuring that smallholder organic rice farmers have access to clean irrigation water. WUAs promote social cohesion, reduce conflicts, and improve water-use efficiency. While coordination challenges and capacity-building efforts are required, the low-cost nature of this strategy makes it highly feasible. WUAs ensure that water management is responsive to local needs, fostering long-term sustainability.
- **Farmer training for water-efficient practices:** Training farmers in water-efficient irrigation techniques, such as AWD, is crucial for reducing water consumption and building climate resilience. These practices not only

conserve water but also reduce methane emissions, making them environmentally and economically beneficial. Although there may be an initial learning curve and upfront costs for equipment, the long-term gains in water savings and climate resilience make this strategy both technically and financially feasible, especially with support from provincial authorities and international funding.

❖ **Feasibility:**

- **Technical feasibility:** The technical requirements for zoning, buffer zones, and WUAs are well within reach for provincial authorities, especially with access to geographic information systems (GIS) and support from agricultural extension services. The strategies are highly adaptable to local conditions, making them suitable for different provincial contexts.
- **Financial feasibility:** While some strategies, like constructing separate irrigation systems, are costly, others, such as buffer zones and community-based water management, are relatively inexpensive. Financial feasibility can be improved through government subsidies, international aid, and public-private partnerships.
- **Social feasibility:** The social feasibility of these strategies is high, particularly when farmers are engaged early in the planning process and incentivized through financial support or certification benefits. WUAs and farmer training programs also enhance social cohesion and local ownership of water management practices.

At the provincial scale, localized irrigation systems for organic rice farming offer a comprehensive solution to the challenges of water management, contamination prevention, and climate resilience. By implementing irrigation zoning, buffer zones, community-based water management, and water-saving practices, provincial authorities can support the growth of organic rice farming in an environmentally sustainable and socially equitable manner. The trade-offs, particularly in terms of infrastructure costs and land use, are significant but manageable with proper planning and financial support. Ultimately, this approach strengthens the long-term viability of organic rice farming while contributing to the broader goals of climate adaptation and sustainable agriculture in the Mekong Delta.

3.3. Irrigation Strategies at Inter-provincial Scale

Water management at this scale requires cooperation between provincial governments, national authorities, and WUAs. Effective coordination helps mitigate conflicts, optimise water distribution, and protect both organic and conventional rice farms from resource depletion and environmental degradation.

At the interprovincial level, coordinated irrigation infrastructure and management is essential to balance water demands across multiple provinces, especially in regions where water systems and irrigation networks cover large geographical areas. In the context of the Mekong Delta, where interconnected rivers, canals and reservoirs supply water to vast agricultural areas, a coordinated approach ensures that resources are shared equitably, efficiently and sustainably.

3.3.1. Interprovincial water allocation agreements

(European Commission, 2012; UNECE, 2021)

Overview: Establish interprovincial water management agreements that include representatives from neighboring provinces. These agreements would oversee the allocation of water resources, especially during critical periods (e.g., dry seasons), ensuring that all provinces have equitable access.

Rationale: Water-sharing agreements between provinces ensure that upstream water users do not deplete resources, leaving downstream users without sufficient water. This is especially important in the Mekong Delta, where water resources are shared across multiple provinces.

Implementation steps:

(i) **Initiate stakeholder engagement:** Organize a meeting involving provincial authorities, local farmers (especially organic rice farmers), and the national government to discuss mutual water needs and challenges.

(ii) **Conduct water availability and demand assessments:** Commission hydrological studies to assess water flow, seasonal variability, and long-term trends. Simultaneously, conduct water demand assessments across sectors (agriculture, domestic, industrial).

(iii) **Develop and negotiate water allocation agreements:** Based on the assessments, negotiate water-sharing agreements between provinces. This should include specifying water allocation quotas, prioritization of water use during scarcity, and conflict resolution mechanisms.

(iv) **Establish a monitoring and enforcement Body:** Set up an independent monitoring body, potentially with representation from all provinces and the national government, to track water usage and enforce compliance with the agreement.

Principles addressed:

- **P1 (Sustainability):** Interprovincial agreements promote sustainable water use across larger geographic areas, preventing over-extraction and ensuring equitable distribution.
- **P2 (Equity):** These agreements ensure fair access to water for all provinces, regardless of their upstream/downstream position.
- **P4 (Compatibility with organic farming practices):** These agreements can include provisions for protecting organic farms from contamination by regulating water releases and ensuring upstream activities do not compromise water quality downstream

Detailed strategy: Interprovincial water allocation agreements are formal arrangements between provinces to share water equitably, particularly in areas where rivers, canals, and reservoirs cross provincial borders. These agreements are crucial in regions that experience water scarcity or have competing agricultural needs (e.g., organic vs. conventional rice farming).

(i) **Assessment of water availability:**

- A comprehensive assessment of water availability across the provinces involved is the first step. This includes:
  - **Hydrological studies** to assess water flow, seasonal variability, and long-term trends in water supply, particularly in the context of climate change.
  - **Water demand analysis** to understand the needs of different sectors (e.g., agriculture, industry, domestic use) and prioritize essential uses like irrigation for organic rice farming.

Example: In the Mekong Delta, provinces like An Giang, Dong Thap, and Long An might collaborate on a study to assess the water flow from the Mekong River and its tributaries, ensuring that each province receives a fair share of the water supply during both wet and dry seasons.

(ii) Formalizing water sharing mechanisms:

- Based on the assessment, provinces can negotiate and formalize agreements that specify:
  - **Water allocation quotas** for each province.
  - **Prioritization of water usage** during times of scarcity, with clear guidelines on which sectors (e.g., organic agriculture) receive priority.
  - **Conflict resolution mechanisms:** In case disputes arise over water distribution, a neutral body (e.g., a federal water authority or an interprovincial council) can mediate.

Example: An interprovincial water-sharing agreement between Tra Vinh and Vinh Long could prioritize water for organic rice farmers during the dry season, while ensuring conventional farmers and urban users also have access to sufficient water.

(iii) Monitoring and enforcement:

- An independent body, potentially with representatives from the national government or an interprovincial water management board, is responsible for:
  - **Monitoring water flows** to ensure compliance with the agreements.
  - **Enforcing penalties** for provinces or stakeholders that exceed their allocated quotas or fail to comply with the terms of the agreement.

Example: A team with members from the participating provinces could play a role in monitoring water flows and ensuring compliance with interprovincial water-sharing agreements, especially during critical periods such as the planting season.

Benefits:

- **Equitable water distribution:** Ensures that all provinces, including upstream and downstream regions, receive a fair share of water based on their needs and availability, reducing the risk of water shortages.
- **Conflict prevention:** Establishing agreements reduces the likelihood of water-related conflicts between provinces, especially during periods of scarcity.
- **Efficient water use:** Agreements promote efficient use of available water, prioritizing critical needs such as organic rice farming during droughts or high-demand periods.

Trade-offs:

- **Complex negotiations:** Reaching consensus on water allocation can be time-consuming, especially if provinces have competing interests or priorities. This may delay the implementation of agreements.
- **Enforcement challenges:** Monitoring water use and enforcing compliance with allocation agreements can be difficult, particularly if provinces do not have adequate governance structures or technical capacity.
- **Potential for disputes:** Even with agreements in place, disputes may arise over interpretation, enforcement, or perceived inequities in water distribution during extreme events.

Feasibility:

- **Technical feasibility:** High feasibility as water allocation agreements are primarily institutional and policy-oriented. Hydrological studies and water demand assessments can be conducted using existing technologies and expertise.
- **Financial feasibility:** Moderate feasibility as the main costs are associated with conducting assessments, establishing monitoring systems, and enforcing agreements. These costs can be shared between provinces or supported by national governments and international donors.
- **Social feasibility:** Moderate to high feasibility depends on the willingness of stakeholders to collaborate. Building trust and ensuring transparent, fair negotiations are key to social feasibility.

3.3.2. Joint infrastructure development and maintenance

(CADRI Partnership, 2020; Sadoff et al., 2015; Scheumann & Neubert, 2006; Sun et al., 2023; Varma et al., 2012)

Overview: Develop shared irrigation and drainage infrastructure that serves organic and conventional rice farms in multiple provinces. This infrastructure should be designed to prevent contamination while ensuring efficient water use.

Rationale: Shared infrastructure can reduce costs and improve water distribution efficiency. Provinces could collaborate on building canals, sluice gates, and storage reservoirs that serve both agricultural and environmental needs.

Implementation steps:

(i) **Form an interprovincial infrastructure committee:** Create a joint committee composed of officials from each province involved in shared irrigation infrastructure. The committee should also include technical experts and representatives from local farming communities.

(ii) **Conduct joint infrastructure needs assessment:** Evaluate current irrigation infrastructure (canals, reservoirs, pumping systems) and identify areas that need repairs, upgrades, or new construction. Include an environmental impact assessment to ensure sustainability.

(iii) **Develop a joint infrastructure development plan:** Draft a comprehensive plan that outlines the shared infrastructure projects (e.g., new canals, reservoirs, pumps), timelines, and budgets. Ensure that cost-sharing mechanisms are agreed upon (e.g., proportional, equal contributions).

(iv) **Secure funding and resources:** Seek funding from multiple sources, including provincial budgets, national government programs, and international organizations (e.g., World Bank, Asian Development Bank). Explore public-private partnerships (PPP) if necessary.

(v) **Establish joint maintenance protocols:** Develop a maintenance schedule and assign responsibilities for regular infrastructure upkeep (e.g., dredging, repairs). Set up joint teams from each province responsible for ongoing inspections and maintenance.

(vi) **Monitor and adjust infrastructure plans:** Regularly review the performance of shared infrastructure, particularly during times of drought or high-water demand. Adjust plans as necessary based on real-world performance and emerging needs.

Principles addressed:

- **P1 (Sustainability):** Shared infrastructure optimises the use of resources and reduces the collective environmental impact of farming. This efficient approach minimises redundancy and encourages collaboration.
- **P4 (Compatibility with organic farming practices):** Joint infrastructure must be designed and managed to prevent cross-contamination. This could involve separate channels for organic and conventional systems or strict protocols for cleaning and maintenance to prevent the introduction of prohibited substances into the organic water supply.
- **P5 (Cross-contamination prevention):** Careful design and management of shared infrastructure can prevent cross-contamination between organic and conventional systems. This requires clear procedures and regular monitoring.

Detailed strategy: Shared irrigation infrastructure, such as reservoirs, canals, and pumping systems, often spans multiple provinces and requires joint investment, maintenance, and management. Coordinating the development and upkeep of this infrastructure is crucial to ensure efficient water distribution and reduce the risk of system failures that could impact multiple provinces.

(i) Collaborative infrastructure planning:

- Provinces work together to plan large-scale irrigation projects that benefit multiple regions. This includes:
  - **Building new canals or upgrading existing ones to** improve water delivery to organic rice farms.
  - **Developing joint reservoirs** that store water for use during the dry season, ensuring a reliable supply for organic farming.
  - **Installing shared pumping and filtration systems** to improve water quality and prevent contamination of water supplies used by organic farms.

Example: Provinces like Dong Thap and An Giang could collaborate on the construction of a new reservoir that serves both provinces, ensuring that organic rice farmers in both regions have access to clean water during dry periods.

(ii) Cost-sharing agreements:

- Provinces establish agreements that outline how the costs of developing and maintaining shared infrastructure will be divided. These agreements may be based on:
  - **Proportional usage**: Provinces that use more of the shared infrastructure contribute a larger share of the costs.
  - **Equal contribution:** Each province contributes equally to the cost of building and maintaining shared infrastructure, regardless of their usage.

Example: An agreement could be made to equally share the costs of maintaining a major irrigation canal that provides water for both organic and conventional rice farmers.

(iii) Joint maintenance teams:

- Provinces form joint teams responsible for the regular maintenance of shared infrastructure. This ensures that:
  - **Canals remain free of blockages** (e.g., sediment buildup, plant growth).

- **Pumps and filtration systems** are regularly serviced to prevent breakdowns and ensure efficient water delivery.
- **Reservoir levels** are monitored to ensure they meet the needs of all stakeholders.

Example: A joint maintenance team could be responsible for dredging shared canals and ensuring that water flows remain unobstructed, particularly during the dry season when water levels are low.

Benefits:

- **Cost sharing**: Provinces can share the financial burden of building and maintaining large-scale irrigation infrastructure, reducing the individual costs for each province.
- **Improved water delivery:** Joint infrastructure projects, such as new canals or reservoirs, can improve the efficiency and reliability of water delivery across provinces, benefiting both organic and conventional farmers.
- **Resilience to climate change:** Shared infrastructure, such as reservoirs, can help provinces store water for use during droughts and manage excess water during floods, increasing resilience to climate change impacts.

Trade-offs:

- **High Initial Costs:** Building new infrastructure or upgrading existing systems can be expensive, particularly for large-scale projects that span multiple provinces.
- **Coordination and Management Complexity:** Managing shared infrastructure requires strong coordination between provinces, which can be challenging, especially if there are differences in governance capacity or priorities.
- **Maintenance Burden:** While cost sharing reduces the financial burden, long-term maintenance requires continuous collaboration and investment, which could be difficult to sustain over time.

Feasibility:

- **Technical feasibility:** High feasibility as provinces can use existing engineering expertise and technologies to design and implement large-scale infrastructure projects. However, technical challenges may arise in areas with complex topography or environmental sensitivities.
- **Financial feasibility:** Moderate to low feasibility depends on availability of funding. Large infrastructure projects require significant up-front investment, which may require financial support from national governments or international organisations (e.g. World Bank).
- **Social feasibility:** Moderate feasibility as local communities may resist infrastructure projects that require land acquisition or disrupt existing land use patterns. Public consultations and compensation mechanisms may be needed to address these concerns.

3.3.3. Climate-resilient infrastructure investments

(Buchanan, 2019; GCF, 2019; Lückerath et al., 2022; OECD, 2024)

Overview: Climate-resilient infrastructure investments focus on upgrading or building new water management systems that can withstand the impacts of climate change, such as extreme weather events (floods, droughts), rising temperatures, and shifting rainfall patterns. These investments are crucial for ensuring the long-term sustainability of irrigation and water supply systems across provinces, particularly in regions like the Mekong Delta, where agriculture is highly sensitive to climate variability

Rationale: The Mekong Delta is highly vulnerable to climate change, with increasing risks of sea-level rise, droughts, and extreme weather. Climate-resilient infrastructure ensures that irrigation systems remain functional in the face of these challenges.

Implementation steps:

- **(i) Conduct a climate vulnerability assessment:** Assess the current and projected climate risks (e.g., floods, droughts, sea-level rise) to existing water infrastructure. Use climate models to predict future scenarios and their impacts on irrigation systems.
- **(ii) Design climate-resilient infrastructure:** Develop engineering solutions that enhance the resilience of irrigation systems to climate stressors. This may include constructing flood-resistant canals, building reservoirs with higher storage capacities, and installing drought-resistant pumps.
- **(iii) Secure funding for climate-resilient projects:** Explore funding options from national governments, international development organizations, and climate finance initiatives. Consider PPP for financing large-scale projects.
- **(iv) Implement pilot projects:** Start with pilot projects in high-risk areas to test the effectiveness of climate-resilient designs. Monitor the performance of these projects during extreme weather conditions (e.g., floods, droughts) and adjust designs as necessary.
- **(v) Scale up investments across provinces:** Based on the success of pilot projects, expand climate-resilient infrastructure investments to other provinces. Create a standardized set of design guidelines for climate-resilient infrastructure that can be adopted by provincial governments.
- **(vi) Establish maintenance and monitoring protocols:** Develop a long-term maintenance plan and monitoring system to ensure the continued functionality of climate-resilient infrastructure. This should include regular inspections, repairs, and upgrades as needed.

Principles addressed:

- **P1 (Sustainability):** Climate-resilient infrastructure ensures the long-term functionality of water systems, safeguarding agricultural productivity. These investments protect against future disruptions and ensure continued access to water.
- **P3 (Climate Resilience):** Investments in resilient infrastructure directly address climate change impacts, protecting against extreme weather and changing water availability. This proactive approach safeguards agricultural livelihoods and ensures food security.
- **P4 (Compatibility with organic farming practices):** Climate-resilient infrastructure should incorporate design features that protect organic farms from contamination, especially during extreme weather events that increase the risk of runoff and flooding

Detailed strategy: To develop and implement infrastructure that is resilient to the impacts of climate change, ensuring the sustainability of irrigation systems, water supply, and flood protection across provinces. This involves upgrading existing infrastructure and designing new systems that can withstand floods, droughts, sea-level rise, and shifting weather patterns.

(i) Conduct a climate vulnerability and infrastructure assessment:

- Assessing climate risks and identifying vulnerable infrastructure is the first step in building climate resilience. This includes understanding how climate change will affect existing water management systems and prioritizing areas for intervention:
  - **Conduct climate risk assessments** using models to predict future climate impacts (e.g., floods, droughts).
  - **Audit existing infrastructure** to identify weaknesses and vulnerabilities to climate stressors.
  - **Prioritize high-risk regions** with critical agricultural or water needs for immediate action.

Example: A vulnerability assessment in the Mekong Delta could identify areas at risk of sea-level rise and saltwater intrusion, prioritizing these regions for the construction of saltwater barriers and flood-resistant infrastructure.

