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Chapter 4
Rice Production for Sustainable Agriculture: Case Studies in Vietnam and Japan

Thanh Tam HO

Abstract: As climate change poses significant challenges to global food security and safety, strategic policies to mitigate food safety risks while minimizing environmental impacts in the era of climate change are becoming more important. Sustainable agriculture is a potential solution for sequestering carbon as climate change mitigation, improving environmental health and economic performance, as well as satisfying society's need for food security. This research reports on two case studies. The first case will present climate change responses in the Mekong Delta, Vietnam. To cope with more frequent and serious salinity intrusion and drought, national policies promote mitigation strategies with the aims of reducing GHGs emissions and managing resource uses as well as promoting adaptation strategies as emergent action for farmers to effectively reduce climate change vulnerability and enhance resilience. Especially, this study will focus on how these climate change responses could improve the economic performance of rice farmers. The second case will introduce the development of sustainable agriculture, especially sustainable rice in Shiga Prefecture, where the unique policy of direct payment was the earliest and most advanced in Japan and has since been popularly adopted at the national level. The study concludes with policy implications for both cases.

1. Introduction

In the era of climate change, our food security and safety are being seriously threatened, while at the same time, it is becoming increasingly challenging to devise strategies to mitigate food safety risks while minimizing the environmental impacts. Sustainable agriculture can be part of the solution.

In Vietnam, due to serious droughts and extreme weather events during 2016–2017, rice production was remarkably reduced. Meanwhile, in Japan, heavy rains and windy storms caused by five typhoons and rainy season fronts brought about 126.4 billion Japanese yen in agricultural damage in 2017 (MAFF 2018). Consequently, rice production was also affected in both countries (Figure 4.1).

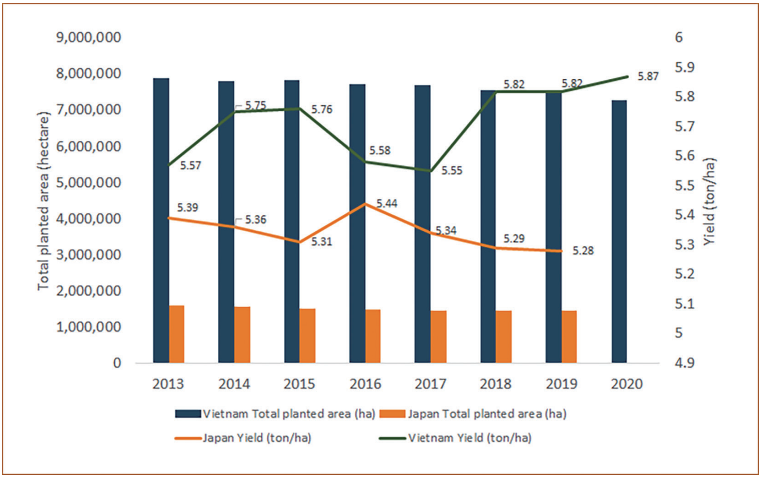

Figure 4.1 Rice production in Japan and Vietnam during 2013–2019.
Source: Author

In Vietnam, rice is the most important crop, occupying more than 90% of total grain food. Vietnam is the world's third major rice exporter. In 2020, the country exported 6.2 million tons (3.1 billion USD), accounting for 13.8% of total production. Recently, Japan's rice exports have grown further. 7,640 tons of Japanese rice were exported in 2015. In 2020, Japan exported 19,700 tons of rice (47.79 million USD), accounting for 0.2% of total production (Figure 4.2).

