APPLYING SWOT ANALYSIS TO A ONE-MILLION-HECTARE RICE PROJECT AIMED AT REDUCING GREENHOUSE GAS EMISSIONS

Phuong Nguyen Vu Hoang, Hien Nguyen Thu, Ba Le Huy*

Ho Chi Minh City University of Industry and Trade (HUIT)

*Email: *lhuyba@gmail.com*

Received: 29 November 2024; Revised: 31 December 2024; Accepted: 17 January 2025

ABSTRACT

The research has clearly identified the strengths, weaknesses, opportunities, and threats (SWOT) for the implementation of the One Million Hectare Rice Project in the next phase. In which, the project offers a significant opportunity for the agricultural sector to restructure the rice production industry in the context of globalization, aiming for green and clean agricultural products with reduced greenhouse gas emissions. The implementation of the project requires a strong and synchronized approach with multiple strategic solutions, and particularly, the support of domestic and international stakeholders. The project will create new momentum for the development of Vietnam's rice industry, fostering a model that adapts to climate change and promotes sustainable development through suitable methods in the context of local conditions.

Keywords: Rice cultivation model, one-million-hectare rice project, emission reduction, greenhouse gases, SWOT (Strengths, Weaknesses, Opportunities, Threats).

1. INTRODUCTION

Greenhouse gas (GHG) emissions are one of the main causes of climate change. Its consequences include global average temperature rise, sea level rise, soil salinization, and adverse effects on the quality of freshwater resources used for domestic, agricultural, industrial, and service purposes. According to a report by the World Resources Institute [1], the global GHG emissions structure by sector is ranked from lowest to highest as follows: Waste < Industrial processes < Agriculture < Energy. Statistics indicate that GHG emissions from agriculture rank second in proportion compared to other sectors.

In Vietnam, the GHG emissions structure follows a similar pattern, as detailed below:

Table 1. GHG emissions by sector in 1994, 2000, 2010, and 2013 ([1])
(Unit: million tons of CO_2 equivalent)

Sector	1994	2000	2010	2013
Energy	25.6	52.8	146.2	151.4
Industrial processes	3.8	10.0	21.7	31.8
Agriculture	52.4	65.1	87.6	89.4
Land use	19.4	15.1	-20.7	-34.2

Sector	1994	2000	2010	2013
Waste	2.6	7.9	17.9	20.7
Total	**103.8**	**150.9**	**252.6**	**259.0**

This trend is expected to continue as forecasted up to 2030. Tables 1 and 2 show that GHG emissions in agriculture account for the second-largest proportion and have increased compared to other sectors.

Table 2. GHG emissions by sector in 2020 and projections for 2030 [1]
(Unit: million tons of CO_2 equivalent)

Sector	2020	2030 (Projected)
Energy	381.1	648.5
Agriculture	100.8	109.3
Land use	-42.5	-45.3
Waste	26.6	48
Total	**466.0**	**760.5**

According to a report by the Ministry of Agriculture and Rural Development (MARD), Vietnam's agricultural sector contributes approximately 30% of the country's total GHG emissions. GHG emissions in agriculture are primarily concentrated in three main areas: rice cultivation emits 49.7 million tons of CO_2 equivalent (50%); livestock farming emits 18.5 million tons of CO_2 equivalent (19%); and soil management and fertilizer use emit 13.2 million tons of CO_2 equivalent (13%) [2].

More specifically, other studies indicate that the main reasons for increasing GHG emissions in Vietnam's crop production sector include unsustainable agricultural intensification, high fertilizer application rates, inefficient water use for irrigation, improper management of rice residues such as straw and husks, and inefficient energy use in farming activities [3, 4].

Currently, GHG emission reduction is one of the issues receiving global attention, especially in the context of climate change impacting countries worldwide, including Vietnam. Reducing emissions in agricultural production is also a key component of the National Strategy on Climate Change to 2050, approved by the Prime Minister under Decision No. 896/QĐ-TTg dated July 26, 2022. This is also the reason why MARD and local authorities are promoting the implementation of the project “Sustainable development of 1 million hectares of high-quality, low-emission rice associated with green growth in the Mekong Delta region by 2030.”

The use of the SWOT analysis tool is widely applied in macro-level development management (nation, region, industry) or micro-level business management (companies, projects, individuals). The tool helps to identify strengths, weaknesses, opportunities, and threats in evaluating the potential of a project.

Furthermore, in order to create new momentum for the development of an efficient, sustainable rice industry with reduced emissions, the implementation of the Project will provide many opportunities to increase the income of participants in the rice value chain by producing rice responsibly towards the environment and its ecosystems. However, to ensure that both environmental goals are met and the income of the participants in the rice value chain, particularly the income of rice farmers, is increased, it is essential for the Project to be successfully implemented as expected. From the above issues, this research aims to assess the potential for reducing GHG emissions using the SWOT tool for the "One Million Hectare Rice" project.