(ii) Design and pilot climate-resilient infrastructure:

- Developing climate-resilient designs ensures that infrastructure can handle future climate impacts. Pilot projects help test these designs under real-world conditions before scaling up:
  - **Design flood-resistant canals,** drought-tolerant irrigation systems, and saltwater intrusion barriers.
  - **Incorporate nature-based solutions,** such as wetlands for flood management or reforestation for water retention.
  - **Test pilot projects** in high-risk areas to evaluate performance under extreme weather conditions.

Example: In a coastal province, a pilot project could involve building a saltwater intrusion barrier and a rainwater harvesting system to protect rice fields from both seawater contamination and seasonal droughts.

(iii) Secure funding:

- Securing financial resources is essential to support large-scale infrastructure investments. This step involves exploring various funding sources, including international climate finance and private sector partnerships:
  - **Apply for funding** from international climate finance mechanisms.
  - **Leverage PPP** to involve private companies in the development of water-efficient technologies.
  - **Allocate provincial and national budgets** to co-finance infrastructure investments.

Example: A province could secure funding from the UN National Adaptation Plans Program to construct climate-resilient reservoirs, with additional financial support from private investors interested in sustainable agriculture.

(iv) Scale up implementation:

- Once pilot projects prove successful, scaling up climate-resilient infrastructure across provinces ensures broader protection from climate risks:
  - **Expand pilot projects** to other high-risk regions, focusing on areas most vulnerable to floods, droughts, or sea-level rise.
  - **Standardize resilient infrastructure designs** to ensure consistent implementation across provinces.

- **Ensure equitable distribution of resources** to upstream and downstream areas.

Example: After a successful pilot project in one province, flood-resistant canal designs could be standardized and implemented across multiple provinces to protect rice farming areas from future heavy rainfall events.

(v) Establish long-term maintenance and monitoring:

- Maintaining climate-resilient infrastructure over time is critical for its long-term success. This step involves regular inspections, repairs, and real-time monitoring of climate impacts:
  - **Develop long-term maintenance plans,** including regular inspections and repairs of infrastructure.
  - **Install real-time monitoring systems** to track climate conditions and infrastructure performance.
  - **Create a centralized monitoring body** to oversee the performance and adaptation of infrastructure.

Example: A centralized monitoring system could be set up to track flood risks and water levels in reservoirs, ensuring that floodgates are opened in time to prevent overflow during heavy rains.

Benefits:

- **Increased resilience to climate change:** Infrastructure designed to withstand extreme weather events like floods, droughts, and sea-level rise, ensuring long-term water availability.
- **Long-term cost savings:** Investing in resilient infrastructure now reduces the need for costly repairs or emergency interventions in the future.
- **Improved water security:** Ensures sustainable water supplies for agriculture and communities, even under climate stress.

Trade-offs:

- **High upfront costs:** Designing and building climate-resilient infrastructure requires significant initial investment.
- **Longer planning periods:** Extensive data collection and modeling are needed to design infrastructure that suits future climate scenarios, delaying some projects.
- **Complex decision-making**: Prioritizing areas for investment can be politically and socially challenging, especially when resources are limited.

Feasibility:

- **Technical feasibility:** There are proven engineering solutions with a high degree of feasibility (e.g. flood-proof canals, drought-proof irrigation), although they may need to be adapted to local conditions.
- **Financial feasibility:** Moderate feasibility because infrastructure investment is costly, but access to climate finance and development loans can make it feasible.
- **Social feasibility**: High feasibility due to strong local support, especially in vulnerable areas, although equitable distribution of resources across provinces is key.

Summary for section 3.3:

Table 2 gives a summary of the irrigation strategies derived based on the Guiding Principles:

Table 2. Mapping of guiding principles and proposed irrigation strategies at inter-provincial scale

Strategy	P1 (Sustainability)	P2 (Equity)	P3 (Climate Resilience)	P4 (Compatibility with Organic Farming)	P5 (Cross-Contamination Prevention)	P6 (Economic Viability)
Interprovincial Water Allocation Agreements	✓	✓		✓		
Joint Infrastructure Development and Maintenance	✓			✓	✓	
Climate-Resilient Infrastructure Investments	✓		✓	✓		

Managing water resources at the interprovincial scale is critical in ensuring equitable, sustainable, and climate-resilient water distribution across multiple provinces, especially in regions like the Mekong Delta where shared water systems, such as rivers and canals, span large geographical areas. Provinces must collaborate to optimize water use, reduce conflicts, and protect farming systems—both organic and conventional—from water scarcity and contamination. This requires robust governance mechanisms, shared infrastructure investments, and climate-resilient planning that align the needs of different stakeholders.

❖ **Key takeaways:**

- **Interprovincial water allocation agreements:** Establishing formal agreements between provinces for water sharing is essential to ensure equitable distribution, particularly during critical periods such as dry seasons. These agreements help prevent upstream provinces from depleting water resources, leaving downstream provinces vulnerable. The agreements also promote fairness by prioritizing essential uses, such as organic rice farming, during periods of scarcity. However, reaching consensus on water allocation can be time-consuming and complex, requiring strong stakeholder engagement and negotiation mechanisms.
- **Joint infrastructure development and maintenance:** Developing shared irrigation and drainage infrastructure between provinces offers significant benefits, including cost-sharing, improved water delivery, and increased resilience to climate change. Provinces can collaborate on building and maintaining canals, reservoirs, and pumping systems that serve both organic and conventional farms. Joint maintenance protocols and cost-sharing mechanisms ensure the long-term functionality of these systems. While initial costs and coordination complexities may present challenges, the financial and operational efficiencies gained make this strategy highly feasible.
- **Climate-resilient infrastructure investments:** As the Mekong Delta faces increasing risks from climate change, such as sea-level rise, floods, and droughts, investing in climate-resilient infrastructure is crucial for the long-term sustainability of irrigation systems. Projects like flood-resistant canals, drought-tolerant irrigation systems, and saltwater intrusion barriers help protect both organic and conventional rice farms. While these projects require significant up-front investment and longer planning periods, they offer long-term cost savings by reducing the need for emergency interventions and repairs in the future.

❖ **Feasibility:**

- **Technical feasibility:** The technical requirements for conducting hydrological studies, developing shared infrastructure, and designing climate-resilient systems are well within reach, especially with existing engineering expertise and technologies. However, certain projects may need to be adapted to local environmental conditions, particularly in areas with complex topography or climate vulnerabilities.
- **Financial feasibility:** While large infrastructure projects and climate-resilient investments require significant financial resources, they are feasible with the support of provincial budgets, national governments, and international development organizations. Public-private partnerships (PPP) and climate finance mechanisms can also help offset costs.
- **Social feasibility:** The social feasibility of these strategies depends on the willingness of stakeholders to collaborate and share resources. Building trust through transparent negotiations, equitable resource distribution, and public consultations will be key to ensuring the success of interprovincial agreements and infrastructure projects.

Interprovincial cooperation on irrigation strategies is essential for managing the shared water resources that sustain agriculture in the Mekong Delta. Formal water allocation agreements, joint infrastructure development, and climate-resilient investments are crucial for maintaining a balance between water demands, preventing conflicts, and protecting both organic and conventional farming systems from environmental degradation. While these strategies involve significant coordination, financial commitments, and technical expertise, the long-term benefits in terms of sustainability, equity, and climate resilience far outweigh the challenges. By adopting a collaborative approach, provinces can ensure that water resources are used efficiently and equitably, paving the way for sustainable agricultural growth in the region.

3.4. Irrigation Strategies at Mekong Delta Scale

The delta-scale irrigation strategy focuses on large-scale infrastructure and management approaches that can serve multiple provinces while ensuring water quality, ecological sustainability, and social equity. This strategy integrates the directions outlined in the Decision 287/QD-TTg about Mekong Delta Regional Master Plan 2021–2030, with a Vision to 2050, emphasizing sustainable and climate-resilient agriculture, particularly organic rice farming.

3.4.1. Integrated water resource management at delta scale

(Abdelwahab et al., 2020; Burton, 2001; MARD, 2016a; Martinez-Santos et al., 2014; Roy et al., 2011; van Steenbergen & Dayem, 2007; World Bank, 2011; Xu et al., 2021)

Overview: A cohesive water management system for the entire Mekong Delta is essential to address the cross-boundary nature of water resources. This includes managing the flow from upstream areas, regulating water levels in canals, and ensuring equitable water distribution across provinces. The strategy also involves collaboration between central and provincial governments to effectively manage water resources for organic farming without compromising conventional agriculture or other industries.

Rationale: The Mekong Delta faces unique water challenges, such as salinity intrusion in coastal areas and flooding in upstream regions. To ensure that organic rice farms receive uncontaminated water, the irrigation system must be managed at a regional level to prevent agrochemical runoff from conventional farms and industrial pollutants from entering the water supply for organic farms.

Implementation steps:

(i) **Water Flow Regulation:** Coordinate water releases from upstream reservoirs and dams to maintain appropriate water levels and quality for organic rice farming. This is especially important during critical periods of the growing season when water demand is high.

(ii) **Flood and Salinity Control:** Implement large-scale infrastructure, such as sluice gates and embankments, to protect organic rice farms from flooding and salinity intrusion.

(iii) **Water Allocation Plans:** Develop and enforce water allocation plans that designate clean water sources for organic rice farms, prioritizing uncontaminated water from upstream rivers, rainwater collection, or groundwater.

Principles addressed:

- **P1 (Sustainability):** Delta-scale management promotes holistic and sustainable water use, balancing the needs of all stakeholders. This integrated approach takes into account the interconnected nature of the entire water system.
- **P4 (Compatibility with organic farming practices):** Delta-scale management provides an opportunity to prioritize organic farming within the broader water resource plan, ensuring that water allocation and quality standards support organic production.
- **P5 (Cross-contamination prevention):** Delta-scale management provides coordinated strategies to minimise contamination risks across the region. This comprehensive approach protects organic farms within the larger ecosystem.

Detailed strategy: To develop and implement an integrated water resource management (IWRM) system that ensures the equitable and sustainable distribution of water across the Mekong Delta. This involves coordinating provinces on water usage, upgrading infrastructure to manage salinity and flooding, and ensuring that organic rice farms have access to clean, uncontaminated water

(i) **Conduct a comprehensive water availability and vulnerability assessment:**

- The first step is to conduct a thorough assessment of the water resources in the Mekong Delta, considering both surface water and groundwater. This involves mapping water availability, usage patterns, and vulnerabilities.
  - **Map water resources:** Use satellite data and ground surveys to map the delta's rivers, canals, and groundwater resources. Identify areas where water is abundant and areas where it is scarce.
  - **Assess current water usage:** Identify how much water is being used by different sectors, including agriculture (organic and conventional), industry, and domestic use. This will help pinpoint inefficiencies and overuse.
  - **Identify vulnerabilities:** Recognize regions where water resources are threatened by factors such as salinity intrusion, land subsidence, or pollution from agrochemical runoff.
  - **Engage stakeholders:** Involve local water authorities, communities, and farmers in the assessment process to ensure that the data collected reflects on-the-ground realities.

Example: A vulnerability assessment in the Ca Mau Peninsula could highlight areas where salinity intrusion is likely to worsen during the dry season, leading to the prioritization of this region for water management interventions like sluices or freshwater reservoirs.

(ii) Development of a coordinated water management framework:

- Once the water resources and usage patterns are understood, a coordinated water management framework must be developed to ensure that water is managed efficiently and sustainably across the delta.
  - **Create a central coordinating body** responsible for overseeing water resource management across the delta. This body should include representatives from all relevant sectors (agriculture, industry, local governments, etc.) and should have the authority to enforce water management policies.
  - **Develop an integrated water use plan** that allocates water across sectors based on demand, availability, and sustainability. The plan should prioritize organic rice farming and other sustainable agriculture practices.
  - **Set water usage targets** for each province, ensuring that water is used efficiently and that over-extraction is avoided. These targets should be based on the water resource assessment and should be updated regularly.
  - **Incorporate upstream-downstream dynamics** into the plan, ensuring that water use by upstream provinces does not negatively impact downstream provinces, particularly in terms of water quality and salinity intrusion.

Example: A coordinated water management plan might allocate more water to downstream provinces during dry seasons to prevent salinity intrusion in critical organic rice-growing areas.

(iii) Infrastructure optimization and smart water management technologies:

- IWRM at the delta scale requires optimizing existing infrastructure and incorporating new technologies to improve water efficiency and distribution.
  - **Upgrade irrigation infrastructure** to reduce water losses and improve efficiency. This could include lining canals to prevent seepage, installing automated sluice gates, and promoting drip irrigation.
  - **Use smart water management technologies** such as real-time water monitoring systems and remote sensing to track water levels, flows, and usage across the delta. These systems can help optimize water distribution and prevent overuse.
  - **Develop water storage systems** such as reservoirs and retention basins to capture excess water during the rainy season and release it during droughts. This helps regulate water availability throughout the year.
  - **Promote water recycling and reuse:** Encourage the reuse of treated wastewater for irrigation, provided it meets organic farming standards, to reduce the pressure on freshwater resources.

Example: Automated sluice gates could be installed in provinces to regulate water flows in response to real-time data, ensuring that organic rice farms receive adequate water throughout the growing season.

(iv) Cross-sectoral collaboration and policy alignment:

- IWRM requires collaboration across multiple sectors, including agriculture, industry, and urban development. It also requires aligning local, provincial, and national policies to ensure consistency in water management.
  - **Facilitate cross-sectoral collaboration** by bringing together representatives from agriculture, industry, and local governments to discuss water management challenges and solutions. Regular meetings should be held to ensure that all sectors are working towards common water management goals.
  - **Align policies at all levels:** Ensure that water management policies at the local, provincial, and national levels are aligned and support the goals of IWRM. This includes harmonizing regulations on water use, pollution control, and infrastructure development.
  - **Develop financial incentives** for sectors that use water efficiently or invest in water-saving technologies. This could include subsidies for farmers who adopt drip irrigation or tax breaks for industries that recycle water.

Example: A cross-sectoral collaboration might result in the development of regulations that limit industrial water pollution, protecting water quality for organic rice farms downstream.

(v) Monitoring, evaluation, and adaptive management:

- Effective IWRM requires ongoing monitoring and evaluation of water resources and usage patterns to ensure that the system remains sustainable and responsive to changing conditions.
  - **Implement a real-time monitoring system** to track water levels, flows, and usage across the delta. This system should be linked to a central database that can be accessed by all relevant stakeholders.
  - **Establish performance indicators** to assess the effectiveness of water management policies. These indicators could include measures of water efficiency, crop yields, and water quality.
  - **Review and update the water management plan** regularly, based on monitoring data and new information about climate risks or water availability. This ensures that the plan remains relevant and effective over time.
  - **Engage in adaptive management:** Adjust water allocation, infrastructure investments, and policies as needed to respond to changes in water availability, climate conditions, or economic demands.

Example: A real-time monitoring system could provide data on water levels and flows, allowing water authorities to adjust irrigation schedules based on current conditions.

<u>**Benefits:**</u>

- **Improved water security:** By managing water resources across provinces, organic rice farms will have access to a reliable and clean water supply, even during dry seasons. This ensures that organic rice farms are not compromised by water scarcity or contamination from agrochemical runoff.
- **Salinity control:** The installation of sluices and dikes controls saltwater intrusion, which is crucial for protecting organic rice farms, particularly in coastal areas. This reduces the risk of soil and water salinization, which can otherwise damage crops and degrade land quality.

- **Flood protection**: Flood control measures, such as upgraded canals and floodgates, protect organic rice farms from waterlogging, reducing crop losses. Effective flood management also improves overall agricultural productivity by preventing the destruction of crops during heavy rains.
- **Regional collaboration**: By fostering water-sharing agreements and coordination across provinces, this component promotes equitable access to water and enhances cooperation between regions. This is particularly important in optimizing resource use and ensuring no region disproportionately suffers from water scarcity.

Trade-offs:

- **High initial costs:** The construction of new sluices, dikes, and water control systems requires significant financial investments. This may strain provincial budgets or require long-term loans that could increase financial pressure on local governments.
- **Potential conflicts over water allocation**: Provinces located upstream may have to release more water for downstream regions, leading to potential disagreements or conflicts over water-sharing agreements. The balancing of local needs versus regional goals may lead to tension among stakeholders.
- **Environmental impact**: Large-scale infrastructure projects (e.g., sluices and dikes) may disrupt local ecosystems, particularly in areas with delicate wetlands or coastal mangroves. The alteration of natural water flows can affect fish habitats, biodiversity, and wetland ecosystems critical for flood control.

Feasibility:

- **Technical feasibility**: High. The delta has extensive experience in water management, and the necessary expertise and technology for building water control systems (e.g., sluices, dikes, reservoirs) are available. Proven infrastructure models from similar regions (e.g., the Netherlands' flood control systems) can be adapted to the Mekong Delta.
- **Financial feasibility**: Moderate. While the costs are high, international climate finance and public-private partnerships can help reduce the burden on government budgets. The challenge lies in securing consistent funding sources and managing long-term maintenance costs.
- **Social feasibility**: Moderate to high. Collaboration between provinces and engagement with local communities will be critical to ensuring the success of water-sharing agreements. Public education campaigns can help mitigate potential conflicts, but long-standing water rights issues may still arise.