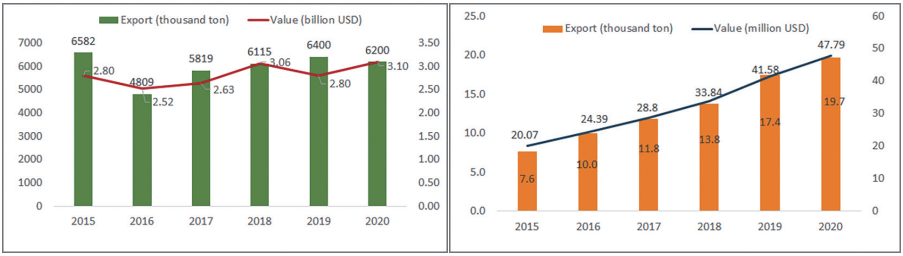

Figure 4.2 Rice exports in Vietnam and Japan. Source: Author

There are several problems in rice production in both Vietnam and Japan. In Vietnam, serious climate change and extreme weather events (i.e., drought, salinity intrusion), the low efficiency of rice farming (i.e., overuse of inputs such as fertilizers and chemical uses), and low quality of rice are the three main concerns. Whilst, in Japan, a decreasing demand for rice in the domestic market, an aging population, and a decreasing labor force for agricultural sectors are the main constraints. This study aims to give an overview by measuring the effects of climate change responses on rice production in Vietnam and a review of the sustainable agriculture and promotion policy of rice in Japan.

2. A Case Study in Vietnam

(1) Background

The Mekong Delta in Vietnam is one of the biggest rice production regions (GSO 2018), contributing 52% of the total rice production of the country, ensuring livelihoods for 60% of its regional residents. Also, it is one of the most vulnerable regions to climate change and sea-level rise in the world (Yusuf and Francisco 2010). Rice production potential in Vietnam is forecast to decline by up to 50% by the year 2100. To cope with climate change and its adverse impacts, adaptation and mitigation are emergent responses to enhance the resilience of the agricultural sector, protect the livelihood of poor communities, and ensure food security and the environment. Therefore, it is necessary to investigate the effects of climate change responses on rice farming in the Mekong Delta of Vietnam.

(2) Data and Method

1) Data Collection

The cross-section data of 352 rice farmers in the study were collected from the field survey in three provinces in the Mekong Delta: Long An, Ben Tre, and Tra Vinh in February 2018. These three provinces were purposively selected as the case studies because they are representative of each group of low, medium, and high levels of vulnerability to climate change and have intensive rice farming (2-3 cropping seasons per year). In each province, two districts were randomly selected, and then two communities were chosen from each district.

2) Research Approach and Method

Decisions in response to climate change depend on a farmers' ability and motivation. In addition, their ability and motivation also contribute to different farm performances regarding their choices (i.e., self-selection). These could lead to selection bias. Therefore, the multinomial endogenous treatment effect model (Multinomial ETEM) (Deb and Trivedi 2006a; 2006b) is used to estimate the effects of climate change responses on rice farming and the propensity score analysis for categorical treatment (Inverse Probability Weighting, IPW) (Guo and Fraser 2015) is also used to check the robustness of the estimated results.

3) The Effects of Climate Change Responses

According to the surveyed data, 71% of farmers implemented climate change responses and 29% did not implement any response. Climate change responses are different across geographical locations (i.e., provinces with different levels of vulnerability to climate change). Those climate change responses are divided into four main groups: (1) crop management (i.e., changing rice varieties, changing fertilizer and chemical use, or applying integrated pest management (IPM)), (2) water management, (3) income diversification, and (4) soil conservation (i.e., reduce the farming area of rice, soil preparation) (Figure 4.3).

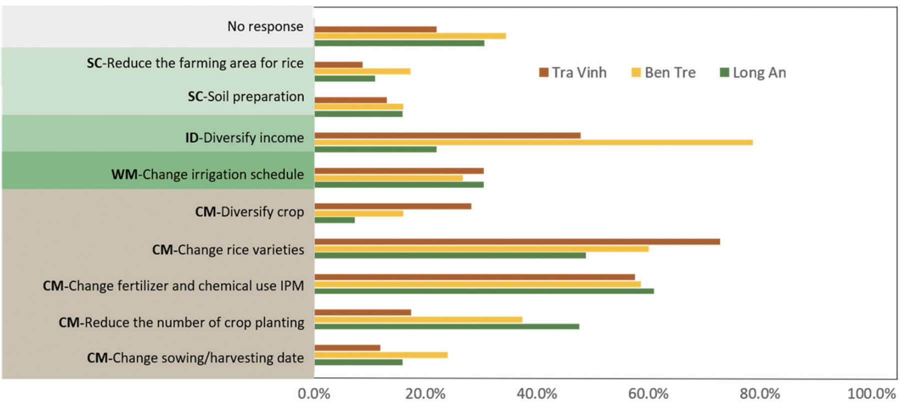

Figure 4.3 Climate change responses by local Vietnamese farmers. Source: Author
Note: SC – Soil conservation package; ID – Income diversification package; WM – Water management package; CM – Crop management package