2. SCOPE AND RESEARCH METHODS

2.1. Research scope

The research area includes regions specializing in high-quality rice cultivation within the "One Million Hectare Rice" project. The "Sustainable Development of One Million Hectares of High-Quality, Low-Emission Rice Linked to Green Growth in the Mekong Delta by 2030" project was approved by the Prime Minister in Decision No. 1490/QĐ-TTg dated November 27, 2023. To contribute to achieving the goals of the project, the Crop Production Department issued the Technical Process for producing high-quality, low-emission rice in the Mekong Delta (One Million Hectare Process).

Vietnam is a country with a relatively low total GHG emission level compared to the world's average. Specifically, in 2014, Vietnam emitted about 284 million tons of CO_2 equivalent. Of this, the energy sector was the largest emitter with 171.62 million tons of CO_2 equivalent, agriculture ranked second with 89.75 million tons of CO_2 equivalent, and industry emitted 38.61 million tons of CO_2 equivalent. The land use, land-use change, and forestry sector did not contribute emissions but instead absorbed 37.54 million tons of CO_2 equivalent [5, 6].

Although Vietnam's per capita emissions are lower than those of China, South Korea, and Thailand, it is increasing at a faster rate compared to these countries. Specifically, per capita emissions have increased nearly six-fold, from 0.3 tons of CO_2 equivalent in 1990 to 1.71 tons of CO_2 equivalent in 2010, while China increased three times, South Korea increased 2.5 times, and Thailand increased two times [7, 8]. In its effort to reduce GHG emissions, Vietnam has submitted its updated Nationally Determined Contributions (NDC) to the UNFCCC. Accordingly, with domestic resources, by 2030, Vietnam aims to reduce 9% of its total GHG emissions compared to the Business-As-Usual (BAU) scenario, equivalent to 83.9 million tons of CO_2 equivalent (NDC 2020). According to the NDC 2022, this 9% contribution could increase to 27% reduction in GHG emissions compared to the national BAU scenario (equivalent to 250.8 million tons of CO_2 equivalent) under the supports from international cooperation through bilateral, multilateral mechanisms, and the Paris Agreement on climate change [9].

2.2. Research methods

2.2.1. Literature review and evaluation

This research comprehensively synthesizes relevant materials (information, data, concepts, theories, and principles) related to the issue of concern from various sources such as statistical reports, scientific papers, and other resources.

2.2.2. SWOT tool [10]

The SWOT analysis model was developed by Albert Humphrey in the 1960s-1970s. SWOT analysis (Figure 1) is an acronym for four words:

- Strengths
- Weaknesses

- Opportunities
- Threats

In this research, the SWOT tool is applied to better understand the strengths, weaknesses, opportunities, and threats of the project. Applying the SWOT analysis model will include the following main steps:

1. Identifying strengths, weaknesses, opportunities, and threats
2. Collecting and analyzing data to assess the application of the different categories
3. Analyzing different perspectives and the potential for application in Vietnam's context

Figure 1. SWOT Tool

2.2.3. Relevant legal documents for the research

- Decision No. 1490/QĐ-TTg signed on November 27, 2023, approving the project "Sustainable Development of One Million Hectares of High-Quality, Low-Emission Rice Linked to Green Growth in the Mekong Delta by 2030."
- Decision No. 896/QĐ-TTg signed on July 26, 2022, regarding the National Strategy on Climate Change for the period up to 2050.
- Resolution No. 120/NQ-CP signed on October 17, 2017, by the Government on the sustainable development of the Mekong Delta in adaptation to climate change.
- Decision No. 150/QĐ-TTg dated January 28, 2022, by the Prime Minister on the approval of the Strategy for Sustainable Agricultural and Rural Development for the period 2021-2030, with a vision to 2050.
- Decision No. 287/QĐ-TTg by the Prime Minister on the approval of the Mekong Delta Region Planning for the period 2021-2030, with a vision to 2050.
- Decision No. 942/QĐ-TTg dated August 5, 2022, by the Prime Minister on the "Commitment to Global Methane Emission Reduction," with the goal of reducing methane emissions in Vietnam by 2030.

3. RESULTS AND DISCUSSION

3.1. Results

Table 3 summarizes the SWOT analysis for the Project, with detail explaination for each criteria is described accordingly.

Table 3. SWOT Analysis Results

Criteria	Details
Strengths	- High and stable rice productivity
	- Rice export positions Vietnam among the leading countries
Weaknesses	- Farmers' income from rice cultivation is still low and unstable
	- Low rice product prices
	- Inconsistent rice quality
	- The connection between farmers is not sustainable
	- High GHG emissions
Opportunities	- Creation of high-quality specialized cultivation areas with the potential to reduce GHG emissions
	- Improved livelihoods for farmers
	- Environmental protection
	- Adaptation to climate change
	- Achieving national sustainable development goals
Threats	- High financial investment required
	- Large-scale area needed
	- Necessary collaboration between stakeholders in the project (government, cooperatives, banks, international donors, etc.)

3.1.1. Analysis of the "Strengths" criteria

The food production sector plays an important role in stabilizing society and contributing to the economic development of Vietnam. The Mekong Delta contributes 50% of the country's rice production and 90% of rice exports. In recent years, Vietnam has produced about 43-45 million tons of rice annually, equivalent to 26-28 million tons of rice. Vietnam's rice exports have consistently ranked among the top in the world, with 5-7 million tons per year and a value exceeding 2 billion USD (statistical data from 2016-2022) [4].