3.4.2. Water sharing agreements across the delta

(Global Water Security, 2012; OECD, 2014; Pronatura-noroeste, 2022)

Overview: Formulate formal water-sharing agreements between provinces to ensure that water resources are distributed equitably, particularly during times of drought. These agreements will be enforced through a regional water authority, ensuring that upstream provinces release adequate water for downstream provinces. This collaborative approach to water distribution is critical for maintaining the sustainability of organic rice farming in the Mekong Delta, especially as climate change increases water scarcity and variability.

Rationale: Water is a shared resource in the Mekong Delta, and upstream provinces often have more control over water flows, particularly during the dry season. Downstream provinces, however, depend on these flows for irrigation and preventing salinity intrusion. Without coordinated water-sharing agreements, conflicts may arise, and downstream organic rice farms may not receive the clean water they require. These agreements will ensure that water is fairly distributed, reducing conflict and ensuring equitable access to water for organic farming practices.

Implementation steps:

(i) **Conduct a water needs assessment:** Assess water needs across provinces, focusing on both upstream and downstream regions. Identify periods of water scarcity (e.g., dry seasons or droughts) and the potential impact on organic rice farming.

(ii) **Develop water-sharing agreements:** Establish formal agreements that define how much water each province must release or retain during critical periods. Develop enforcement mechanisms to ensure compliance, such as penalties for non-compliance or incentives for cooperation.

(iii) **Monitor and adjust agreements as needed:** Use real-time water monitoring systems to track water flows and ensure provinces are adhering to the agreements. Adjust water-sharing terms based on changing conditions, such as prolonged droughts or unexpected floods.

Principles addressed:

- **P1 (Sustainability):** Delta-wide agreements ensure sustainable water use and prevent regional overuse, protecting the resource for all. This collaborative approach promotes responsible water management.
- **P2 (Equity):** Delta-wide agreements ensure equitable distribution of water among all stakeholders, promoting fairness and cooperation. This collaborative approach promotes shared responsibility and prevents conflict over water resources.
- **P4 (Compatibility with organic farming practices):** Similar to interprovincial agreements, these delta-wide agreements can include specific provisions for protecting organic farms from contamination by regulating water usage and ensuring water

Detailed strategy:

(i) **Water needs assessment and stakeholder engagement:**

- The first step is to assess the water needs of each province, with a particular focus on organic rice production. This requires working with local stakeholders, including farmers, provincial governments, and water authorities, to build a comprehensive understanding of current water usage patterns, vulnerabilities, and future needs.
    - **Conduct a water use audit** across the delta to identify how much water is being used by different sectors (e.g., agriculture, industry, domestic use) and how this usage changes seasonally.
    - **Assess the water needs of organic rice farms**, particularly during critical periods such as the dry season or the growing season.
    - **Identify vulnerable regions:** Downstream provinces may be more vulnerable to water shortages if upstream provinces retain too much water. Coastal areas face higher risks from salinity intrusion, which can be exacerbated by reduced freshwater flows.

- **Engage stakeholders** (provincial governments, farmers, water authorities, and NGOs) to ensure that all voices are heard in the decision-making process. Smallholder farmers should have a say in how water is allocated to avoid inequities.

Example: An assessment might reveal that upstream provinces are using more water during the dry season for irrigation, which reduces the flow of freshwater to downstream provinces, increasing the risk of salinity intrusion in coastal areas.

(ii) Development of formal water-sharing agreements:

- Based on the water needs assessment, formal agreements must be developed between provinces to ensure that water is distributed equitably. These agreements should define how much water each province is entitled to during different seasons and under varying climatic conditions (e.g., droughts, floods).
  - **Establish formal agreements** specifying the amount of water each province can extract or retain during different times of the year. Agreements should be flexible enough to adapt to changing conditions, such as dry seasons or unexpected floods.
  - **Define water release schedules** for upstream provinces, ensuring that they release adequate amounts of water to downstream provinces during critical periods (e.g., during the dry season or when salinity levels rise).
  - **Incorporate climate variability** into agreements, recognizing that some years may see more or less water availability than others due to changing rainfall patterns or upstream dam operations.
  - **Ensure equitable access:** Prioritize the needs of vulnerable groups, such as smallholder organic rice farmers, who may rely more heavily on consistent water supplies.
  - **Establish conflict resolution mechanisms to** manage disputes between provinces over water allocation during times of scarcity. This could include mediation processes or penalties for non-compliance.

Example: A formal agreement between upstream and downstream provinces could stipulate that the upstream provinces releases a specific volume of water from its reservoirs during the dry season to ensure adequate flows for downstream organic rice farms in the downnstream provinces.

(iii) Monitor and adjust the agreements based on real-time conditions:

- Effective water-sharing agreements require robust monitoring and enforcement mechanisms to ensure that all provinces comply with the terms. This includes real-time monitoring of water flows and levels, as well as penalties or incentives to encourage compliance.
  - **Establish a centralized monitoring system** to track water flows across the delta in real-time. This system should measure water levels in rivers, reservoirs, and canals, as well as monitor salinity levels in coastal areas.
  - **Use satellite data and remote sensing** to monitor water usage and ensure that upstream provinces are adhering to their water release schedules.
  - **Create enforcement mechanisms:** Develop penalties for provinces that do not comply with the agreements (e.g., fines or reductions in future water allocations) and incentives for those that do (e.g., financial support for infrastructure improvements).

- **Engage independent auditors or third-party organizations** to monitor compliance and provide transparent reporting on water usage across the delta.

Example: A real-time monitoring system could be set up to track water levels in the Mekong River and its tributaries, ensuring that upstream provinces are releasing enough water to downstream areas during the dry season.

(iv) Adaptation to changing climate conditions:

- Water-sharing agreements must be flexible enough to adapt to changing climate conditions, such as increased droughts, more intense rainy seasons, or shifts in water availability due to upstream dam operations in neighboring countries.
  - **Build flexibility into agreements** by allowing water allocations to be adjusted based on real-time climate data and projections. For example, if a drought is predicted, provinces could agree to reduce their water use proportionally to ensure that downstream areas still receive sufficient water.
  - **Incorporate long-term climate projections** into agreements, ensuring that they account for future decreases in water availability or increases in salinity intrusion due to sea-level rise.
  - **Develop contingency plans** for extreme events such as multi-year droughts or severe floods. These plans should outline how water will be shared during these periods and prioritize the most vulnerable regions and organic farms.
  - **Review and revise agreements** regularly to ensure that they remain relevant as climate conditions change. This could be done every 3-5 years or as needed when new climate data becomes available**.**

Example: If climate projections indicate a future decrease in rainfall during the dry season, water-sharing agreements could be updated to allocate a greater share of water to downstream provinces, which are more vulnerable to salinity intrusion.

(v) Capacity building and stakeholder collaboration:

- To ensure the success of water-sharing agreements, all stakeholders must have the capacity to manage water resources effectively and collaborate with other provinces.
  - **Train local water authorities** on how to manage water resources in line with the agreements. This training should focus on monitoring water flows, enforcing water release schedules, and responding to disputes.
  - **Engage farmers and communities** in the decision-making process to ensure that they understand the agreements and can provide input on how water should be allocated.
  - **Foster collaboration between provinces** to build trust and ensure that water-sharing agreements are implemented fairly. This could involve regular meetings between provincial water authorities, farmers, and other stakeholders to discuss water management issues.
  - **Provide technical support** to provinces that lack the infrastructure or expertise to manage their water resources effectively. This could include financial assistance for building monitoring systems or upgrading irrigation infrastructure.

Example: Workshops could be held to train water managers on how to use real-time monitoring systems to ensure that they are releasing the correct amounts of water to downstream provinces during the dry season.

Benefits:

- **Equitable water distribution:** Ensures that both upstream and downstream provinces receive their fair share of water, reducing the risk of conflict and ensuring that organic rice farms have enough clean water to thrive. This promotes social stability by ensuring that no province is disadvantaged, especially during periods of drought or water scarcity.
- **Sustainability of water resources**: Encourages the sustainable use of water resources by coordinating water releases in a way that balances the needs of all provinces. This ensures that water is not over-extracted in any one region, helping to maintain long-term water availability for agriculture, domestic use, and industry.
- **Improved resilience to climate variability:** Formal water-sharing agreements provide a structured response to periods of drought or irregular rainfall, ensuring that water is available when it is most needed. This enhances the delta's resilience to climate change, which is expected to exacerbate water shortages and increase competition for resources.
- **Support for organic rice farming:** By ensuring that downstream organic farms receive clean water, the agreements help maintain the integrity of organic rice farming, contributing to higher yields and better marketability of organic rice.

Trade-offs:

- **Potential conflicts over water allocation:** Water-sharing agreements could lead to conflicts between provinces, particularly if upstream provinces feel they are being asked to release too much water during critical times for their own agricultural or industrial needs. Negotiating these agreements may be challenging, requiring careful balancing of competing interests.
- **Enforcement challenges:** Ensuring compliance with water-sharing agreements may be difficult, especially during times of extreme drought when upstream provinces may prioritize their own water needs. Enforcement mechanisms may require additional resources and political will to ensure that all provinces adhere to the agreements.
- **Administrative complexity**: Developing and managing formal water-sharing agreements across multiple provinces adds administrative complexity, including the need for real-time monitoring, enforcement, and dispute resolution mechanisms.
- **Impact on upstream provinces:** Upstream provinces may have to release more water than they would prefer, particularly during dry periods. This could limit water availability for their own agricultural or industrial activities, leading to economic trade-offs.

Feasibility:

- **Technical feasibility:** Moderate to high. The technical aspects of water-sharing agreements (e.g., real-time water monitoring, water flow management) are feasible with existing technology. The Mekong Delta already has some monitoring infrastructure in place, but it may need to be expanded and upgraded to ensure real-time data collection and enforcement of agreements.
- **Financial feasibility:** While the financial costs of developing water-sharing agreements are relatively low, the costs of implementing real-time water monitoring systems and enforcement mechanisms may be

significant. Funding could be sourced from provincial budgets, national government support, or international donors interested in sustainable water management.

- **Social feasibility:** While water-sharing agreements are beneficial in the long term, they may face initial resistance from upstream provinces that are concerned about losing control over their water resources. Success will depend on building trust and ensuring that all stakeholders feel their needs are being addressed. Public awareness campaigns and transparent decision-making processes can help mitigate potential conflicts.

3.4.3. Long-term climate projections

(Fathi et al., 2024; OECD, 2024)

Overview: Incorporate long-term climate change projections into water management plans to ensure that organic rice production systems are resilient to future climate impacts. This includes modeling future water availability, salinity intrusion, flood risks, and droughts under various climate scenarios. Adaptation strategies and infrastructure will be developed to mitigate these risks and ensure the long-term sustainability of organic rice farming in the Mekong Delta.

Rationale: The Mekong Delta faces significant risks from climate change, including rising sea levels, increased salinity intrusion, more frequent flooding, and prolonged droughts. Organic rice farming, which relies on clean and consistent water supplies, is particularly vulnerable to these changes. By incorporating climate projections into irrigation strategies, the delta can build resilience, protect its water resources, and ensure the long-term viability of organic rice farming.

Implementation steps:

(i) **Conduct climate impact assessments:** Use climate models to project future water availability, salinity intrusion, and flood risks under different climate scenarios. Identify the areas of the delta most vulnerable to these impacts.

(ii) **Incorporate climate projections into water management plans:** Update water management plans to account for future climate risks, ensuring that infrastructure and water-sharing agreements are resilient to changing conditions. Develop contingency plans for extreme climate events, such as prolonged droughts or severe floods.

(iii) **Monitor and update climate projections:** Continuously monitor climate data and update water management plans as new information becomes available

Principles addressed:

- **P1 (Sustainability):** Climate projections support the long-term viability of organic rice production by ensuring that farmers can adapt to future changes in water availability, salinity, and flooding. In addition, by accounting for future climate conditions, water management plans can optimize water use, prevent over-extraction, and conserve resources.
- **P3 (Climate resilience):** Directly addresses the need to enhance resilience to climate change impacts, including droughts, sea-level rise, and extreme weather events. In addition, recognizes the

interconnectedness of water systems and the long-term impacts of climate change on water availability and quality.

- **P4 (Compatibility with organic farming practices):** By looking ahead to future climate impacts, water management plans can proactively address potential threats to organic farming, such as increased salinity intrusion or changes in water availability, and develop strategies to maintain organic integrity under changing conditions.
- **P6 (Economic viability):** By proactively addressing climate risks, the strategy reduces the likelihood of crop failures due to climate impacts, thereby supporting the economic viability of organic rice farms. Long-term planning based on climate projections enables cost-effective investments in infrastructure and water-efficient technologies, reducing future adaptation costs and improving market stability for organic rice.

Detailed strategy:

(i) Climate impact assessment:

- The first step is to conduct thorough assessments of how climate change will affect water availability, salinity intrusion, flood risks, and drought patterns over the coming decades. This involves collaboration with climate scientists, local stakeholders, and water authorities.
  - **Gather historical climate data and current trends** (temperature, rainfall, sea-level rise, and extreme weather events) that will impact the Mekong Delta.
  - **Develop climate models** using a range of emission scenarios (e.g., IPCC's RCP 2.6, RCP 4.5, RCP 8.5) to project potential changes in water availability, rainfall distribution, river flow, and salinity intrusion.
  - **Assess vulnerability of organic rice farming** in different parts of the delta to these projected changes. This includes mapping areas that are at higher risk of salinity intrusion, flooding, or drought.
  - **Engage local stakeholders** such as provincial governments, farmers, and water authorities to ensure that the assessment addresses the real-world impacts on the agricultural and water systems.

Example: Climate models might show that coastal provinces like Soc Trang and Bac Lieu will face increasing salinity intrusion due to sea-level rise, while inland provinces like Long An and An Giang could experience prolonged droughts due to reduced upstream water flows.

(ii) Integration of climate projections into water management plans:

- Once climate impacts are assessed, the next step is to integrate these projections into existing water management plans to ensure that irrigation systems and water-sharing agreements are resilient to future conditions.
  - **Update water allocation models** to reflect future climate conditions. For instance, adjust water release schedules during the dry season based on projected changes in river flows and rainfall patterns.
  - **Incorporate infrastructure upgrades** such as the building of reservoirs, sluice gates, and embankments to manage anticipated changes in water levels and salinity. Infrastructure should be adaptable to different climate scenarios, allowing for flexibility in managing water resources.
  - **Design climate-smart irrigation systems** that optimize water use efficiency in light of future water scarcity. This could involve promoting drip irrigation, rainwater harvesting, or other water-saving technologies.

- ○ **Prioritize vulnerable areas** in water distribution plans. Regions at high risk of salinity intrusion or drought should be prioritized for water resources, especially critical organic rice-growing areas.

Example: Water-sharing agreements could be updated to ensure that downstream provinces receive more water during the dry season to combat salinity intrusion, while upstream provinces hold water during the rainy season to prevent flooding.

(iii) Infrastructure adaptation and climate-resilient technologies:

- This component focuses on upgrading or constructing new infrastructure to mitigate the physical impacts of climate change, such as salinity barriers, reservoirs, and flood control infrastructure.
  - **Build salinity barriers and floodgates** to prevent saltwater intrusion into freshwater systems, particularly in coastal regions. These structures will need to be designed to handle higher sea levels and more frequent storm surges.
  - **Develop adaptable reservoirs** that can store excess water during the rainy season and release it during periods of drought. This helps regulate water availability throughout the year.
  - **Install real-time monitoring systems** to track water levels, salinity, and weather patterns. This allows for dynamic management of water infrastructure, ensuring timely responses to extreme weather events.
  - **Promote water-efficient irrigation technologies** such as drip systems, especially in drought-prone areas, to reduce water usage and ensure that organic rice farming remains viable in water-scarce conditions.

Example: In the coastal province, a salinity barrier could be constructed to protect organic rice farms from saltwater intrusion. In addition, real-time monitoring systems could be installed to measure salinity levels and adjust water flows accordingly.

(iv) Adaptive management and contingency planning for extreme events:

- Long-term climate projections are uncertain, and the system must be flexible enough to cope with unexpected or extreme events, such as prolonged droughts or severe floods.
  - **Develop contingency plans** for extreme climate scenarios, such as multi-year droughts or flooding beyond historical norms. These plans should outline emergency water allocation strategies, prioritizing the most vulnerable regions and organic farms.
  - **Establish early warning systems** for extreme events like floods or salinity spikes, based on real-time monitoring data and weather forecasts. These systems should notify farmers and local authorities in advance, allowing them to take protective measures.
  - **Incorporate adaptive management practices** in water policies, allowing for flexibility in water resource allocation and infrastructure management based on real-time conditions.
  - **Train local communities and farmers** in climate adaptation techniques, such as planting drought-resistant rice varieties, using flood-tolerant farming techniques, or adopting water-saving irrigation practices.

Example: A contingency plan could be established in the province, where farmers switch to drought-resistant rice varieties during prolonged dry spells, while upstream water reservoirs release more water to prevent crop losses.