The key determinant of multiple choices of climate change responses (i.e., one package, two packages, and three or more packages) is sources of information on climate change response. Education and farm size are also found to influence the multiple choices among rice farmers. Furthermore, geographical locations (i.e., provincial level or vulnerability level and access to water sources) significantly drive the choice of multiple climate change responses among rice farmers (Table 4.1).

Table 4.1 Determinants of multiple choices of climate change responses.

Covariate	**Category 1**	**Category 2**	**Category 3**	**Category 4**
Education	0.00 (0.06)	-0.22* (0.12)	0.03 (0.06)	0.04 (0.06)
Age	0.01 (0.02)	-0.04 (0.03)	-0.00 (0.02)	-0.02 (0.02)
Information on CC responses	0.83** (0.37)	1.22** (0.72)	0.66* (0.38)	1.21*** (0.38)
Asset	-0.00 (0.00)	-0.01 (0.01)	-0.01 (0.01)	-0.00 (0.00)
Farm size	0.09 (0.15)	0.11 (0.27)	0.09 (0.17)	0.28** (0.16)
Region (Low vulnerability)	-0.27 (0.42)	0.71 (0.89)	-0.89* (0.7)	-1.07** (0.49)
Region (Medium vulnerability)	-2.02*** (0.50)	-0.51 (0.95)	-0.39 (0.44)	-0.34 (0.45)
Access to water (Near)	1.46** (0.72)	1.06 (1.21)	1.19* (0.70)	0.35 (0.68)
Access to water (Medium)	1.54** (071)	-0.23 (1.36)	1.12* (0.70)	0.87 (0.67)
Constant	-2,09 (1.27)	-0.58 (2.22)	-1.45 (1.26)	-0.72 (1.15)
Likelihood-ratio chi^2 (32)	187.27			
Probability > chi^2	0.00			
Pseudo R^2	0.08			
Observations	90	12	76	71

Note: ***, **, and * represent significant levels at 1%, 5%, and 10% respectively. Category 1 - A package related to crop management; Category 2 - A package related to water management, income diversification, or soil conservation; Category 3 - Two packages; Category 4 - Three or more packages. Source: Author

To measure the benefits of climate change responses on the outcome of rice farming, both the multinomial ETEM and propensity score matching (i.e., IPW) are applied. The multinomial ETEM shows a more reliable result compared to the IWP estimates. One up to multiple packages of climate change coping practices can significantly improve rice yield, profitability, and income, and reduce chemical fertilizer use. A more comprehensive package would not always result in greater profitability than a less comprehensive package (Table 4.2).

Table 4.2 Effects of categorical climate change responses on outcomes of rice farming.

Outcome	**Category 1**	**Category 2**	**Category 3**	**Category 4**
Ln Yield				
IPW	0.22*** (0.04)	0.20*** (0.06)	0.22*** (0.05)	0.22*** (0.05)
Multinomial ETEM	**0.13*** (0.03)**	**0.11*** (0.05)**	**0.13*** (0.03)**	**0.15*** (0.03)**
Ln Profitability				
IPW	0.46*** (0.11)	0.46** (0.15)	0.50*** (0.12)	0.38*** (0.12)
Multinomial ETEM	**0.14*** (0.04)**	**0.11* (0.06)**	**0.14*** (0.04)**	**0.14** (0.04)**
Ln Income				
IPW	0.72*** (0.16)	1.50*** (0.15)	0.80*** (0.18)	0.99*** (0.17)
Multinomial ETEM	**0.19*** (0.05)**	**0.25*** (0.08)**	**0.23*** (0.05)**	**0.26*** (0.05)**
Ln Fertilizer use				
IPW	-0.18*** (0.07)	0.12 (0.15)	-0.22*** (0.07)	0.00 (0.01)
Multinomial ETEM	**-0.07*** (0.01)**	0.00 (0.02)	**-0.08*** (0.01)**	-0.01 (0.01)