In addition, the Mekong Delta is Vietnam's main rice-growing region, with a natural area of 4.092 million hectares, of which 2.575 million hectares are used for agricultural production, accounting for 62.9% of the total natural area of the region. The rice production in the region has remained stable at around 24-25 million tons in recent years, contributing over 50% of the national rice production and exporting more than 90% of the country's rice exports [3].

3.1.2. Analysis of the "Weaknesses" criteria

Currently, the income of farmers is the lowest in the agricultural sector. On average, rice yields in the Mekong Delta reach 5-7 tons per hectare per season, and farmers typically cultivate 2-3 crops per year. The rice price fluctuates between 6,000 and 8,000 VND per kilogram. Rice farmers who own land can achieve a profit of around 40% after deducting production costs. However, if they have to rent land, the profit is reduced to around 20-30% [3]. On average, a rice farming household in the Mekong Delta has 1.24 hectares of land (as per 2020 statistics). A household cultivating 3 rice crops can only earn approximately 40-60 million VND annually. This income is hardly sufficient to cover the expenses for a four-person rice farming household. Therefore, if rice prices are unstable, combined with low yields during unfavorable seasons, rice farmers in the Mekong Delta are easily prone to debt and an uncertain livelihood.

According to a study by Dao The Anh [11], one of the reasons for the low profits in rice farming is the high production costs, due to the excessive use of seeds, fertilizers, and pesticides. According to 2022 statistics, although farmers have reduced the amount of rice seed sown compared to 10 years ago, the seed rate in the Mekong Delta still averages 100-150 kg per hectare. The excessive use of seeds, fertilizers, and pesticides not only increases the cost of rice production but also causes environmental pollution. Post-harvest losses reach up to 10%, much higher than Thailand (4.2%).

The quality of Vietnamese rice is inconsistent, which is a weakness in the international market. This inconsistency is due to the low quality of rice seeds, insufficient post-harvest storage, and processing. Although the percentage of farmers using certified rice seeds has rapidly increased over the past 10 years to over 75%, there are still limitations in the management of rice seeds on the market, leading to inconsistent seed quality. Rice drying, storage, and preservation remain significant weaknesses in the Mekong Delta compared to other rice-exporting countries in the region. Additionally, small-scale production is another reason why Vietnamese rice quality is inconsistent.

Although the number of rice farmers in Vietnam is large, the scale of production is still small and spontaneous. The connection between farmers and rice enterprises faces many difficulties. This is because enterprises have to manage a large number of farmers, which increases management costs and reduces the profits for all parties in the value chain. Recently, many cooperatives have been formed to strengthen the linkage among farmers, enabling larger-scale production and reducing the management burden on enterprises. However, the low level of management in these cooperatives still hinders the connections between farmers and enterprises.

Additionally, rice farming is the largest emitter of greenhouse gases in agriculture, accounting for about 50.31% of total emissions (equivalent to nearly 50 million tons of CO_2 per year), with over 75% of methane emissions from the agriculture sector [12]. Due to the nature of rice farming, with fields often submerged in water, organic matter in the soil decomposes anaerobically, releasing CH_4. Furthermore, continuous cultivation, the use of excessive seed, and overuse of chemical fertilizers and pesticides, along with the maintenance of highwater levels, contribute to inefficiency in rice farming, low fertilizer use efficiency, and increased greenhouse gas emissions. For fertilizers, 2019 data shows that on average, more than 0.4 tons of fertilizer is used per hectare, ten times more than 60 years ago. Excessive use of nitrogen-based fertilizers also increases nitrous oxide (N_2O) emissions. In terms of global warming potential, 1 kg of methane is equivalent to 28 kg of CO_2, and 1 kg of N_2O is equivalent to 256 kg of CO_2. Furthermore, post-harvest losses also negatively impact climate change, as the emissions from post-harvest losses account for more than 10% of total emissions from rice production [13].

3.1.3. Analysis of the "Opportunities" criteria

The overall goal of the project is to establish one million hectares of high-quality, low-emission rice farming areas linked to a restructured production system according to value chains. This will apply sustainable farming practices to increase value, ensure the sustainable development of the rice sector, improve production efficiency, income, and livelihoods for rice farmers, protect the environment, adapt to climate change, and reduce greenhouse gas emissions, contributing to Vietnam's international commitments.

The specific goal by 2030 is to achieve one million hectares of high-quality, low-emission rice farming areas. This includes reducing rice seed usage to below 70 kg per hectare, cutting chemical fertilizer and pesticide use by 30%, reducing water usage by 20% compared to traditional methods, and ensuring that 100% of the area applies at least one sustainable farming practice such as 1P5G, SRP (sustainable rice farming models), AWD (Alternate Wetting and Drying), etc., with certified agricultural practices and regional codes.

Regarding production organization, the project will ensure that:

1. 100% of the specialized rice production areas will have links between businesses, cooperatives, or farmer organizations for production and product consumption.
2. Over 70% of the area will be mechanized.
3. More than 1 million households will adopt sustainable farming practices.