(v) Monitoring, evaluation, and updating projections:

- Climate change is dynamic, and strategies must be regularly updated to reflect new data and evolving climate conditions.
  - **Regularly update climate models** with new data from local weather stations, satellite information, and global climate models. This ensures that water management plans reflect the most up-to-date understanding of future risks.
  - **Establish a framework** for periodic review of water management plans, ensuring that they remain relevant as climate conditions change. Reviews could be scheduled every 3-5 years to align with new scientific findings and climate data.
  - **Track the effectiveness** of climate adaptation measures by monitoring crop yields, water usage, and the frequency of climate-related disruptions (e.g., flooding, droughts). Adjust strategies as needed to improve resilience.
  - **Collaborate with international and regional climate** monitoring organizations to ensure access to the latest climate projections and innovations in adaptation technology.

Example: In response to updated climate projections showing faster-than-expected sea-level rise, the Mekong Delta's water authority could upgrade floodgates and increase investment in salinity barriers to protect vulnerable areas.

(vi) Capacity building and stakeholder engagement:

- Ensuring that all stakeholders are informed and capable of participating in climate adaptation efforts is essential for the long-term success of the strategy.
  - **Provide training** for farmers and local water authorities on the impacts of climate change and best practices for water management in a changing climate. Training should focus on organic rice farmers, who are more vulnerable to climate variability.
  - **Engage provincial governments** in the decision-making process, ensuring that they have the data and resources needed to adapt their water management strategies to future climate conditions.
  - **Foster collaboration** between provinces, international organizations, and research institutions to ensure a coordinated and well-supported response to climate change across the Mekong Delta.
  - **Raise public awareness** about the importance of climate adaptation and the potential impacts of climate change on water resources and agriculture. This can encourage more widespread support for necessary infrastructure investments and water-saving practices.

Example: Workshops could be held across the delta to train farmers on drought-resistant rice varieties and water-saving irrigation techniques, while water authorities receive training on using real-time monitoring systems to manage water flows

Benefits:

- **Increased resilience to climate change:** Organic rice production systems are better equipped to handle the impacts of climate change, including droughts, floods, and salinity intrusion, ensuring long-term sustainability.
- **Efficient resource use:** Climate projections help optimize water use, ensuring that irrigation systems are designed for future conditions, reducing waste and conserving water resources.
- **Protection against salinity intrusion**: By incorporating sea-level rise and salinity projections, the strategy ensures that organic farms are protected from contamination, preserving soil quality and organic certification.
- **Enhanced disaster preparedness**: The development of contingency plans for extreme weather events ensures that organic rice farms can continue operating even during adverse conditions.
- **Equitable adaptation**: Vulnerable and smallholder farmers receive the support they need to adapt to climate change, ensuring equitable access to water and other resources.

Trade-offs:

- **Uncertainty in climate projections:** While climate models provide valuable insights, there is still uncertainty in long-term projections, making it difficult to plan with absolute certainty. This may lead to over- or under-investment in certain adaptation measures.
- **High upfront costs:** Incorporating climate adaptation measures into water management plans may require significant investment in infrastructure and technologies, which could strain government and local community budgets.
- **Potential for over-engineering:** In some cases, plans may be overly conservative or too focused on long-term risks, leading to higher costs than necessary in the short term. Balancing near-term needs with long-term adaptation is a challenge.
- **Complexity in decision-making:** Integrating climate projections into water management adds layers of complexity, requiring collaboration between multiple stakeholders, including provincial governments, farmers, and water authorities.

Feasibility:

- **Technical feasibility:** Climate models and data are widely available and can be integrated into water management plans with current technology. Existing infrastructure (e.g., sluice gates, reservoirs) can be upgraded to accommodate projected climate changes.
- **Financial feasibility:** While climate assessments themselves are not costly, implementing the necessary adaptation measures (such as salinity barriers, flood control systems, and water-efficient infrastructure) may require significant investment. However, international climate adaptation funds, such as the Green Climate Fund, may help offset costs.
- **Social feasibility:** Given the increasing awareness of climate risks, there is likely to be strong support from both local communities and international donors for strategies that build resilience to climate change. However, ensuring equitable adaptation across provinces and among farmers will require careful planning and stakeholder engagement.

Summary for section 0:

Table 3 gives a summary of the irrigation strategies derived based on the Guiding Principles:

Table 3. Mapping of guiding principles and proposed irrigation strategies at inter-provincial scale

Strategy	P1 (Sustainability)	P2 (Equity)	P3 (Climate Resilience)	P4 (Compatibility with Organic Farming)	P5 (Cross-Contamination Prevention)	P6 (Economic Viability)
IWRM at Delta Scale	✓			✓	✓	
Water Sharing Agreements Across the Delta	✓	✓		✓		
Long-Term Climate Projections	✓		✓	✓		✓

The irrigation strategies proposed for the Mekong Delta, with a focus on sustainable, climate-resilient organic rice farming, represent a holistic and forward-thinking approach to water management. By integrating the principles of IWRM at the delta scale, fostering regional collaboration through water-sharing agreements, and incorporating long-term climate projections into water management plans, the strategy addresses the complex and interrelated challenges posed by climate change, water scarcity, and salinity intrusion.

❖ **Key takeaways:**

- **Integrated Water Resource Management (IWRM):** At the delta scale, IWRM emphasizes the need for a coordinated and cross-provincial approach to managing water resources. This includes regulating water flow, controlling salinity, and ensuring equitable water distribution to organic rice farms. The development of a central water management body and the use of smart technologies like real-time water monitoring systems are crucial components of this strategy. The long-term sustainability of water resources and the prevention of cross-contamination from conventional farms are vital to maintaining the purity of water for organic rice farming.
- **Water sharing agreements:** Formal water-sharing agreements between provinces are essential to prevent conflict and ensure equitable water distribution, particularly during times of drought or water scarcity. These agreements help balance the needs of upstream and downstream provinces, ensuring that downstream organic rice farms receive adequate water to prevent salinity intrusion. The success of these agreements depends on robust monitoring systems, conflict resolution mechanisms, and the flexibility to adjust terms based on real-time environmental conditions.
- **Long-term climate projections:** Incorporating long-term climate projections into water management plans ensures that the Mekong Delta is resilient to future climate impacts, such as rising sea levels, increased salinity, and more frequent droughts. By assessing climate risks and updating infrastructure accordingly, the strategy builds resilience into the delta's irrigation systems. This forward-looking approach enables organic rice farmers to adapt to changing conditions, ensuring the long-term sustainability and economic viability of organic farming in the region.

❖ **Feasibility:**

- **Technical feasibility:** The Mekong Delta has a strong track record of water management, and the necessary expertise and technology for implementing IWRM, water-sharing agreements, and climate-resilient infrastructure are in place. Proven models from other regions can be adapted to the delta's unique challenges.
- **Financial feasibility:** While the costs are high, international climate finance, public-private partnerships, and government support can help mitigate financial pressures. Securing consistent funding sources will be key to ensuring the long-term success of the strategy.
- **Social feasibility:** Collaboration between provinces and engagement with local communities are critical to the strategy's success. Building trust and ensuring that all stakeholders, particularly smallholder farmers, are involved in decision-making will help overcome potential resistance and foster long-term cooperation.

The proposed irrigation strategies for the Mekong Delta offer a comprehensive and adaptive framework for addressing the region's water management challenges. By integrating sustainability, equity, and climate resilience, the strategy not only protects organic rice farming but also enhances the overall resilience of the delta's agricultural systems. The trade-offs and challenges associated with large-scale infrastructure development and cross-provincial collaboration are significant but can be managed through careful planning, stakeholder engagement, and investment in adaptive technologies. Ultimately, the success of these strategies will ensure that the Mekong Delta continues to thrive as a hub for organic rice production in the face of growing climate risks.

<u>Final Summary and Conclusions for Sections 3.2, 3.3, and 0:</u>

Effective irrigation management for organic rice farming in the Mekong Delta requires a multi-scale approach that integrates provincial, interprovincial, and regional strategies. At the provincial level, localized systems protect organic farms from contamination while promoting efficient water use. At the interprovincial scale, formal agreements and shared infrastructure investments ensure fair and equitable water distribution. Finally, at the Mekong Delta scale, regional coordination through IWRM and climate-resilient infrastructure is essential to safeguard the Delta's agricultural systems from the growing impacts of climate change.

❖ **Key themes across all scales:**

- **Sustainability and equity:** Across all scales, water management strategies must prioritize sustainability and equity, ensuring that resources are used responsibly and distributed fairly among all stakeholders, particularly smallholder organic farmers.
- **Infrastructure and investment:** Investment in both localized and large-scale infrastructure is crucial to improving water availability and ensuring resilience to environmental challenges such as climate change and resource depletion.
- **Climate adaptation:** Building climate resilience is a central theme, with strategies at all levels focusing on adapting irrigation systems to withstand the impacts of extreme weather events, droughts, and flooding.

Overall, a coordinated, multi-scale approach to water management is essential for supporting organic rice farming in the Mekong Delta, ensuring long-term sustainable and equitable use of water resources.

IV. Field Trip Results and Analysis

This section presents the findings and analysis from a field trip to the Mekong Delta in Vietnam in November 2024. It describes the consultation process with local stakeholders, including farmers, irrigation managers and local authorities. It then provides an overview and summary of the existing irrigation infrastructure and practices specific to organic rice production in each of the participating provinces. Perspectives from local authorities on the proposed irrigation strategies at provincial scale mentioned in **section 3.2** are also included.

4.1. Consultation Process

The November 2024 field trip to differences provinces in the Mekong Delta conducted from the 6th to 18th November. The fieldwork for this report involved consultation meetings and questionnaire interviews with a diverse range of stakeholders across several provinces:

- **Department of Agriculture and Rural Development (DARD) Representatives:** The Department of Agriculture and Rural Development (DARD) is a specialized agency under the provincial People's Committee. It advises and assists in managing state functions related to agriculture, forestry, aquaculture, irrigation, rural clean water, disaster prevention, agricultural extension, rural development, and food safety for agricultural products. The department operates under the direction of the provincial People's Committee, while also following guidelines from the Ministry of Agriculture and Rural Development.
  In this field trip, interviews with DARD representatives from An Giang, and Dong Thap provinces provided insights into regional policies, regulations, and support systems related to irrigation management for organic rice production. Representatives from Vinh Long were unable to attend this scheduled meeting.
- **Irrigation Center (IC) Representatives:** The Irrigation Center (IC) is an administrative organization under the DARD. It assists the Director in advising the provincial People's Committee on state management and implementing tasks related to irrigation, rural clean water supply, water security, dam safety, and disaster prevention according to legal regulations.
  In this field trip, discussions with representatives from ICs of An Giang, and Dong Thap provinces offered valuable perspectives on the practical challenges and opportunities associated with managing irrigation for organic rice farming. Representatives from Vinh Long were unable to attend this scheduled meeting.
- **Cooperative Managers:** Agricultural cooperatives are collective economic organizations of working farmers, based on voluntary principles, mutual benefit, and democratic management, supported by the Vietnamese Communist Party and Vietnamese Government. Their specific activities include providing agricultural products and services, signing contracts for cooperation, and participating in public service provision to meet the agricultural production and business needs of members and non-member customers.
  In this field trip, interviews with managers of agricultural cooperatives provided insights into the organizational and economic aspects of transitioning to and maintaining organic rice production, including the role of irrigation management in cooperative success.
- **Farmers:** In this field trip, interviews with farmers across Vinh Long, Dong Thap, An Giang, Tra Vinh, and Ca Mau provinces, including those engaged in organic rice farming, safe rice farming, and ecological rice

farming, offered crucial firsthand perspectives on the realities of irrigation management and the challenges and benefits associated with different approaches.

4.2. Existing Irrigation Practices for Organic Rice Farming:

4.2.1. Information provided by DARD and IC

This section summarizes information gathered from the DARD and IC of Dong Thap and An Giang provinces regarding the current status, challenges, and opportunities for organic rice irrigation. Information was collected during meetings held on November 8, 2024, at Can Tho University with Dong Thap representatives, and on November 14, 2024, at the IC in Long Xuyen City with An Giang representatives.

❖ **Current status:**

- **Dong Thap:**
  - Organic rice production is currently limited due to farmer preference for conventional methods and economic factors. Conventional rice yields 6-7 t/ha with 2-3 crops annually, while organic rice yields are lower (3-5 t/ha) with 1-2 crops.
  - No dedicated irrigation system exists for organic rice. The existing system, comprising natural and artificial canals, 833 canal structures, farm canals, and 2,219 electric pumping stations, prioritizes flood control and water-saving irrigation for conventional rice.
  - While the province aims to expand organic agricultural land (including rice paddies) to 605hectare by 2025 and 1,710hectare by 2030, no specific irrigation plan exists for this expansion.
  - Current irrigation management is influenced by a provincial initiative to upgrade systems for 1 million hectares of high-quality rice, focusing on emission reduction and incorporating AWD where suitable.
  - Water quality assessment follows QCVN 08:2023/BTNMT standards. Water availability is managed through agreements between pumping station operators and farmers.
- **An Giang:**
  - The An Giang IC focused on existing irrigation infrastructure and its potential adaptation for organic rice. Specific organic rice policies fall under the DARD.
  - An Giang participates in the Long Xuyen Quadrangle (LXQ) irrigation system, a joint project with Kien Giang and Can Tho provinces, managing freshwater resources, saltwater intrusion, flood control, drainage, and waterway development.
  - The province operates under three flood alert levels, with Level 1 (low water levels) prevalent since 2012 due to upstream hydropower dams, impacting water availability.
  - Specific data on yields and cropping intensities for organic rice were deferred to the Ministry of Agriculture and Rural Development (MARD) and the Sub-Department of Crop Production.
  - The LXQ Irrigation System is central to provincial irrigation management. Water requirements are calculated based on local conditions (2,050,000 m^3/season/265,000hectare for winter-spring), referencing TCVN 9170:2012. Water scarcity management follows a provincial allocation priority plan.

❖ **Challenges and opportunities:**

- **Challenges (both provinces):**
  - **Lack of organic rice-specific strategies:** Current irrigation practices and infrastructure are not tailored to the specific needs of organic rice. This includes the lack of specific infrastructure and management practices for organic rice in Dong Thap, where the current system prioritises conventional rice. In An Giang, the lack of specific policies for organic rice within the existing irrigation framework is a significant barrier.
  - **Ageing infrastructure:** Deteriorating irrigation equipment and on-farm canals, particularly earthen canals in Dong Thap and ageing pumping stations in both provinces, pose challenges to efficient water management. This ageing infrastructure leads to inefficiencies and increased maintenance costs. In An Giang, Resolution 05 provides insufficient support for the necessary infrastructure upgrades.
  - **Increased pumping costs (An Giang):** Low river levels during prolonged dry periods, exacerbated by upstream hydropower dams and the prevalence of Level 1 flood alert (low water levels) since 2012, significantly drive up irrigation costs for farmers.
  - **Pesticide drift (Dong Thap):** Cross-contamination from neighboring conventional rice fields poses a major threat to organic rice production. While buffer zones of fruit trees exist for organic fruit cultivation, no effective solution exists to prevent pesticide drift, especially with the increasing use of drone application in conventional rice farming.
  - **Uneven infrastructure development (Dong Thap):** The uneven development of infrastructure across the province, with many farm canals remaining earthen and pumping stations ageing, poses further challenges to efficient and equitable water distribution.
  - **Lack of specific regulations (Dong Thap):** The absence of specific discharge regulations for organic rice production makes it difficult to monitor and manage water quality effectively, potentially impacting certification and market access.
  - **Climate change adaptation (Dong Thap):** No specific strategies are in place to address the impacts of climate change on water availability and irrigation needs for organic rice production, leaving the sector vulnerable to future climate-related risks.
- **Opportunities (both provinces):**
  - **Adapting existing infrastructure:** The existing polder system and LXQ infrastructure in An Giang, along with the planned upgrades for high-quality rice production in Dong Thap (including canal reinforcement and modernization of pumping stations), offer a strong foundation for developing organic rice-specific irrigation strategies. This allows for leveraging existing investments and minimizing the need for entirely new infrastructure.
  - **AWD implementation:** The widespread use of AWD in both provinces provides a basis for water conservation and improved water use efficiency in organic rice production. This aligns with broader sustainability goals and can contribute to reducing water stress.
  - **Emerging technologies:** The use of drip and sprinkler irrigation for vegetables in An Giang, along with the adoption of pipes, pumps, AWD, and drone technology for rice in both provinces, demonstrates a willingness to adopt new technologies, which could be further leveraged to benefit organic rice farming. These technologies offer potential for water savings, increased yields and quality, reduced

emissions, and cost optimization, although cost, farmer access, and long-term sustainability need consideration.

- **Interprovincial collaboration (Dong Thap):** Projects like the Hong Ngu-Vinh Hung canal project with Long An province promise improved freshwater flow and shared water resource management, which could support organic farming by enhancing water security and regional cooperation.
- **Water retention lakes (An Giang):** Existing water retention lakes in upland areas (Tinh Bien, Tri Ton, and Thoai Son) offer potential for water storage and management during dry periods, providing a valuable resource for irrigating organic rice paddies.
- **Water quality monitoring (Dong Thap):** Ongoing monitoring by the Department of Natural Resources and Environment (DONRE) provides a baseline for managing water quality for organic systems and can inform targeted interventions to address specific contaminants.