Note: ***, **, and * represent significant levels at 1%, 5%, and 10% respectively. Category 1 - A package related to crop management; Category 2 - A package related to water management, income diversification, or soil conservation; Category 3 - Two packages; Category 4 - Three or more packages. Source: Author

3. A Case Study in Japan

(1) Background

Japan is one of the world's top five greenhouse gas (GHG) emitters, with nearly 1,200 million tons of CO_2 equivalent in 2019. Especially, GHG emissions from agriculture are the third largest contributor to global warming in Japan (47.44 million tons of CO_2), behind the energy and industrial sector. In 2019, the largest source of CH_4 emissions was rice cultivation, accounting for 46.2%. Japan is the third largest fertilizer user with nearly 232 kg per ha in 2017 and the second largest pesticide user, with around 11.85 kg per ha in 2014. The overuse of chemical fertilizers and pesticides for a long time has resulted in polluting the air, water, and soil.

(2) A Review of Sustainable Agriculture and Promotion Policy

The Japanese government has recognized its responsibility to address agri-environmental issues in its domestic agricultural policy. The importance of biodiversity in Japanese rural areas, including paddy fields, has recently attracted more attention. Figure 4.4 shows the historical data of agricultural policies which promote sustainable agriculture involving environmentally friendly agriculture and organic agriculture.

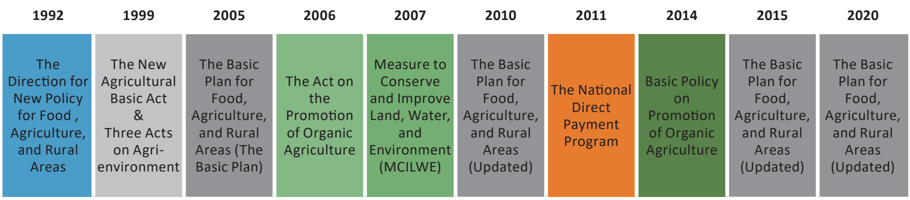

Figure 4.4 Government policy regarding sustainable agriculture in Japan.

Source: Author

The term “environmentally friendly agriculture” was mentioned for the first time in The Direction for New Policy for Food, Agriculture, and Rural Areas by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in June 1992. This policy document was the starting point for the renewal of the Agriculture Basic Act.

Measures for sustainable agriculture during this phase were the dissemination of environmentally friendly farming practices to farmers, and the promotion of farmers' awareness of the environment. Since 1999, the Food, Agriculture, and Rural Areas Basic Act and the Three Acts on Agri-environment have been enacted and seriously focused on promotion and development.

In 2005, MAFF released a five-year plan, namely the Basic Plan for Food, Agriculture and Rural Areas (or the New Basic Plan). The Good Agricultural Practices Harmonious with Environment Plan was also introduced in the same year. After this, the Act on the Promotion of Organic Agriculture was enacted in 2006.

The Measures to Conserve and Improve Land, Water, and Environment plan which started in 2007, is known as a subsidy program. Under this subsidy program, action groups receive financial aid for collaborative action to maintain and improve farmland and water resources and for farming activities reducing chemical inputs.

In the Basic Policy for Promotion of Organic Agriculture enacted in 2014, the main goal is to double the percentage of agricultural land devoted to organic farming to 1.0% by FY2018.