For environmental protection and green growth, the project aims to:

1. Reduce post-harvest losses to below 8%.
2. Collect 100% of straw in specialized production areas for reuse.
3. Reduce greenhouse gas emissions by over 10% compared to traditional rice farming.

The project's outcomes can be compared and improved based on Table 4 as outlined below:

Table 4. Comparison of irrigation methods and their impact on greenhouse gas emissions

Irrigation Method	Water Consumption	CH_4 Emissions	N_2O Emissions	Global Warming Potential	Rice Yield	References
AWD	Decrease by approx. 19-56%	Decrease by approx. 72-100%	Decrease by approx. 12-70%	Decrease by approx. 25-73%	Negligible difference	[14]
AWD	\	Decrease by approx. 35%	\	Decrease by approx. 35%	No change	[15]
Partial AWD	Decrease by approx. 13.72%	Decrease by approx. 10.62%	Increase by approx. 5.94%	Decrease by approx. 5.32%	Decrease by approx. 9.12%	[16]
Complete AWD	Decrease by approx. 4.52%	Decrease by approx. 23.1%	Increase by approx. 14.79%	Decrease by approx. 10.83%	Increase by approx. 2.42%	[16]
AWD	Decrease by approx. 59.9-63.2%	Decrease by approx. 64.9%	Increase by approx. 160%	Decrease by approx. 42.2%	Decrease by approx. 11.6%	[17]
AWD	\	Decrease by approx. 87.1%	Increase by approx. 280%	\	No change	[18]
MSD	\	Decrease by approx. 63.4%	Not significantly influenced	Decrease by approx. 59.7%	No change	[19]
MSD	\	Decrease by approx. 52%	Increase by approx. 242%	Decrease by approx. 47%	No impact	[20]
Extended MSD	\	Decrease by approx. 69.5%	\	Decrease by approx. 72%	Slight decrease by approx. 3.8%	[21]

Irrigation Method	Water Consumption	CH_4 Emissions	N_2O Emissions	Global Warming Potential	Rice Yield	References
Ridge Irrigation	\	Decrease by approx. 34%	Decrease by approx. 23%	Decrease by approx. 30%	Decrease by approx. 6.18%	[22]
Ridge Irrigation	\	Decrease by approx. 10%	Decrease by approx. 78%	\	Increase by approx. 2.5%	[23]
Slope Irrigation	\	Decrease by approx. 45.6-70.3%	Slight increase	Decrease by approx. 45.2-61.4%	Increase by approx. 11.3-17.6%	[24]
Winter irrigation (water-saving)	\	Decrease by approx. 62.3%	\	\		[25]
Subsurface irrigation using recycled water	\	Decrease by approx. 80%	\	\	No impact	[26]
Subsurface Irrigation using recycled water	\	Decrease by approx. 95.69%	Increase by 5-15%	Slight decrease, approx. 7%	Increase in yield and nutritional content	[26]
Continuous subsurface irrigation using recycled water	\	Decrease by approx. 84%	Decrease by approx. 28%	Decrease by approx. 66%	Increase in yield and nutritional content	[27]

Note: “\” indicates no available results

Additionally, the value added in the rice value chain has increased by 40%, with the profit margin for rice farmers exceeding 50%. The export of rice bearing a high-quality, low-emission brand now accounts for more than 20% of the total rice export volume from the specialized cultivation area [9].

One of the key factors for the success of the Project is the ability to increase the income of farmers and businesses involved in the rice value chain. To achieve this goal, the Project’s activities will focus on reducing production costs and increasing the value added of rice sold in the market. Reorganizing production among farmers within cooperatives will help significantly reduce input costs, as farmers can buy materials in bulk at lower prices. Moreover, participating in cooperatives will create opportunities for people to jointly invest in production and post-harvest storage and processing equipment, improving the quality of rice and reducing production costs. According to the Crop Production Department, participation in large-scale fields can reduce production costs by 10-15% and increase the value of output by 20-25%.

The Project will create an opportunity for Vietnam to build a sustainable and environmentally friendly rice production industry, increase farmers' incomes, and enhance the value-added production of rice. The total capital required for the implementation of the Project is estimated to be about 650 million USD, divided into two phases:

(i) Phase 1 requires about 60 million USD to consolidate the 180,000 hectares already invested in the VnSAT project;

(ii) Phase 2 requires 590 million USD to expand an additional 820,000 hectares of high-quality, low-emission specialized rice cultivation areas [9].

Collecting rice straw for animal feed, mushroom cultivation, etc., is still quite common in the Mekong Delta and provides significant profits for rice farmers. However, the collection and processing of rice residues after harvest are still challenging due to the low value of the residues and the high collection costs. Many technologies for processing rice residues in the field into organic fertilizer and reducing environmental pollution have been introduced to the farmers, but the scale of adoption remains limited. Currently, the trend of using low-carbon, environmentally friendly branded products is also creating market advantages and increasing the export value of certified low-emission products. Some developed countries are even considering imposing carbon taxes on imported goods. Therefore, investing in environmentally protective production is an inevitable trend for many industries, including rice production. However, the comparison and balance between potential revenue sources such as selling carbon credits, enhancing the rice brand value, reducing carbon taxes, and the investment costs for low-emission rice production infrastructure need to be carefully considered to ensure that the economic, social, and environmental impacts are fully accounted for at the investment decision stage.