❖ **Key Considerations for Future Development:**

- **Dedicated organic rice irrigation strategies:** Developing specific irrigation plans and regulations for organic rice is crucial. This includes addressing cross-contamination in Dong Thap through a combination of dedicated systems, buffer zones, and time separation of irrigation activities. In An Giang, this involves developing clear standards and procedures for organic rice production, encompassing production models, seed-to-harvest processes, organic standards, and cost-benefit analyses compared to conventional rice.
- **Clear standards and procedures (An Giang):** Comprehensive guidelines are needed to ensure the integrity of organic rice production. This includes defining acceptable production models, outlining seed-to-harvest processes, establishing clear organic standards, and conducting thorough cost-benefit analyses to compare organic and conventional rice farming.
- **Improved infrastructure management (Dong Thap):** Clarifying responsibilities and improving coordination between provincial and local management of irrigation infrastructure is essential for efficient water allocation and maintenance. This includes addressing the uneven development of on-farm canals and the aging of pumping stations.
- **Addressing water risks:** Managing water risks requires a multi-faceted approach. In Dong Thap, this involves addressing localized flooding from high tides and heavy rainfall, while also leveraging the benefits of periodic flooding for nutrient supply. This requires careful planning and coordination to balance competing needs. In An Giang, strict input water quality control is essential, with regular testing and the implementation of water treatment solutions where necessary. Prioritizing existing one-crop polders for pilot organic rice projects with manageable areas and good water quality control is also recommended.
- **Funding and implementation (Dong Thap):** Securing funding for proposed upgrades and ensuring timely implementation are critical. This includes leveraging funding mechanisms like Decree No. 35/2023/ND-CP and Decree 112-HĐBT to support infrastructure development and modernization.
- **Research and planning (Dong Thap):** Further research is needed to adapt delta irrigation systems to the specific needs of organic rice production, including exploring water storage/rainwater harvesting and water-efficient irrigation techniques. This research should inform the development of tailored irrigation strategies that optimize water use and minimize environmental impact.
- **Farmer support (An Giang):** Secure market linkages (e.g., contract farming), technical assistance, and financial support are vital for farmer transition to organic practices. This support will incentivize adoption

and ensure the long-term viability of organic rice farming. Expanding An Giang's existing planting area code system (currently used for mangoes) to track organic rice production can enhance transparency and consumer trust, further supporting market access.

- **Evaluation of production models (An Giang):** Rigorous comparison of different organic rice production models based on cost, yield, quality, and market potential is crucial for identifying the most suitable and sustainable approaches for the region. This evaluation should consider the specific environmental and economic conditions of An Giang.

❖ **Short summary:**

Both Dong Thap and An Giang provinces face similar challenges and opportunities in developing organic rice irrigation. While Dong Thap has ambitious goals for expanding organic agriculture, its current irrigation practices are primarily geared towards conventional and high-value rice production. An Giang has significant irrigation infrastructure and experience in water management through the LXQ system, but lacks practices specifically tailored to organic rice production.

Addressing the identified challenges and capitalising on existing opportunities is critical for both provinces. In Dong Thap, dedicated planning, investment in infrastructure and the development of specific management strategies tailored to organic rice are essential to achieve the province's organic farming goals. In An Giang, developing specific strategies, addressing water quality issues specific to organic production, and providing comprehensive farmer support are critical to the successful integration of organic rice into the province's agricultural landscape. Collaboration between the IC, DARD and other relevant agencies is essential in both provinces to develop and implement effective organic rice irrigation plans that utilise existing infrastructure and address the specific needs of this growing sector. Ultimately, a shift in focus and investment towards organic rice-specific irrigation strategies is needed in both provinces to support the sustainable growth of this promising agricultural sector.

4.2.2. Information provided by cooperative managers practice organic rice farming

Information was gathered from the Cooperative Director of Hung My Cooperative in Hung My Commune, Chau Thanh District, Tra Vinh Province (interviewed November 16, 2024), and the Chairman and Director of Tri Luc Cooperative in Tri Luc Commune, Thoi Binh District, Ca Mau Province (interviewed November 18, 2024). Hung My Cooperative manages a diverse range of rice production systems, while Tri Luc Cooperative has been implementing organic rice production since 2018 and currently manages 50 hectares of organic farmland.

❖ **About irrigation and water quality:**

- **Irrigation methods:** The Hung My Cooperative in Tra Vinh uses AWD for organic rice and conventional methods (varying inundation levels depending on growth stage and shrimp co-cultivation) for other rice types, sourcing water directly from the Tien River. The Tri Luc Cooperative in Ca Mau relies solely on rainwater, collected within the fields, and manages runoff for water exchange.
- **Irrigation requirements for organic rice production**: Hung My Cooperative primarily monitors salinity for the two-crop rice model. For the rice-shrimp model, only salinity is monitored by the cooperative, while other water quality parameters are assessed by the certifying company (specifics not shared). Tri Luc Cooperative's main requirement is using only rainwater, avoiding river water entirely.

- **Changes in water quality:** Both cooperatives report improved water quality since transitioning to organic practices. Hung My notes reduced chemical inputs, lower alum content, and increased soil pH. Tri Luc observes cleaner, odourless water and the survival of shrimp within the fields.
- **Water quality problems/contamination:** Hung My Cooperative avoids cross-contamination through individual polders with separate inlet/outlet sluices managed by farmers. Tri Luc acknowledges potential contamination from neighboring farms using pesticide drones, but the extent is unknown.
- **Water quality requirements for organic rice production:** The director at Hung My is unaware of specific standards but plans to develop internal ones, believing water should be free of E. coli and contamination from livestock farms and tourist areas. Tri Luc leaders also lack knowledge of specific standards but monitor pH, estimating rainwater acidity based on experience.
- **Water quality monitoring:** Hung My monitors salinity intrusion hourly in collaboration with the Irrigation Centre and the People's Committee, informing farmers of irrigation schedule changes. Tri Luc measures rainwater and field water pH using a tool, aiming for 7.5-8, and uses organic manure to adjust pH.
- **Water storage/rainwater harvesting:** Neither cooperative practices rainwater harvesting. Hung My pre-fills fields with available fresh water (5cm for 5-7 days) during salinity intrusion. Tri Luc relies on natural rainfall and accepts potential drought-related yield losses.
- **Water efficiency methods:** Hung My uses AWD for organic rice. Tri Luc manages water levels using a staff gauge, maintaining 5 cm initially, 10 cm after one month, and 20 cm after three months.

❖ **Overall:**

The cooperative managers demonstrate varying levels of awareness and implementation of organic rice-specific irrigation and water quality management practices. While both prioritize avoiding contamination and perceive water quality improvements, knowledge gaps regarding specific standards and the reliance on farmer-managed infrastructure (Hung My) or susceptibility to drought (Tri Luc) pose challenges.

4.2.3. Information provided by cetified organic rice farmers

Interviews were conducted with certified organic rice farmers in two provinces: Tra Vinh and Ca Mau. In Tra Vinh, four farmers from Lam Hoa Commune, Chau Thanh District, members of the Chau Hung Cooperative and practicing mixed rice-shrimp farming, were interviewed on November 16, 2024. These farmers have been certified organic for varying durations, from 3 to 5 years, and their farms range from 1 to 2 hectares. They primarily cultivate fragrant rice varieties. In Ca Mau, three farmers from Tri Luc Commune, Thoi Binh District, members of the Tri Luc Cooperative and practicing mixed rice-shrimp-crab farming with one rice crop per year, were interviewed on November 18, 2024. These farmers transitioned to organic farming in 2018 and their farm sizes average around 0.5 hectares. They cultivate a variety of rice suitable for the rice-shrimp-crab system.

❖ **About irrigation and water quality:**

- **Irrigation methods:** Tra Vinh farmers rely on tidal river flow and individual paddy control, utilizing sluice gates to manage water levels within their paddies. This system allows them to regulate salinity and ensure optimal conditions for both rice and shrimp. They open the sluice gates during high tide to flood their fields and close them during low tide to retain water. Ca Mau farmers rely solely on rainwater, which is collected and stored within the poldered fields, each ranging from 20-30 hectares and managed collectively by the cooperative. They manage runoff and water exchange between fields within the polder system through a network of canals and ditches (see Figure 5).

- **Irrigation requirements for organic rice production:** Tra Vinh farmers prioritize avoiding chemical contamination from upstream sources and neighboring conventional farms. They actively participate in the cooperative's efforts to maintain a chemical-free environment within their designated farming area. This includes regular communication and coordination among cooperative members. Ca Mau farmers emphasize exclusive rainwater use, strictly avoiding river water due to potential pollution from agricultural runoff, industrial discharge, and upstream shrimp farms. They rely on the polder system to create a self-contained water management unit.
- **Changes in water quality:** All farmers reported substantial improvements in water quality since transitioning to organic practices. They observed clearer water, a resurgence of diverse aquatic life (including fish, shrimp, crabs, snails, and frogs), and a reduction in foul odors. They also noted improvements in soil health, including increased earthworm activity and better water retention.
- **Water quality problems/contamination:** ra Vinh farmers, while benefiting from community-wide adoption of organic practices, remain vigilant about potential contamination from upstream sources during periods of heavy rainfall. They coordinate with the cooperative and local authorities to monitor water quality and address any potential contamination issues. Ca Mau farmers avoid contamination through the use of polders and buffer zones around their fields. However, they expressed concern about potential drift from pesticide application via drones on neighboring conventional farms, especially during the dry season when winds can carry spray over longer distances. They emphasized the need for stricter regulations and better communication with conventional farmers.
- **Water quality requirements for organic rice production:** While aware of the general principles of organic farming, farmers in both provinces demonstrated a limited understanding of the specific water quality parameters and standards required for organic certification. They primarily rely on visual observations, the absence of chemical inputs, and the thriving biodiversity within their fields as indicators of good water quality. They rely on the certifying body for specific testing and guidance on compliance.
- **Water quality monitoring:** Tra Vinh farmers rely on the Sub-Department of Irrigation for periodic upstream water quality testing, particularly for salinity and pH levels. They also monitor salinity levels through local news and weather forecasts and conduct regular visual inspections of the water in their fields. Ca Mau farmers do not actively monitor rainwater quality parameters, focusing primarily on rainfall quantity and distribution within the polder system. They rely on the natural buffering capacity of the polder and the established ecosystem within the fields to maintain water quality.
- **Water storage/rainwater harvesting:** Tra Vinh farmers do not actively store water beyond the capacity of their individual paddies, relying on the consistent supply of river water during the rainy season and tidal flows during the dry season. Ca Mau farmers rely entirely on rainwater harvested and stored within the polder system. They do not have dedicated rainwater harvesting infrastructure beyond the canals, ditches, and the polder itself.
- **Water efficiency methods:** Tra Vinh farmers primarily manage water efficiency through the careful control of water levels in their paddies using sluice gates. They adjust water levels based on the growth stage of the rice and the needs of the shrimp. Ca Mau farmers practice water retention in their fields on sunny days

based on weather forecasts to minimize evaporation losses. They also emphasize the importance of maintaining appropriate water depths for the different stages of rice and aquatic animal growth within the integrated rice-shrimp-crab system.

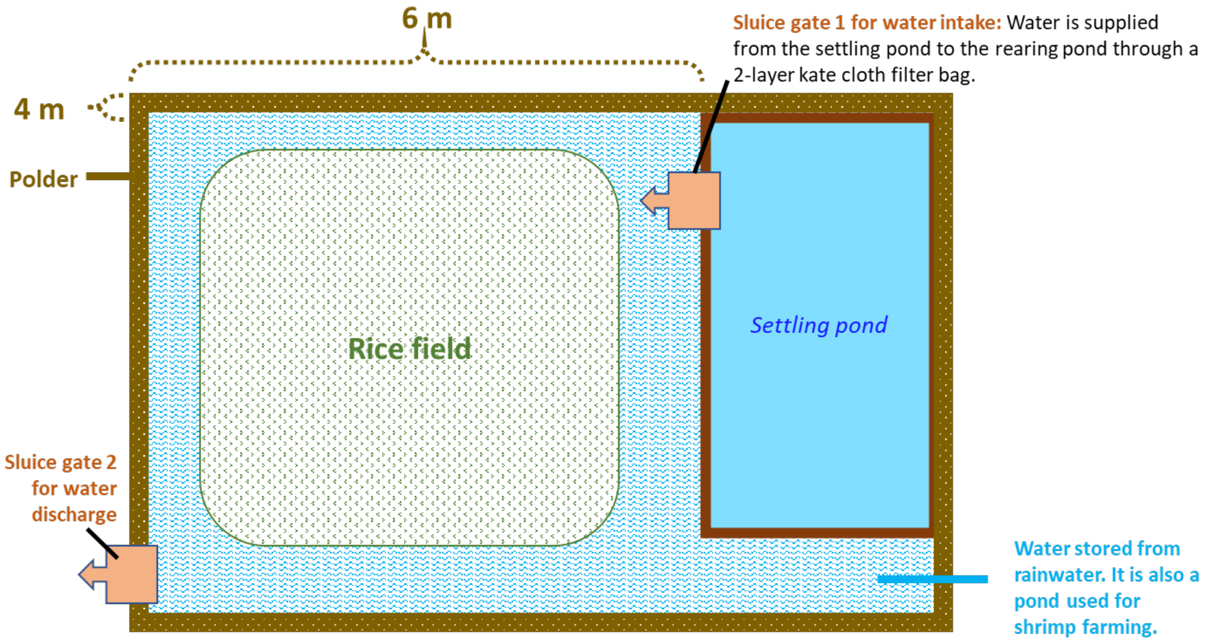

Figure 5. Diagram of current irrigation scheme for rice field provided by farmers in Ca Mau

❖ **Overall:**

These certified organic farmers demonstrate a practical, experience-based understanding of contamination prevention and benefit from the collective commitment to organic practices within their respective cooperatives. However, a notable knowledge gap exists regarding specific organic standards for water quality, highlighting the need for targeted training and information dissemination. Their reliance on external agencies for water quality information (Tra Vinh) and a reactive approach to water management based on observation and weather patterns (Ca Mau) suggest opportunities for more proactive and data-driven management practices.

4.2.4. Information provided by not yet certified organic rice farmers

Interviews were conducted with farmers transitioning to organic practices in Vinh Long and Tra Vinh provinces. In Vinh Long, three farmers from Trung Ngai Commune, Vung Liem District, who have completed three organic crop cycles and rent portions of their conventional farms to a cooperative for seed production, were interviewed on November 9, 2024. These farmers cultivate plots ranging from 0.5 to 1 hectare. In Tra Vinh, two farmers from Hung My Commune, Chau Thanh District, members of the Hung My Cooperative and practicing organic farming for three years, were interviewed on November 16, 2024. These farmers cultivate plots of approximately 1 hectare.

❖ **About irrigation and water quality:**

- **Irrigation methods:** Vinh Long farmers described a complex irrigation process influenced by seasonal salinity intrusion from the Cai River. During the summer-autumn season, if salinity is detected before sowing, they abandon the crop. If salinity occurs after sowing, they pump water from the Cai River into secondary and tertiary canals. For the winter-spring crop, they pump water from the Cai River. They wait for the river to flow at a lower level (see Figure 6). Both Tra Vinh farmers use field canals with inlet and outlet sluices. Farmer A has an excess of water due to the low altitude of his fields, while farmer B has a shortage of water, especially in the summer and autumn, due to the high altitude of his fields (see Figure 7 and Figure 8).
- **Irrigation requirements for organic rice production:** Farmers in both provinces expressed a general understanding that organic farming requires clean water free from chemical contaminants. However, they lacked formal knowledge of specific requirements and standards for organic certification.
- **Changes in water quality:** Vinh Long farmers reported a noticeable improvement in water clarity and a reduction in algae growth since reducing chemical inputs. They also observed a return of small fish and other aquatic life to their fields. Tra Vinh farmers also observed clearer water and a return of small fish to their fields, indicating improved ecological health.
- **Water quality problems/contamination:** Cross-contamination from neighbouring conventional farms using chemical fertilisers and pesticides is a major problem in Vinh Long due to the shared irrigation system. Farmers expressed frustration at the lack of control over upstream water quality. Tra Vinh farmers acknowledged the possibility of cross-contamination, but lacked the capacity to assess it. They also raised concerns about the potential impact of industrial effluent discharged into the canal system.
- **Water quality requirements for organic rice production:** Farmers in both provinces lacked detailed knowledge of specific water quality standards required for organic certification. They expressed a desire for more information and training on this topic.
- **Water quality monitoring:** Vinh Long farmers do not conduct formal water quality testing but visually assess water clarity and salinity levels before irrigating their fields. They rely on their senses and experience to judge water quality. Tra Vinh farmers also rely on visual observation but expressed interest in learning more about water quality monitoring techniques.
- **Water storage/rainwater harvesting:** Vinh Long farmers rely primarily on the Cai River for irrigation but occasionally collect and store rainwater in canals and ditches for use during periods of high salinity. One Tra Vinh farmer has implemented a small-scale rainwater harvesting system for household use but not for irrigation.
- **Water efficiency methods:** Vinh Long farmers practice AWD, adjusting water levels based on the growth stage of the rice and salinity levels in the Cai River. This helps to conserve water and minimize salinity stress on the rice plants. One Tra Vinh farmer requested improvements to the canal infrastructure, including lining and the installation of additional control gates, to address water scarcity and improve water delivery efficiency to higher-elevation fields.

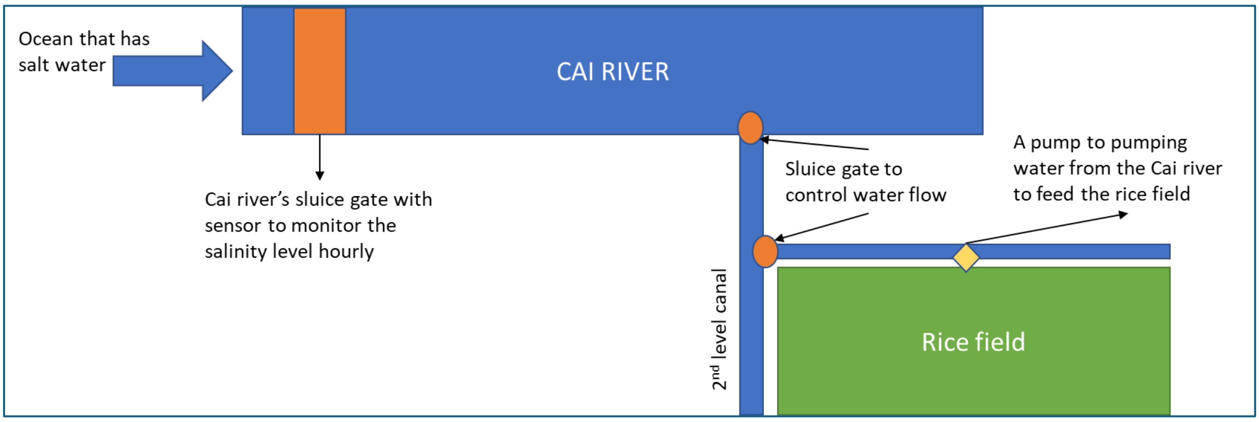

Figure 6. Diagram of current irrigation scheme for rice field provided by farmers in Vinh Long

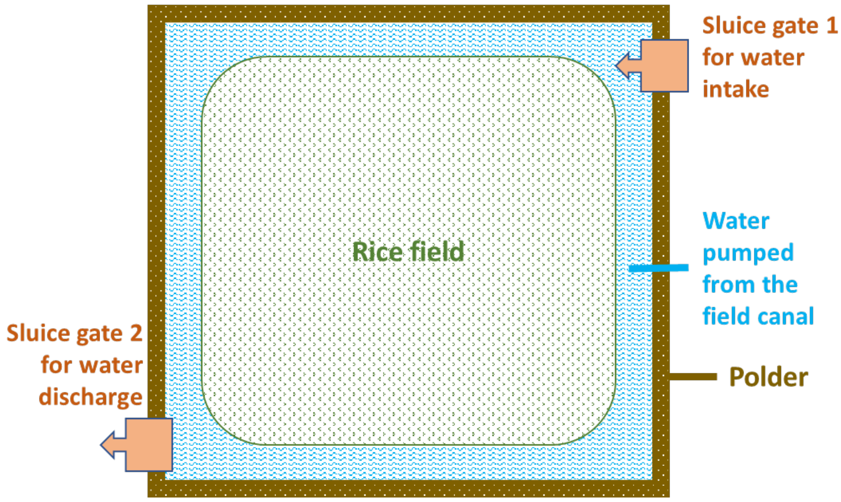

Figure 7. Diagram of current irrigation scheme for rice field provided by farmers in Tra Vinh

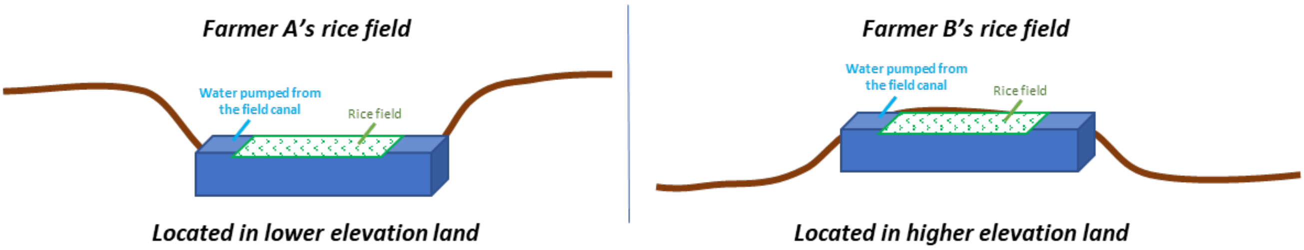

Figure 8. Illustration of the different altitudes of the farm sites of Farmer A and Farmer B

- **Overall:**

These not-yet-certified farmers demonstrate resourcefulness and adaptation to challenging local conditions, including salinity intrusion (Vinh Long) and topographical limitations (Tra Vinh). Their practical experience with organic practices over several crop cycles demonstrates their commitment to the transition. However, their shared need for information and support regarding organic-specific irrigation and water quality management, including appropriate monitoring techniques, is evident. Addressing cross-contamination risks (Vinh Long) and improving irrigation infrastructure (Tra Vinh), along with facilitating access to organic inputs, are crucial for their successful transition to certified organic production.

4.3. Evaluations of Potential Strategies at the Provincial Level by the Local Authorities

4.3.1. Comments from DARD and IC of Dong Thap and An Giang provinces:

❖ **Irrigation zoning and separation of water sources:**

- **Dong Thap**: A pilot project in Thap Muoi district aims to create a dedicated internal canal system sourced directly from the main river/canal for high-quality rice cultivation. This system will provide a controlled and potentially higher quality water source, separated from other land uses. The project is in the design phase, with the Southern Institute of Water Resources Researches conducting irrigation design and water demand calculations. Key challenges include securing investment capital and navigating the technical complexities of construction, particularly calculating accurate technical data and managing potential land acquisition and compensation issues. Dong Thap's overarching irrigation planning policy prohibits agricultural irrigation works near other land uses, requiring consultation with the DARD and preventing interference with agricultural water sources. This model is considered suitable for organic rice production due to its potential for reducing emissions and pesticide use.
- **An Giang:** The An Giang IC proposes a phased approach to organic rice production within the existing polder system. This system is categorized by the number of annual rice crops (one, two, and three) and location along the Tien River's primary canal system. One-crop polders upstream receive the highest quality water and are prioritized for initial organic rice pilots. The phased approach leverages existing infrastructure, minimizing disruption and land encroachment. Success in one-crop polders will lead to expansion to neighboring one-crop polders, then to two-crop and finally three-crop polders. This gradual expansion allows for feasibility assessment, sustainability, risk mitigation, and optimized resource use.

❖ **Buffer zones between rice fields:**

- **Dong Thap**: The province currently does not implement buffer zones due to the lower yields of organic rice, fully utilizing the designated organic rice area for cultivation. The mixed presence of conventional and organic households and fragmented land holdings further complicate buffer zone implementation. Irrigation-based buffer zones using plants as natural filters are deemed infeasible due to high water velocity in rivers and the province's regular dredging and cleaning practices. An exception is Tam Nong district within Tram Chim National Park, where organic rice cultivation is planned around the existing buffer zone.
- **An Giang:** The An Giang IC rejects both land-based and irrigation-based buffer zones. Land-based buffer zones are considered unsuitable due to potential land fragmentation, reduced cultivated area, mechanization difficulties, and potential blockage of small canals by tree roots. Irrigation-based buffer zones using plants as filters are also impractical due to restricted water flow in narrow canals, disruption of waterway traffic, and interference with dredging activities.

❖ **Community-Based Water Management:**

- **Dong Thap**: Community-based water management involves collaboration between households, cooperatives, and water exploitation companies at the commune level. A shared water exploitation schedule is based on the cropping calendar and designated irrigation operator. Currently, the Center for Management and Exploitation of Irrigation Works and Clean Water under the DARD manages irrigation, but responsibility will be transferred to communes, with cooperatives as operators. Key water risks include localized flooding from high tides and heavy rain, often exceeding soil absorption capacity and requiring pumps for drainage, especially for unharvested rice. Flooding between crops is managed by natural absorption. Periodic larger-scale floods are considered beneficial for depositing alluvium and nutrients, introducing fish and shrimp, and mitigating pesticide residues. Irrigation infrastructure upgrades rely on commune reporting of deteriorated embankments and pumping stations to the DARD, with funding allocated based on Decree No. 35/2023/ND-CP and Decree 112-HĐBT.

- **An Giang:** Community-based water management primarily involves individual irrigation with farmer-owned pumps. Collective irrigation, less common, involves a three-way arrangement between water users (farmers without pumps), water providers (local irrigation organizations), and the Commune People's Committee, which facilitates registration and contract signing. Contracts specify pumping costs per 1000 m² per crop/year, payable after harvest.

❖ **Training Farmers on Water-Saving Practices:**

- **Dong Thap**: The province actively promotes AWD involving cycles of water intake and drainage with soil treatment. Implementation varies by locality and cooperative, considering rice variety and topography, influencing pre- and post-pumping procedures.
- **An Giang:** AWD is widely used. Drip irrigation is being piloted in Tri Ton and Tinh Bien districts to address dry season water scarcity (December-April), supplementing the existing pumping system and piped water supply canals.

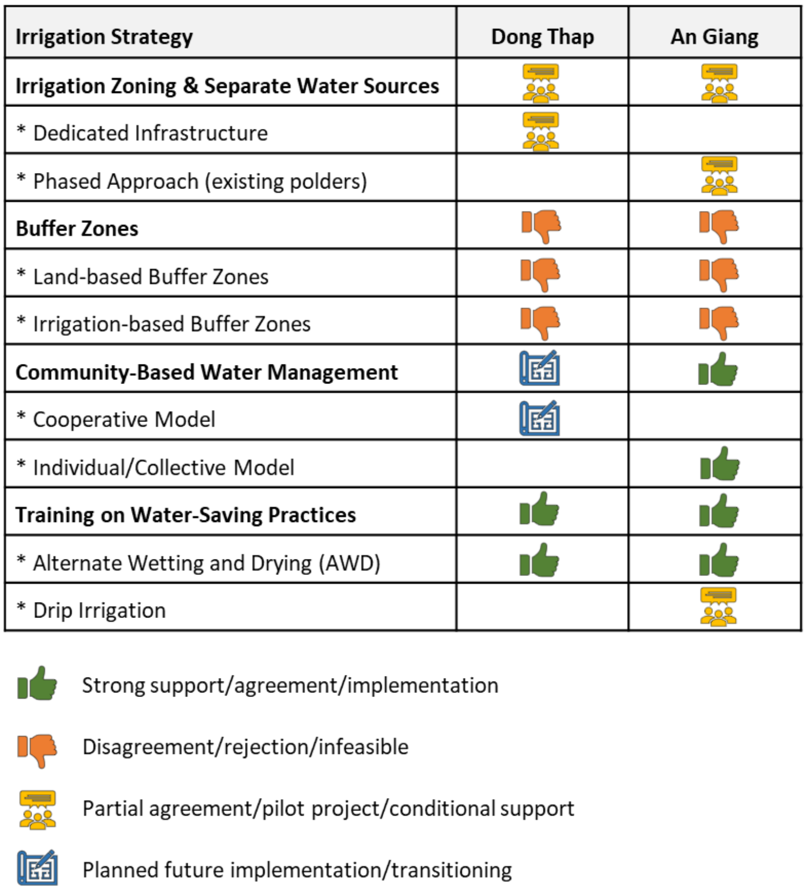

Figure 9. Illustration of comments from the local authorities on suggested irrigation options

4.3.2. Evaluations of potential irrigation strategies using local authority comments

This section evaluates the potential irrigation strategies outlined in section 3.2, analyzing their performance and suitability for organic rice production in the Mekong Delta based on comments and information provided by local authorities in An Giang and Dong Thap provinces.

❖ **Irrigation zoning and separation of water sources:**

- **Strategy overview (from 3.2.1):** Creating separate irrigation zones for organic and conventional rice farms prevents cross-contamination. This involves dedicated channels, reservoirs, or piping systems for organic farms, ensuring a clean water supply.
- **Evaluation based on local authority comments:** Both provinces recognize the importance of separating water sources for organic rice production. Dong Thap's investment in new, dedicated infrastructure, while facing funding and technical challenges, offers a strong long-term solution and a potential model for the Mekong Delta. An Giang's pragmatic, phased approach using existing polders is more cost-effective initially but requires careful water quality management and successful scaling across diverse polder types. Long-term sustainability in An Giang depends on addressing broader Tien River contamination risks. A combined approach of targeted infrastructure development and strategic management of existing systems may be most effective for widespread organic rice adoption in the Mekong Delta.

❖ **Buffer zones between rice fields:**

- **Strategy overview (from 3.2.2):** Establishing buffer zones (vegetative barriers or land) between organic and conventional farms reduces agrochemical drift and run-off contamination.
- **Evaluation based on local authority comments:** The strong resistance to buffer zones in both provinces highlights a critical challenge for organic rice production in the Mekong Delta. While buffer zones offer theoretical benefits, there are significant practical barriers to their implementation. Economic concerns about land use efficiency and the complexities of managing fragmented land holdings are legitimate and need to be addressed. In addition, existing irrigation infrastructure and management practices, such as regular dredging, are not suited to incorporating vegetated buffer zones within waterways. For the Mekong Delta, innovative solutions are needed to mitigate the risks of cross-contamination without compromising the efficiency of land use. This could include exploring alternative buffer zone designs, such as narrow, strategically placed vegetative barriers, or developing community-based agreements to manage pesticide use around organic farms. Further research is needed to identify effective and practical buffer zone strategies that can be adapted to the specific conditions of the Mekong Delta.

❖ **Community-Based Water Management:**

- **Strategy overview (from 3.2.3):** Creating separate irrigation zones for organic and conventional rice farms prevents cross-contamination. This involves dedicated channels, reservoirs, or piping systems for organic farms, ensuring a clean water supply.
- **Evaluation based on local authority comments:** The existing community-based water management in both provinces provides a solid foundation for the transition to organic rice production. Dong Thap's cooperative model, which emphasises shared responsibility, facilitates the adoption of organic practices at the community level, which will be further strengthened by the planned transfer of irrigation management to local control. An Giang's more individualistic model still relies on community agreements for collective irrigation. Strengthening existing structures and promoting cooperation among stakeholders is crucial for

equitable and sustainable water management for organic rice throughout the Mekong Delta. Developing WUAs with participatory decision-making and conflict resolution mechanisms can further improve water governance and support the growth of the organic rice sector.

❖ **Training Farmers on Water-Saving Practices:**

- **Strategy overview (from 3.2.4):** Creating separate irrigation zones for organic and conventional rice farms prevents cross-contamination. This involves dedicated channels, reservoirs, or piping systems for organic farms, ensuring a clean water supply.
- **Evaluation based on local authority comments:** The widespread adoption of AWD in both provinces shows a positive trend towards water conservation in rice production. Continued promotion of AWD and other water-saving practices, such as SRI, is essential for sustainable organic rice production in the Mekong Delta. An Giang's piloting of drip irrigation is a proactive approach to addressing water scarcity in specific areas. Expanding these pilot programmes and exploring the suitability of other innovative irrigation technologies, such as smart irrigation systems, could further improve water use efficiency. Crucially, training programmes need to be tailored to the specific needs and contexts of organic farmers. Integrating water-efficient practices with broader training on organic farming principles will ensure a holistic approach to sustainable rice production in the Mekong Delta.

V. Proposed Optimal Irrigation Strategy

This section presents the refined irrigation strategies, incorporating the valuable feedback received from stakeholders. The revisions made to the initial proposals are explained, demonstrating how stakeholder input has shaped the development of more context-specific and effective solutions. This section emphasizes the collaborative nature of the project and the importance of local knowledge in achieving sustainable outcomes.

5.1. Provincial Scale

5.1.1. Irrigation option 1: Identifying and prioritizing rice areas with clean water sources, combined with infrastructure upgrades and enhanced water quality standards

Overview: This strategy focuses on identifying existing rice-growing areas with access to the cleanest water sources in the province (e.g. single-crop polders in An Giang, upstream areas of irrigation canals, rainwater harvesting areas such as in Ca Mau) and prioritising organic rice development in these areas. At the same time, the existing irrigation system will be reviewed and upgraded to meet the water quality requirements for organic rice production. A crucial component of this option is the development of specific water quality standards for organic rice.

Development basis:

- **Decree 109/2018/ND-CP, TCVN 11041-2:2017:** National policies on organic agriculture set strict requirements for irrigation water quality.
- **Decision 1898/QD-BNN-TT and Decision 555/QD-BNN-TT:** This approach is consistent with the overall goals of the two decision which emphasize sustainable and high-quality rice production.
- **Section IV:** Field survey results indicate varying water quality across different areas within the province. An Giang has classified polders based on water quality, Ca Mau utilizes rainwater for organic rice, and Vinh Long shows farmers independently seeking cleaner water sources. This suggests that leveraging areas with readily available clean water is an effective approach. Furthermore, all provinces have plans to upgrade their irrigation systems, creating a basis for improving irrigation water quality. This approach also directly addresses the identified gap in water quality standards for organic rice.