Table 5. Comparison of rice straw treatment methods and their impact on greenhouse gas emissions

Straw treatment method	CH_4 Emissions	N_2O Emissions	Global warming potential	References
Incorporating straw into soil	/	/	Decrease by approximately 31%	[28]
Removing straw in flooded rice fields	/	/	Decrease by approximately 45%	[28]
Complete removal of straw	Decrease by approximately 35.38%-83.08%	Decrease by approximately 26.3%-50%	Decrease by approximately 56.75%	[29]
Reusing straw	/	Decrease by approximately 16.20%-31.40%	/	[30]
Late incorporation of straw into soil	/	/	Decrease by approximately 206%	[31]

Note: "\" indicates no available results.

3.1.4. Analysis of the "Threats" criteria

An important goal of the Project is to reduce GHG emissions and support green growth in agriculture. The "1 Must 5 Reductions" (1P5G) approach, which includes: Must use certified seeds, reduce the amounts of seeds, fertilizers, pesticides, irrigation water, and post-harvest loss, can all help reduce environmental pollution and GHG emissions. However, since the highest level of GHG emissions in rice cultivation is generated when the fields are flooded throughout the planting season, the "Agricultural - Drying - Flooding" (AWD) method is the main approach to reduce emissions. The AWD method can only be applied on large fields with well-invested irrigation systems that allow flexible water control. To achieve this, smallholder rice farmers in the Mekong Delta will generally not have enough capital to invest, and only the government or businesses can implement it.

Furthermore, draining water between rice crops (AWD) does not significantly increase yield or quality compared to keeping the fields flooded throughout the season. Therefore, for businesses, investing in a well-developed irrigation system with the sole purpose of reducing GHG emissions remains a challenge, especially considering that rice-producing businesses in Vietnam are still struggling with resource constraints. Hence, investment in irrigation systems to implement AWD on 1 million hectares of rice in the Mekong Delta still depends on government investment and support from international donors.

3.2. Discussion

Some results have been achieved in the pilot models of the "One Million Hectare High-Quality Rice" project during the Summer-Autumn and early Autumn-Winter seasons of 2024. Specifically, in the Summer-Autumn 2024 season, 4 models were implemented in 3 provinces with a total area of 196 hectares. In Can Tho City, the model has been harvested with a yield of 64 quintals per hectare, 7 quintals higher than the yield outside the model area. In Tra Vinh Province, the yield reached 61 quintals per hectare, 2 quintals higher than the yield outside the model area. Two models implemented in Tra Vinh and Soc Trang provinces are still in the harvest stage, and the yield is expected to exceed 64 quintals per hectare, 4.6 quintals higher than the average yield outside the model area, with a reduction of 1,262 tons of low-emission rice.

The results of reducing GHG emissions in these models show promising outcomes. In Can Tho City, the pilot model of the Project reduced emissions by 12 tons of CO_2 equivalent per hectare compared to the model where water was kept continuously flooded and straw was buried in the fields; it reduced by 5 tons CO_2 equivalent per hectare compared to farmers outside the model who applied the intermittent wet-dry irrigation technique within the cooperative but buried straw in the fields.

In Soc Trang Province, the pilot model applying the low-emission rice production technique resulted in emissions of 9,505 kg CO_2 equivalent per hectare per season. In contrast, without the emission reduction technique, emissions were 13,501 kg CO_2 equivalent per hectare per season. In Tra Vinh, the average emissions from the two pilot models, applying the low-emission rice production technique, were 7,610 kg CO_2 equivalent per hectare per season, while outside the model, emissions were 13,065 kg CO_2 equivalent per hectare per season.

Based on some of the results and the operational principles of the strategic solutions, the SWOT tool is applied as follows:

- SO (maxi-maxi): Maximize strengths to create opportunities.
- WO (mini-maxi): Overcome existing weaknesses to leverage strengths.
- ST (maxi-mini): Use strengths to eliminate threats.
- WT (mini-mini): Address potential negatives to minimize risks and adverse impacts.

Management and technical solutions aiming at reducing GHG emissions include:

Two main solution groups are proposed:

Solution Group 01: Full mechanization and digital transformation in agriculture to improve precision farming methods, reduce manual labor, decrease input material costs, increase efficiency in land, water, seed, fertilizer, and pesticide use, and reduce GHG emissions.

- Water Management: Based on conservation principles and reducing GHG emissions, such as not keeping fields flooded for more than 30 days before planting, applying wet-dry intermittent irrigation, or draining water during the cropping season.

3.2.1. Sowing

Apply mechanized row sowing or cluster sowing combined with fertilizer burial to increase fertilizer efficiency and reduce GHG emissions.