Implementation process:

(i) Development of organic specific standard: Establish a technical working group comprising representatives from research institutions (e.g., Can Tho University, Southern Institute of Water Resources Science), government agencies (MARD, DONRE, provincial DARDs), and organic certification bodies. This group will analyze existing water quality standards (e.g., QCVN 08:2023/BTNMT) and international organic standards, conducting field research in the Mekong Delta to determine appropriate parameters and thresholds specific to organic rice production. The developed standard will address potential contaminants (pesticides, heavy metals, etc.) and other relevant factors (pH, salinity, etc.).

(ii) Survey and assessment: Assess water quality in various rice-growing areas within the province, identifying those with the cleanest water sources suitable for organic rice standards. Combine this with an analysis of the current irrigation system to identify points requiring upgrades and renovations.

(iii) Mapping and zoning: Map potential organic rice production areas based on water quality. Zone production areas according to priority levels, starting with areas possessing the cleanest water sources.

(iv) Infrastructure upgrade: Prioritize upgrading canal systems, sluices, and dams in potential organic rice areas, ensuring a clean, stable, and controllable water supply. Implement appropriate technical solutions for water treatment if necessary (e.g., filtration systems).

(v) Pilot Implementation: Implement organic rice farming on the selected potential organic rice production areas as a pilot project. Implement the newly developed water quality standards and monitor water quality regularly.

(vi) Expansion: Based on pilot project results, expand organic rice cultivation to other rice polders in the province (e.g., in An Giang province, expand organic rice cultivation to other one-crop polders, then progressively to two-crop and three-crop polders), adapting water management strategies as needed

Challenges:

- Difficulty in identifying and securing a stable source of clean water, especially during the dry season.
- Ensuring consistent water quality throughout the polder system, especially as it expands to rice polders receiving water from secondary and tertiary level canals, which provide water of lower quality than the first level canals.
- Investment costs for the modernisation of irrigation infrastructure.
- Initial costs of implementing and monitoring new water quality standards.
- Potential resistance from farmers accustomed to conventional practices.
- Requires close coordination between relevant departments and agencies.

Trade-offs:

- Focusing on areas with clean water sources may initially limit the area of organic rice production.
- High initial investment costs, but long-term economic and environmental benefits.

Feasibility:

- Technically feasible as water treatment technologies and irrigation system construction are readily available.
- Financially feasible with support from the government and international organizations.
- Socially feasible with community participation and public support.

5.1.2. Irrigation option 2: Utilizing high-quality, low-emission rice areas

Overview: In provinces participating in the high-quality, low-emission rice production, this strategy proposes leveraging these areas for organic rice development. The irrigation infrastructure in these areas has been upgraded, partially meeting the requirements for organic rice production and reducing initial investment costs. Based on the Design Proposal Report provided by Dong Thap province (see in section 2.3.3), the upgrades of irrigation infrastructures include:

- **Smart irrigation systems for pump stations and gates:** Automated gate control systems to raising and lowering gates based on irrigation needs (see Figure 10-1)integrated with smart controllers (see Figure 10-2), ultrasonic water level monitoring stations (see Figure 10-4), and real-time water quality monitoring stations (see Figure 10-5) to measuring salinity, water level, etc. are being implemented. These systems allow for precise water management, optimizing water use and minimizing the risk of contamination from external sources. Remote monitoring and control via mobile applications further enhance management efficiency. This directly supports the principle of separating water sources and creating dedicated irrigation zones for organic rice.

- **Upgraded sluice gates and cannals:** The project includes upgrading various sluice gate types (circular regulating gates D150, box regulating gates 1.0x1.3, and head-end drainage gates) and dredging main field cannals. These improvements enhance water delivery efficiency and control, supporting the establishment of dedicated irrigation zones and minimizing the potential for cross-contamination.
- **Field-level monitoring and pest control:** The deployment of dry-wet sensors (see Figure 10-6) for field-level water monitoring and smart insect traps with AI-powered pest identification and forecasting capabilities (see Figure 10-7) provides precise, real-time information for informed irrigation decisions and integrated pest management. This technology supports water-efficient practices like AWD and reduces reliance on synthetic pesticides, crucial for organic certification.
- **Smart field water intake gates:** Automated field water intake gates (see Figure 10-8), controllable via mobile applications, allow for precise water management within the designated organic rice areas, further supporting the separation of water sources and enabling targeted irrigation based on real-time field conditions.

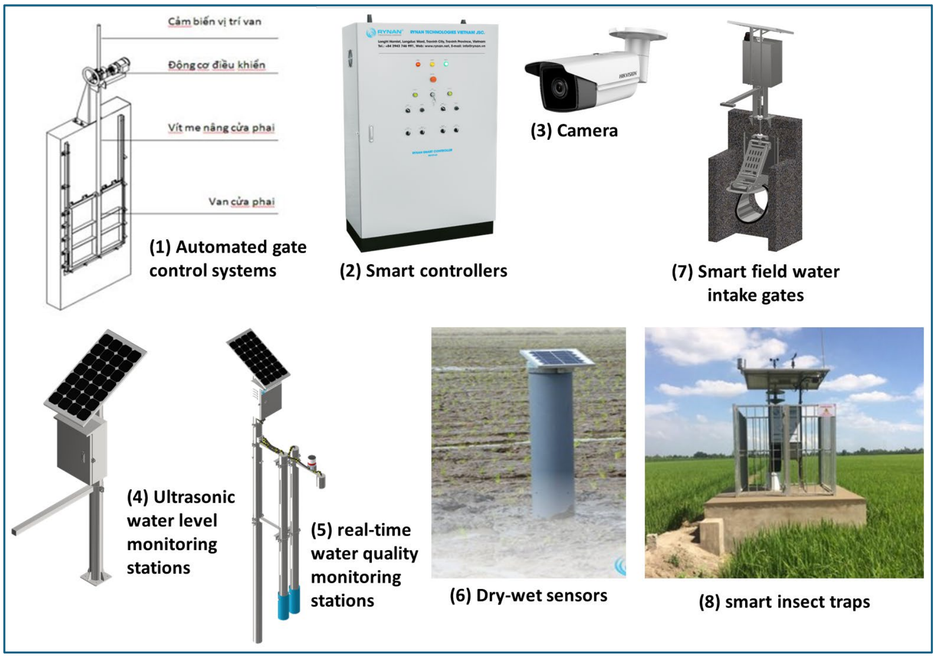

Figure 10. Irrigation infrastructure to be improved under quality rice project
Source: Design Proposal Report provided by Dong Thap province

Development basis:

- **Decision 1898/QD-BNN-TT, Decision 555/QD-BNN-TT:** Decisions on restructuring the rice industry aim towards sustainable rice production with reduced emissions, aligning with the objectives of organic rice production.

- **Decision 287/QD-TTg: This** strategy is supported by Decision 287/QD-TTg which promotes high-quality commercial agriculture and the application of science and technology.
- **Section II-2.3.3 and Section IV-4.2.1; 4.3.1:** This approach builds on existing initiatives such as the pilot project in Dong Thap's Thap Muoi district, which includes dedicated canals and advanced irrigation design. Dong Thap is implementing a pilot project called "Sustainable Development of 1 Million Hectares of High Quality, Low Emission Rice Specialisation Area Linked to Green Growth in the Mekong Delta by 2030". The irrigation infrastructure invested and upgraded under this project can be used for organic rice production.

Implementation process:

(i) Assessment: Identify high-quality rice production areas with upgraded irrigation infrastructure. Assess their suitability for organic rice cultivation, considering water quality, potential for cross-contamination, and farmer interest (see **Figure 11**)

(ii) Upgrade (if needed): Upgrade and supplement necessary components to fully meet the water quality requirements for organic rice *"by doing the survey of the current infrastructure"* (see **Figure 12**).

(iii) Conversion: Support farmers in transitioning from high-quality rice production to organic rice, including training on cultivation techniques, water management, and organic certification procedures.

(iv) Integration: To effectively integrate organic rice production into high quality rice areas and promote synergies, a crucial first step is to identify fields suitable for organic conversion. This requires an assessment of canal water quality, categorising canals into different levels based on their suitability for organic irrigation. Once these grades are established, potential areas for organic rice production can be identified based on their access to appropriately graded canal water. Integrating organic production into existing high-quality rice areas may also involve establishing buffer zones where feasible, or implementing staggered irrigation schedules to minimise the risk of cross-contamination between conventional and organic fields.

(v) Monitoring and evaluation: Monitor and evaluate the effectiveness of the conversion, adjusting the strategy as needed.

Challenges:

- Adjustments in production and management processes are required to meet organic standards.
- Ensuring market outlets for organic rice products.

Trade-offs:

- Additional investment may be needed to upgrade infrastructure, but it will be lower than building entirely new systems.
- Farmers need time to adapt to organic rice production processes.

Feasibility:

- Technically feasible, as the irrigation infrastructure has been partially upgraded.
- Financially feasible, as existing investments can be leveraged.
- Socially feasible with support and encouragement from the government and relevant organizations.

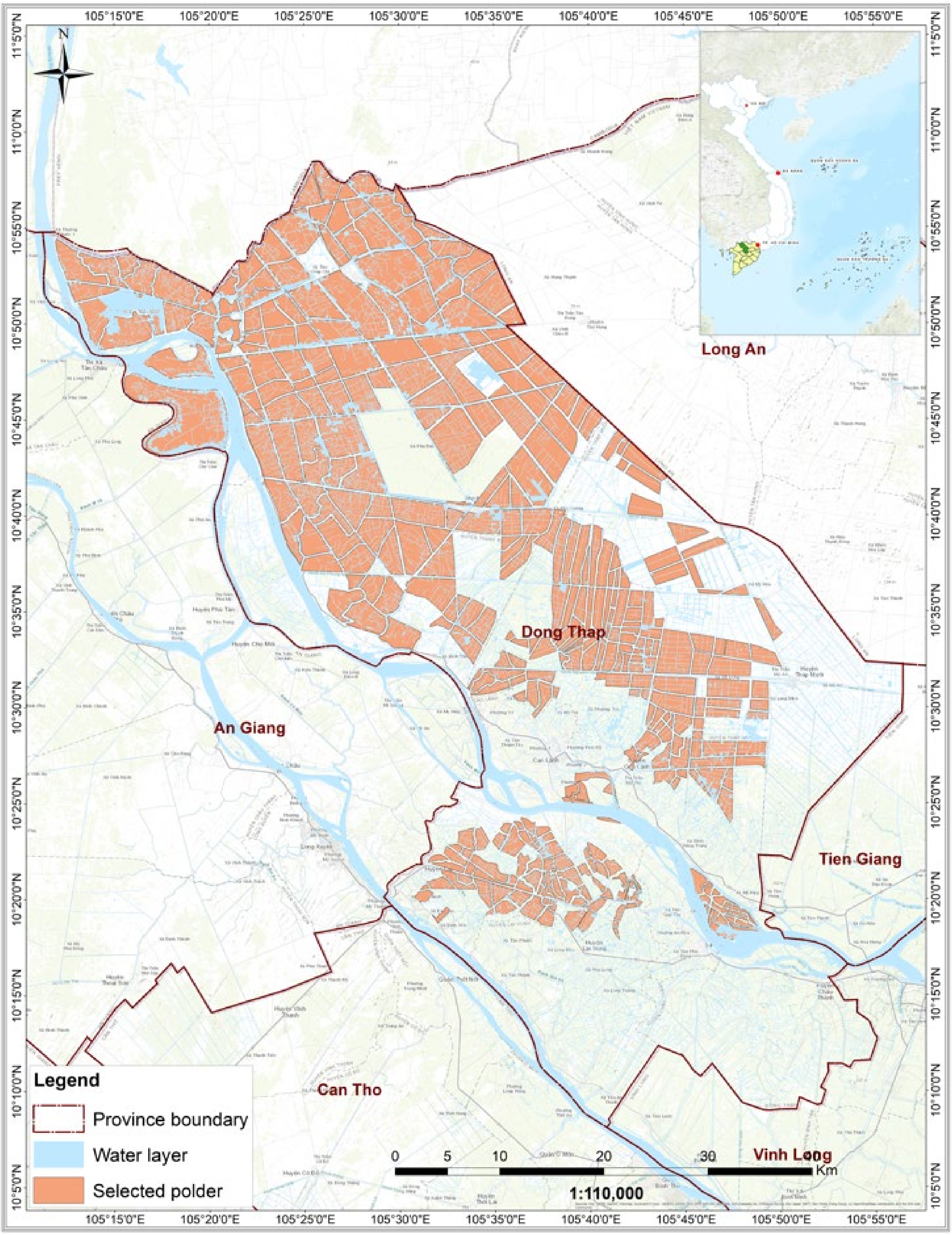

Figure 11. Map of selected polders for high-quality rice project in Dong Thap province

Data sources: Polder data and water layer of Dong Thap province provided by Dong Thap DARD and IC; Province boundary data taken from Vietnamese National Spatial Database; Base map layer taken from ESRI

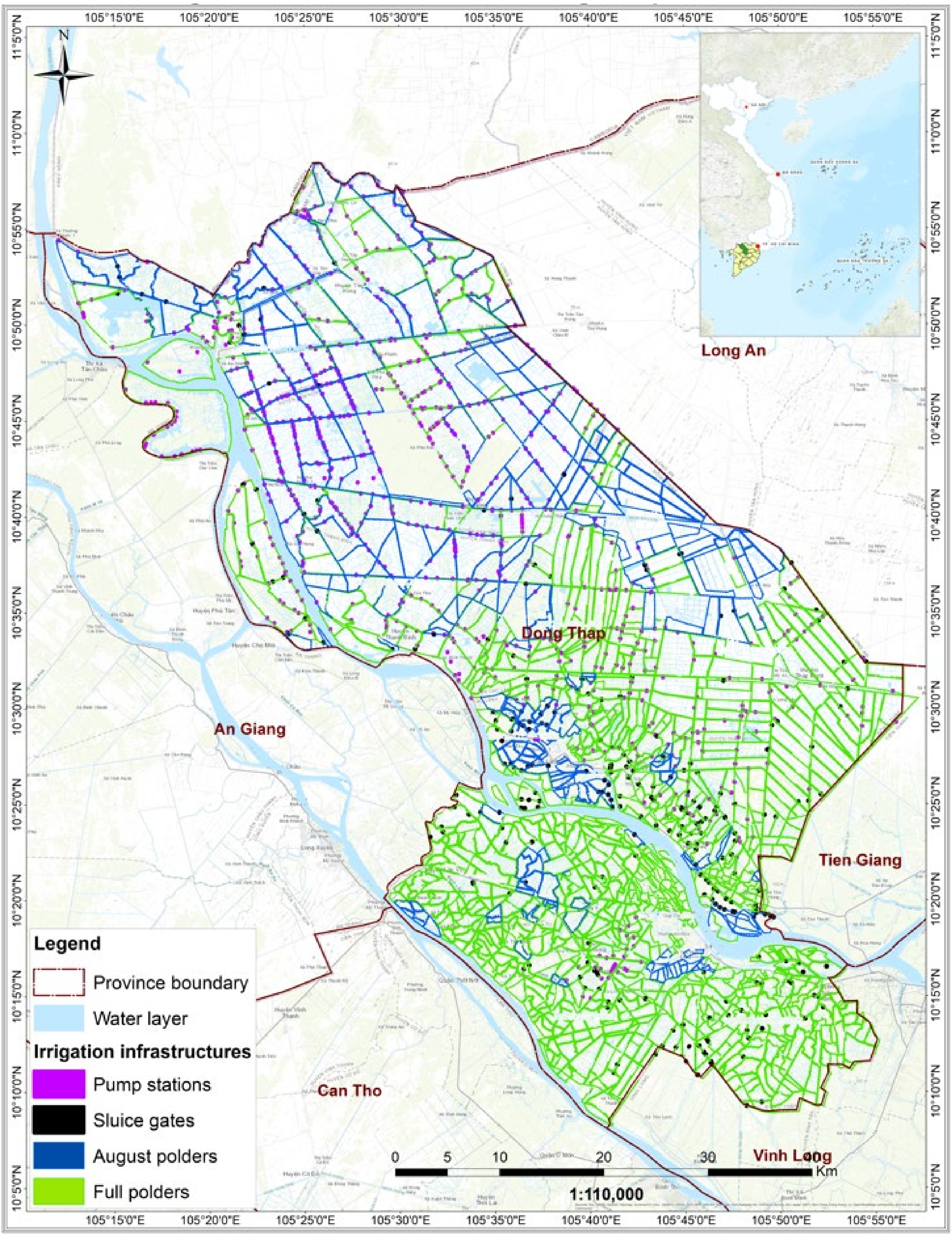

Figure 12. Map of Irrigation Infrastructures in Dong Thap province

Data sources: Irrigation infrastructures data of Dong Thap province provided by Dong Thap DARD and IC; Province boundary data taken from Vietnamese National Spatial Database; Base map layer taken from ESRI

5.1.3. Irrigation option 3: Farmer training and support:

Overview: This strategy focuses on enhancing farmers' awareness and skills in efficient water management, organic rice cultivation techniques, and organic certification regulations. This is a key factor in ensuring the success of both options 1.1 and 1.2.