Figure 3. Traditional rice harvesting activities

Figure 4. Application of mechanization in rice harvesting activities

According to the "Mechanized Sowing Technical Process to Increase Efficiency and Reduce Greenhouse Gas Emissions in Rice Production in the Mekong Delta," as per Decision No. 396/QĐ-TT-VPPN dated October 31, 2023, from the Crop Production Department.

The process includes guidelines for sowing in rows or clusters using machinery in the Mekong Delta; it also provides some recommendations on land preparation, seed selection, and fertilization techniques compatible with mechanized row sowing and cluster sowing (Figure 5). Depending on the mechanization method, the sowing density should not exceed 70 kg per hectare [32, 33].

Requirement for flat land, with the highest and lowest point difference in the field not exceeding 5 cm. The most effective solution is laser leveling.

Row seeding, ≤ 60 kg of seed/ha, adjusting row spacing as required, can be combined with fertilizer application.

Results:

-Reduced seed, fertilizer, and pest risks.

Land preparation: Plowing rice stubble in dry fields combined with organic fertilizer to increase decomposition; tilling, leveling, and irrig

Cluster seeding, ≤ 60 kg of seed/ha, adjusting cluster spacing as required, can be combined with fertilizer application.

-Reduced lodging, decreased post-harvest losses.

-Increased yield by approximately 5% compared to broadcast seeding.

Figure 5. Application of mechanized row or cluster seeding combined with fertilizer burial [32, 33]

3.2.2. Straw collection

Straw can be collected from both dry or flooded fields using corresponding straw baling machines. If the weather is dry, the straw can be dried on the field before being collected. However, the straw should not remain on the field for more than 5 days after harvest to prevent a decrease in quality, particularly the loss of nitrogen in the straw. If the straw is wet after harvest, it should be collected immediately to prevent quality degradation due to decomposition and increased greenhouse gas emissions. Some straw baling machines that operate efficiently in the Mekong Delta include:

(1) Round Bale Straw Baler Attached to a Tractor: This machine rolls and discharges individual straw bales on the field, requiring a collection vehicle to transport the bales to a storage location. The baler cannot operate on wet fields because the tires are prone to getting stuck in the mud, and the straw bales discharged on the field may become contaminated with mud, reducing the quality of the straw.

(2) Rubber Track Self-Propelled Straw Baler: This machine integrates the functions of baling straw, storing the straw bales in a compartment, and transporting them to a collection area. This type of machine can operate in both wet and dry field conditions.

Figure 6. Mechanized collection of dry and wet straw [34, 35]

Solution Group 02: Digital Technology Solutions

a. Site-Specific Nutrient Management (SSNM) has been developed and practiced by IRRI for over 25 years, especially in Southeast Asia. Additionally, SSNM will be customized to the context and optimized by integrating existing tools and databases such as Rice Crop Management (RCM), CS-MAP, AWD-map, and soil maps to reduce fertilizer misuse. The reduction in input materials will help cut greenhouse gas emissions by about 5-10% per kilogram of rice produced [34, 35].

b. Carbon Footprint Calculator for Rice Products (CF-Rice) is a tool developed by IRRI for calculating and labeling rice products with an open-source footprint. CF-Rice is applied to calculate the carbon footprint and then digitally label rice products, especially those grown with irrigation in Southeast Asia. Life Cycle Assessment (LCA) is used to quantify greenhouse gas emissions.

c. MRV System for Greenhouse Gas Reporting is a geographic reference platform developed to monitor rice production progress and implement low-emission practices. Data collected through this system can be used to measure and report greenhouse gas reduction results. Currently, this system is being tested by IRRI and the Department of Crop Production (DCP) in the Mekong Delta (Mekong River Delta) of Vietnam. It shows high potential in supporting national greenhouse gas inventories and transparent reporting.

4. CONCLUSION

The application of the SWOT strategic analysis tool has clearly identified the strengths, weaknesses, challenges, and opportunities of the project. This is a great opportunity for the agricultural sector to restructure rice production during the global integration period when the trend of producing green, clean agricultural products with reduced greenhouse gas emissions is inevitable. For the project to achieve its expected results, macro goals need to be addressed through strong, synchronized strategic solutions, with crucial support from both domestic and international stakeholders. In particular, solutions need to be linked to full mechanization and digital Technology Solutions in agriculture to improve precision farming methods, reduce manual labor, reduce input material costs, increase efficiency in the use of land, water, seeds, fertilizers and pesticides, and reduce greenhouse gas emissions.

REFERECES

1. Ministry of Natural Resources and Environment - Vietnam's first biennial update report to the United Nations Framework Convention on Climate Change, 2014.
2. Some solutions to reduce greenhouse gas emissions in agriculture, 2024, National Standards and Measurement Committee, https://tcvn.gov.vn/mot-so-giai-phap-giam-phat-thai-khi-nha-kinh-trong-nong-nghiep/22/04/2024/
3. Nguyễn Thế Hinh - The “One Million Hectares Rice Emission Reduction Project” – Opportunities and Challenges, Environmental Magazine Issue 1/2024, https://tapchimoitruong.vn/chuyen-muc-3/de-an-mot-trieu-ha-lua-giam-phat-thai--co-hoi-va-thach-thuc-29704
4. General Statistics Office, 2020, 2022, https://www.gso.gov.vn/nong-lam-nghiep-va-thuy-san/
5. Vietnam’s third national communication to the UNFCCC Secretariat, Ministry of Natural Resources and Environment, 2018.

6. Lê Ánh Ngọc, Nguyễn Văn Hồng, Trần Diệu Trang, Nghiêm Thị Huyền Trang - Introduction of some economic tools applied in greenhouse gas emissions management in Vietnam, Climate Change Science Journal No. 16 - December 2020, http://imh.ac.vn/files/doc/tapchibiendoikhihau/TAP%20CHI%20BDKK%20SO%2016_bai%205.pdf.
7. Hà Linh - Current situation of greenhouse gas emissions in Vietnam, 2019.
8. Profeta, T. & Daniels, B. - Design principles of a cap-and-trade system for greenhouse gases, Nicholas Institute for Environmental Policy Solutions, Duke University, 2005.
9. The Socialist Republic of Vietnam - Updated Nationally Determined Contribution (NDC), 2020.
10. SWOT Analysis Tool, https://www.mindtools.com/amtbj63/swot-analysis.
11. Đào Thế Anh - The need for technological innovation in rice production and post-harvest in Vietnam, Vietnam Science and Technology Journal, Issue **6a** (2018) pages 16-18, https://vjol.info.vn/index.php/khcn/article/view/36225/29605.
12. Vietnam - Third Biennial Updated Report: To the United Nations Framework Convention on Climate Change, Ha Noi, 2020. https://unfccc.int/sites/default/files/resource/Viet%20Nam_BUR3.pdf
13. IPCC - Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 2014, 151 pp. https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf
14. Loaiza, S., Verchot, L., Valencia, D., Guzmán, P., Amezquita, N., Garcés, G., Puentes, O., Trujillo, C., Chirinda, N., Pittelkow, C.M. - Evaluating greenhouse gas mitigation through alternate wetting and drying irrigation in Colombian rice production. Agriculture, Ecosystems & Environment **360** (2024) 108787 https://doi.org/10.1016/j.agee.2023.108787
15. Habib, M., Islam, S., Haque, M., Hassan, L., Ali, M., Nayak, S., Dar, M., Gaihre, Y. - Effects of irrigation regimes and rice varieties on methane emissions and yield of dry season rice in Bangladesh. Soil System **7** (2) (2023) 41. https://doi.org/10.3390/soilsystems7020041
16. Sriphinom, P., Chidthaisong, A., Towprayoon, S. - Effect of alternate wetting and drying water management on rice cultivation with low emissions and low water use during wet and dry seasons. Journal of Cleaner Production **223** (2019) 980–988. https://doi.org/10.1016/j.jclepro.2019.03.212
17. Feng Z., Qin T., Du X.Z, Sheng F., Li C.F - Effects of irrigation regime and rice variety on greenhouse gas emissions and grain yields from paddy fields in central China. Agricultural Water Management **250** (2021). https://doi.org/10.1016/j.agwat.2021.106830
18. Liao, P., Sun, Y., Zhu, X., Wang, H., Wang, Y., Chen, J., Zhang, J., Zeng, Yanhua, Zeng, Yongjun, Huang, S. - Identifying agronomic practices with higher yield and lower global warming potential in rice paddies: a global meta-analysis. Agriculture, Ecosystems and Environment **322** (2021). https://doi.org/10.1016/j.agee.2021.107663
19. Martinez-Eixarch, M., Beltran-Miralles, M., Guery, S., Alcaraz, C. - Extended methane mitigation capacity of a mid-season drainage beyond the rice growing season: a case in Spain. Environmental Monitoring and Assessment **9** (2022). https://doi.org/10.1007/s10661-022-10334-y