Development basis:

- **Decree 109/2018/ND-CP**: This approach is supported by Decree 109/2018/ND-CP which emphasizes training and support for organic producers. It also aligns with the recommendations for capacity building and training in the Decree
- **Section IV:** Field survey results indicate that many farmers lack knowledge and experience in organic rice production, especially in water management and certification procedures. For example, farmers in Vinh Long, Tra Vinh, and Ca Mau are not fully aware of the water quality standards for organic rice.

Implementation process:

(i) **Needs assessment:** Survey and assess farmers' training needs regarding water management, organic rice cultivation techniques, and certification procedures.

(ii) **Curriculum development:** A farmer-focused training program will be developed and implemented, tailored to their specific needs and existing knowledge. The curriculum will combine theoretical instruction with hands-on practical experience, supplemented by field trips to successful organic rice farms. This program will be developed and delivered in collaboration with agricultural extension centers, universities, research institutes, NGOs, and relevant experts. Specific training topics will include:

- **Water management:** Water-saving irrigation techniques (such as AWD), saline and flood water management techniques, and polluted water treatment techniques.
- **Organic rice cultivation techniques:** Selection of organic rice varieties, organic soil and nutrient management, organic pest and disease control, and organic rice harvesting and storage.
- **Organic certification procedures**: Organic standards, registration and inspection procedures, and certification issuance procedures.

(iii) **Training implementation:** Training will be delivered through a multi-pronged approach, combining local, in-person training courses, workshops, and individual sessions with online resources such as instructional videos and technical documents. To provide ongoing support, local technical assistance groups will be established to help farmers apply their new knowledge in the field. Finally, a broad range of media outlets (including newspapers, radio, television, and social media) will be used to share information and promote best practices in organic rice production.

(iv) **Ongoing support:** Provide ongoing technical assistance and mentorship to farmers, addressing their specific challenges and questions. Establish farmer networks for knowledge sharing and peer learning.

(v) **Evaluation and improvement:** Evaluate the effectiveness of the training program, gather feedback from farmers, and adjust the program accordingly.

Challenges:

- Ensuring training quality and accessibility for farmers, especially those in remote areas.

- Changing traditional farming practices of farmers.
- Costs and resources for training.

Trade-offs: Investment of time and resources for training is required, but in return, farmers' capacity is enhanced, contributing to the sustainable development of organic rice production.

Feasibility: Technically and socially feasible. Financially feasible with support from local authorities, national target programs, and international organizations.

5.1.4. Integrated Irrigation Strategy for Organic Rice Production

This integrated strategy combines the above options into a comprehensive approach:

Phase 1: Foundation – Water quality standards and pilot implementation:

- **Objective:** Establish water quality standards and initiate pilot projects in one-crop polders.
- **Activities:**
  - **(i) Form technical working group**: Assemble a group with representatives from research institutions, government agencies, and organic certification bodies.
  - **(ii) Develop water quality standards:** Conduct literature reviews, field studies, and stakeholder consultations to define water quality parameters and thresholds specific to organic rice in the Mekong Delta. Consider existing standards (QCVN 08:2023/BTNMT) and international benchmarks.
  - **(iii) Select pilot polders:** Identify suitable rice polders based on water quality, existing infrastructure, and farmer willingness.
  - **(iv) Implement pilot projects:** Establish organic rice cultivation in selected polders, implementing the new water quality standards and monitoring protocols. Provide initial farmer training on organic irrigation practices and water quality management.
  - **(v) Develop monitoring framework:** Define key indicators (water quality parameters, rice yields, farmer adoption rates, environmental impacts) and data collection methods. Establish baseline data in pilot polders.

Phase 2: Expansion and infrastructure adaptation:

- **Objective:** Expand organic rice cultivation to other polders and adapt existing high-quality rice infrastructure.
- **Activities:**
  - **(i) Evaluate pilot projects:** Assess the performance of pilot projects based on the established monitoring framework. Identify successes, challenges, and lessons learned.
  - **(ii) Refine water quality standards and management practices:** Adjust water quality standards and irrigation practices based on pilot project results. Develop specific guidelines for managing water quality in different polder types (one-crop, two-crop, three-crop).
  - **(iii) Expand to other polders:** Gradually expand organic rice cultivation to other rice polders in the province.
  - **(iv) Assess high-quality rice infrastructure:** Identify high-quality rice production areas in other provinces with upgraded irrigation infrastructure. Evaluate their suitability for organic rice production.

(v) **Adapt existing infrastructure:** Modify water delivery and drainage systems in selected high-quality rice areas to meet the specific needs of organic rice production. Prioritize areas with the cleanest water sources and potential for dedicated organic systems.

Phase 3: Scaling up and knowledge sharing:

- **Objective:** Scale up organic rice production across the Mekong Delta and promote widespread adoption of best practices.
- **Activities:**
  - **(i) Intensify farmer training and support:** Expand training programs to cover all participating provinces, focusing on organic irrigation techniques, water quality management, and sustainable water use. Provide ongoing technical assistance and mentorship to farmers.
  - **(ii) Promote inter-provincial collaboration:** Organize workshops, exchange visits, and online platforms to facilitate knowledge sharing and collaboration between provinces. Disseminate best practices and lessons learned from pilot projects and research initiatives.
  - **(iii) Develop market linkages:** Support the development of market linkages for organic rice, connecting farmers with buyers and promoting the benefits of organic products to consumers.
  - **(iv) Refine monitoring and evaluation framework:** Continuously monitor and evaluate the effectiveness of the integrated strategy, collecting data on water quality, rice yields, farmer adoption rates, and environmental impacts. Use this data to adapt and improve the strategy over time.

Phase 4: Long-term sustainability:

- **Objective:** To establish a resilient and adaptable system that can thrive despite long-term challenges.
- **Activities:**
  - **(i) Continuous improvement:** Regularly review and update water quality standards, irrigation practices, and training programs based on ongoing research and farmer feedback.
  - **(ii) Adaptive management:** Adapt the strategy to changing environmental conditions and emerging challenges, such as climate change and water scarcity.
  - **(iii) Community ownership:** Promote community-based water management and empower local stakeholders to take ownership of organic rice irrigation systems.

5.2. Inter-provincial Scale and Mekong Delta Scale

The potential irrigation strategies outlined for the inter-provincial and Mekong Delta scales have not yet been presented to local stakeholders for feedback. As stakeholder input is crucial for refining and validating these strategies, **Section 5.2** for these two scales will remain preliminary until after the planned Mekong Delta field trip in March 2025. During this trip, the potential strategies will be presented to local stakeholders, allowing for valuable discussion, feedback integration and identification of potential challenges and opportunities. Following the field trip in March 2025, this section will be updated to reflect the lessons learned from the stakeholder consultations and to ensure that the proposed strategies are contextually appropriate, locally supported and ultimately more effective.

VI. Conclusion

This report provides a comprehensive analysis of the irrigation strategies that are critical to the successful and sustainable expansion of organic rice production in the Mekong Delta, Vietnam. Through an in-depth review of existing national and regional policies, combined with valuable on-site insights gathered during a field trip in November 2024, we have identified a complex interplay of factors influencing irrigation practices and their impact on organic rice production. The proposed strategies, tailored to the specific contexts at the provincial, inter-provincial and Mekong Delta levels, offer a multi-faceted approach to ensuring access to clean, uncontaminated water, a cornerstone of organic agriculture.

The field trip revealed a marked contrast between the goals set by national policies to promote sustainable agriculture, and the practical realities faced by farmers in the field. While policies such as Decree 109/2018/ND-CP and TCVN 11041-2:2017 provide a framework for organic agriculture, their implementation, particularly with regard to irrigation for organic rice, remains fragmented and often inadequate. Many farmers, especially those in the process of transitioning to organic practices, lack awareness of the specific water quality requirements and management practices needed for organic certification and optimal yields. This knowledge gap, combined with the existing challenges of cross-contamination from conventional agriculture and the looming threat of climate change, underlines the urgency of targeted interventions and a more integrated approach to irrigation management.

Comments from local authorities on potential irrigation strategies, combined with current policies and plans collected from the provinces during the field trip, were used to refine the potential irrigation strategies into proposed optimal strategies. These optimal strategies for sustainable organic rice production in the Mekong Delta involve a multi-stage approach. Prioritising areas with access to clean water sources is crucial, along with infrastructure upgrades and strict water quality standards to minimise contamination risks and support organic certification. Leveraging the availability of future high-quality, low-emission rice production areas offers a cost-effective way to expand organic farming. Farmer capacity building through training and support is essential for successful adoption of water-efficient and organic farming techniques, as well as ensuring understanding of organic certification requirements.

These proposed optimal strategies will be implemented through a phased approach, starting with pilot projects in areas with readily available clean water sources and gradually expanding to other regions as experience and knowledge is gained. This phased implementation allows for adaptive management, incorporating lessons learned and ensuring that strategies are tailored to the specific needs and challenges of each locality. In addition, integrating climate change projections into long-term water management plans is critical to building resilience and ensuring the sustainability of organic rice production in the face of a changing climate.

The planned field trip in March 2025 will be instrumental in gathering further stakeholder input, refining these strategies and ensuring their long-term effectiveness. By encouraging collaboration between farmers, local authorities, researchers and policymakers, a sustainable and thriving organic rice sector can be established in the Mekong Delta, contributing to both economic prosperity and environmental health. This report provides a foundation for achieving these goals, offering a framework for action and highlighting the critical role of irrigation in shaping the future of organic rice.

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Appendices

Appendix 1: Irrigation Questionnaire Form for Local Authorities

United Nations University, Institute for Environment and Human-Security (UNU-EHS)

OrganoRice Project
Organic rice production in the Mekong Delta: improving product safety, environmental sustainability, and livelihoods through better land and water management on multiple scales

Questionnaire on Irrigation Strategy in Organic Rice Production for Department of Agriculture and Rural Development and Irrigation Centers

Section 0: Interviewee Information

Name (Optional): --

Position/Title: --

Department/Center: --

Province: --

Date of Interview: --

Contact Information: --

(Optional, for follow-up only)

Section 1: Current Status

Introduction: This section aims to understand the current landscape of organic rice farming and irrigation management in your province.

1. What are the typical yields and cropping intensities for both conventional and organic rice farming? Please provide estimates or ranges if precise data is unavailable.)

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2. What is the overall strategy for managing water resources in the province?

----

3. Could you describe the technical characteristics and operational procedures for managing of the main irrigation systems used for organic rice production in your province (e.g., canal network, pumping stations, water sources)?

----

4. What are the typical water requirements for organic rice farming in this region?

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5. How is water availability and distribution managed during periods of water scarcity, specifically for organic rice farmers?

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6. What are the main irrigation challenges faced by organic rice farmers in your province (e.g., cross-contamination, water scarcity, infrastructure limitations)?

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7. How is the existing irrigation infrastructure (dikes, canals, sluice gates) managed in your province? What are the roles of different entities (e.g., irrigation companies, water user associations)?

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8. What water quality monitoring efforts are currently in place? What standards and regulations are relevant to organic rice irrigation? Please share any water quality reports if available.

---

9. Are there any regional cooperation initiatives related to irrigation management?
   If yes, please describe them briefly.
   If no, what are the potential conflicts or challenges in coordinating irrigation across provinces?

Section 2: Irrigation Strategies & Zoning

Introduction: This section explores different irrigation strategies and the potential for zoning to support organic rice production.

1. What are the most common irrigation practices used by organic rice farmers in your province? What are their perceived advantages and disadvantages?

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2. What is the technical feasibility and effectiveness of different cross-contamination prevention strategies (dedicated systems, buffer zones, temporal separation)? Explain the technical aspects.

---

3. Does your province implement irrigation zoning specifically for organic rice production?
   If yes, what are the suitable criteria for defining these zones (hydrological, land-use based, participatory)?
   If no, what are the perceived barriers or challenges to implementing irrigation zoning for organic rice production in your province? (e.g., technical feasibility, cost, lack of political will, farmer resistance)

---

4. How can existing delta-scale irrigation schemes be adapted to accommodate the specific needs of organic rice production?

---

5. Are there any specific infrastructure upgrades or modifications are needed to enhance the resilience of irrigation systems serving organic rice production to climate change impacts? If yes, please describe it.

Section 3: Water and Soil Management

Introduction: This section explores how the province manages water and soil for organic rice production.

1. Do you use any water storage or rainwater harvesting techniques? If so, what are they?

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2. Are you familiar with water-efficient irrigation techniques?
   If yes, how do you use them?
   If none are used, what are the technical barriers? Are there any solutions you are currently implementing or planning to apply in your province?

---

3. What regulations/policies do you have in place to control the discharge of fertilizers or soil amendments used in organic rice production into the irrigation system in your province? Are there any challenges?

Section 4: Future Considerations and Technological Advancements

Introduction: This section looks ahead to the future of organic rice irrigation, considering climate change and new technologies

1. What are the potential impacts of climate change on water resources and organic rice production in your province? What adaptation strategies should be considered?

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2. What are the opportunities and challenges of adopting emerging technologies (e.g., remote sensing, precision irrigation) for organic rice irrigation management?

Other information provided by the interviewee:

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Appendix 2: Irrigation Questionnaire Form for Organic Cooperative Managers

Interview for Organic Cooperative Manager (Tool 1A)

Interview No.: ____________________ Interview Date: ______________

Interviewer's Name: ______________ Interviewer's email: ________________

Province: __________________

District: ____________________

Commune: ____________________

Personal Information

1. **Interviewee**

a. Name: ____

b. Gender: ☐ Male ☐ Female

c. Currently farming ☐ Organic rice ☐ Transition to Organic rice

d. Education level:

☐ No formal education

☐ Primary/ elementary school

☐ Secondary/ high school

☐ Post-secondary education (university, vocational/ technical training etc.)

e. Main responsibilities: ____

Current Farm Management

2. ***Describe the structure of the cooperative:***

3. ***Who are the main decision-makers for the farm?***

4. ***To what degree are farmers involved in decision-making?***

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5. ***What irrigation methods do you currently use? Would you like to change it? If yes, what is the method you would like to change to?***

6. ***Do you know/be informed about the irrigation requirements for ORF? If YES, what are the requirements? What sources give you the information?***

7. **Since converting to organic agriculture, what changes in water quality have you observed?**

☐	☐	☐
+	+/-	-
Improved	Remained the same	Worsened

7.1 ***Describe the changes observed and what you think has caused an increase/ decrease (have organic practices influenced this change?):***

8. **Have you experienced any problems with water quality or contamination from neighboring farms? If YES: How have you addressed these issues?**

9. **Do you know/be informed about the water quality requirements for ORF? If YES, what are the requirements? What sources give you the information?**

10. ***How do you monitor your water quality during organic rice farming to ensure the water quality meets the requirements of organic standars?***

11. ***Do you use any water storage or rainwater harvesting techniques? If YES, what is the method? If NO, how can you deal with water scarcity issues (if any)?***

12. **Do you use any methods to use water more efficiently? If YES, what is the method(s)? If NO, why do you not use it, are there any challenges?**

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Appendix 3: Irrigation Questionnaire Form for Organic Farmers

Interview for Certified Organic Farmers (Tool 1B)

Interview No.: ____________________ Interview Date: ________________

Interviewer's Name: _______________ Interviewer's email: _________________

Province: ____________________

District: ______________________

Commune: ______________________

Personal Farmer Information

1. **Interviewee**

a. Name: ____

b. Age: ____

c. Gender: ☐ Male ☐ Female

d. Currently farming ☐ Organic rice ☐ Transition to Organic rice

e. Farmer's highest education level:

☐ No formal education

☐ Primary/ elementary school

☐ Secondary/ high school

☐ Post-secondary education (university, vocational/ technical training etc.)

f. Occupation, Role, Responsibilities

☐ Farm owner

☐ Farm worker

g Who is the main decision-maker for the farm? ____________________________

h. Size of farm (ha): ______________

i. Number of years practicing organic farming on your farm: ______________________

k. Are you part of a cooperative?: ☐ Yes ☐ No

IRRIGATION AND WATER QUALITY

9. ***What irrigation methods do you currently use? Would you like to change it? If yes, what is the method you would like to change to?***

10. ***Do you know/be informed about the irrigation requirements for ORF? If YES, what are the requirements? What sources give you the information?***

11. ***(*) Since converting to organic agriculture, what changes in water quality have you observed?***

☐	☐	☐
+	+/-	-
Improved	Remained the same	Worsened

10.1 ***Describe the changes observed and what you think has caused an improvement/ worsening (have organic practices influenced this change?)***

12. ***Have you experienced any problems with water quality or contamination from neighboring farms? If YES: How have you addressed these issues?***

13. ***Do you know/be informed about the water quality requirements for ORF? If YES, what are the requirements? What sources give you the information?***

14. ***How do you monitor your water quality during organic rice farming to ensure the water quality meets the requirements of organic standars?***

15. ***Do you use any water storage or rainwater harvesting techniques? If YES, what is the method? If NO, how can you deal with water scarcity issues (if any)?***

16. **Do you use any methods to use water more efficiently? If YES, what is the method(s)? If NO, why do you not use it, are there any challenges?**