20. Liao B., Wu, X., Yu, Y., Luo, S., Hu, R., Lu, G. - Effects of mild alternate wetting and drying irrigation and mid-season drainage on CH_4 and N_2O emissions in rice cultivation. Science of the Total Environment **698** (2020). https://doi.org/10.1016/j.scitotenv.2019.134212
21. Itoh, M., Sudo, S., Mori, S., Saito, H., Yoshida, T., Shiratori, Y., Suga, S., Yoshikawa, N., Suzue, Y., Mizukami, H., Mochida, T., Yagi, K. - Mitigation of methane emissions from paddy fields by prolonging midseason drainage. Agriculture, Ecosystems and Environment **141** (2011) 359–372. https://doi.org/10.1016/j.agee.2011.03.019
22. Timm, P., Scivittaro, W., Parfitt, J., Bayer, C., Soares, A., Vasconcelos, E., Souza, P., Sousa, R., Busato, C., Carlos, F.S. - New ridge–furrow irrigation system reduces methane emissions and partial global warming potential in rice cultivation. (2024). https://doi.org/10.21203/rs.3.rs-4223151/v1
23. Yousefian, M., Shahnazari, A., Ahmadi, M.Z., Sarjaz, M.R., Arabzadeh, B. - The effect of irrigation management on rice grain yield, irrigation water productivity and methane emissions in northern Iran. Irrigation and Drainage **73** (2024) 230–243. https://doi.org/10.1002/ird.2867
24. Zeng, Y., Li, F. - Ridge irrigation reduced greenhouse gas emission in double cropping rice field. Archives of Agronomy and Soil Science **67** (2021) 1003–1016. https://doi.org/10.1080/03650340.2020.1771698
25. Ji, Y., Xu, Y., Zhao, M., Zhang, G., Conrad, R., Liu, P., Feng, Z., Ma, J., Xu, H. - Winter drainage and film mulching cultivation mitigated CH_4 emission by regulating the function and structure of methanogenic. (2022).
26. Phung, L., Miyazawa, M., Pham, D., Nishiyama, M., Masuda, S., Takakai, F., Watanabe, T. - Methane mitigation is associated with reduced abundance of methanogenic and methanotrophic communities in paddy soils continuously subirrigated with treated wastewater. Scientific Reports **1** (2021). https://doi.org/10.1038/s41598-021-86925-5
27. Phung, L., Pham, D., Sasaki, Y., Masuda, S., Takakai, F., Kaku, N., Watanabe, T. - Continuous sub-irrigation with treated municipal wastewater for protein-rich rice production with reduced emissions of CH_4 and N_2O. Scientific Reports **1** (2020). https://doi.org/10.1038/s41598-020-62247-w
28. Gummert, M., Hung, N.V., Chivenge, P., Douthwaite, B. (Eds.) - Sustainable Rice Straw Management. Springer International Publishing, Cham (2020). https://doi.org/10.1007/978-3-030-32373-8
29. Romasanta, R.R., Sander, B.O., Gaihre, Y.K., Alberto, MaC., Gummert, M., Quilty, J., Nguyen, V.H., Castalone, A.G., Balingbing, C., Sandro, J., Correa, T., Wassmann, R. - How does burning of rice straw affect CH4 and N2O emissions? A comparative experiment of different on-field straw management practices. Agriculture, Ecosystems and Environment **239** (2017) 143–153. https://doi.org/10.1016/j.agee.2016.12.042
30. Rassaei, F. - Nitrous oxide emissions from rice paddy: impacts of rice straw and water management. Environmental Progress and Sustainable Energy **42** (2023) e14066. https://doi.org/10.1002/ep.14066
31. Belenguer-Manzanedo, M., Alcaraz, C., Camacho, A., Ibañez, C., Català-Forner, M., Martínez-Eixarch, M. - Effect of post-harvest practices on greenhouse gas emissions in rice paddies: flooding regime and straw management. Plant and Soil **474** (2022) 77–98. https://doi.org/10.1007/s11104-021-05234-y

32. Technical process for mechanized rice sowing to increase efficiency and reduce greenhouse gas emissions in rice production in the Mekong Delta. (n.d.). https://hdl.handle.net/10568/139937
33. Handbook for the technical process of mechanized rice sowing to increase efficiency and reduce greenhouse gas emissions in rice production in the Mekong Delta. (n.d.). https://hdl.handle.net/10568/136108
34. Rice straw management process for circular agriculture and low emissions in the Mekong Delta. (n.d.). https://hdl.handle.net/10568/139935
35. Handbook for rice straw management in circular agriculture and low emissions in the Mekong Delta. (n.d.). https://hdl.handle.net/10568/139938z

TÓM TẮT

ỨNG DỤNG CÔNG CỤ SWOT TRONG PHÂN TÍCH ĐỀ ÁN MỘT TRIỆU HECTA LÚA HƯỚNG ĐẾN MỤC TIÊU GIẢM PHÁT THẢI KHÍ NHÀ KÍNH

Phương Nguyễn Vũ Hoàng, Hiền Nguyễn Thu, Bá Lê Huy*

Trường Đại học Công Thương Thành phố Hồ Chí Minh (HUIT)

*Email: *lhuyba@gmail.com*

Kết quả của nghiên cứu xác định rõ ràng các điểm mạnh, điểm hạn chế, cơ hội và thử thách trong tương lai khi thực hiện Đề án 1 triệu hecta lúa trong giai đoạn tiếp theo. Ngoài ra, Đề án là một cơ hội lớn cho ngành nông nghiệp nhằm tái cơ cấu lại ngành sản xuất lúa gạo trong giai đoạn hội nhập với thế giới, khi hướng tới sản xuất các sản phẩm nông nghiệp xanh, sạch, giảm phát thải KNK. Việc thực hiện đề án cần tiến hành nhiều giải pháp chiến lược một cách mạnh mẽ, đồng bộ và đặc biệt cần sự hỗ trợ của các bên liên quan trong và ngoài nước… Đề án sẽ tạo động lực mới cho phát triển ngành lúa gạo của Việt Nam tạo nên mô hình thích ứng với biến đổi khí hậu, phát triển bền vững thông qua các phương pháp phù hợp với điều kiện thực hiện nay của các địa phương.

Từ khóa: Dự án lúa 1 triệu ha, giảm phát thải, khí nhà kính, SWOT.