(3) Shiga Prefecture and Promotion Policies for Sustainable Agriculture

Lake Biwa, which occupies one-sixth of the entire area of Shiga Prefecture, is the largest lake in Japan. Lake Biwa was seriously polluted due to population growth and industrial developments in the 1960s. Also, the extensive use of pesticides and chemical fertilizers in the agricultural sector was another cause of the water pollution in the lake. Especially, eutrophication spread in the 1970s. In 1977, Lake Biwa experienced a large-scale freshwater red tide for the first time and such outbreaks continued up to the 1990s. Recently, however, the number of days during which red tides occur and affected areas have decreased. Blue-green algae first appeared in Lake Biwa in 1983 and has continued to appear almost every year since then.

Perceiving the importance of Lake Biwa as a water source and for its biodiversity, the Shiga government has enacted several laws, regulations, and policies to protect biodiversity and the environment, especially in water preservation, agriculture, and forestry conservation. The details are described as follows:

- 1979: Ordinance for Eutrophication Prevention in Lake Biwa
- 1980: Clean and Recycling Agriculture
- 1984: Landscape Preservation Ordinance
- 1985: Special Law for Preserving Lake Water
- 1987: Lake Water Quality Conservation Plan
- 1990: Master Plan for Environmental Management of Yodo River System
- 1992: Reed Colony Conservation Ordinance
- 2001: Shiga's Vision for Agriculture and Forestry, especially Environmentally Friendly Agriculture (EFA)
- 2002: Lake Biwa Sport Activities Control Ordinance
- 2003: Shiga Prefecture Ordinance Promoting Environmentally Friendly Agriculture
- 2004: Shiga Agri-environmental Direct Payment Scheme
- 2007: MCILWE (developed by MAFF) and Development of the Plan for Conservation of the Lake Water Quality in Lake Biwa, Fifth Period
- 2011: The National Policy on Direct Payment Program (MAFF) and The Lake Biwa Comprehensive Conservation Plan (Mother Lake 21 Plan) were revised
- 2012: Development of the Plan for Conservation of the Lake

Water Quality in Lake Biwa, Sixth Period

- 2015: Development of the Plan for Conservation of the Lake Water Quality in Lake Biwa, Seventh Period
- 2017: Development of the Plan for the Lake Biwa Conservation and Regeneration Measures
- 2021: Shiga Prefecture Basic Plan for Agriculture and Fisheries

Based on the definition of sustainable agriculture from the government, Shiga Prefecture set up cultivation standards for environmentally friendly agriculture, which include:

(i) The amount of chemically synthesized pesticides used is less than half of the normal amount, and the total number of ingredients is seven or less.

(ii) The amount of chemical fertilizer (nitrogen component) is less than half of the normal amount, 4kg/10a or less.

(iii) Adopted environmentally friendly cultivation techniques for Lake Biwa.

(iv) A record is kept of how it was cultivated.

The "Fish Cradle Rice Paddies Project" and Shiga's Vision for Agriculture and Forestry, especially Environmentally Friendly Agriculture (EFA) have been implemented in Shiga since 2001. Although rice-fish farming, a traditional practice for more than 170 years in Japan, has been declining, it has recently received renewed interest for its potential as a sustainable agricultural practice. Farmers enrolling in this project must comply with several conditions including the use of pesticides that result in the lowest level of fish toxicity and specific water management to maintain fish habitats. Furthermore, the Shiga government established the Ordinance for Promotion of Environmentally Friendly Agriculture in March 2003 to proactively promote "environmentally friendly agriculture" which aims to reduce the pollution load to Lake Biwa, conserve its biodiversity, and provide consumers with safe and reliable agricultural products. As early as 2004, Shiga Prefecture started an agri-environmental policy, namely the Environmentally Friendly Agriculture Direct Payment Scheme which is the most advanced policy with the aim of Lake Biwa conservation. This unique policy by Shiga Prefecture was adopted at the national level by Measures to Conserve and Improve Land, Water, and Environment (2007–2011) and has developed into the National Direct Payment Scheme since 2011.

In Japan, Shiga has the largest amount of EFA cultivated area, about 33%. Especially, the total of EFA rice in Shiga is nearly 13,000 ha, occupying about 44% of the total cultivated area of rice (nearly 30,000 ha), and nearly 90% of total EFA farming in Shiga (total of EFA: 14,057 ha) (Figure 4.5).

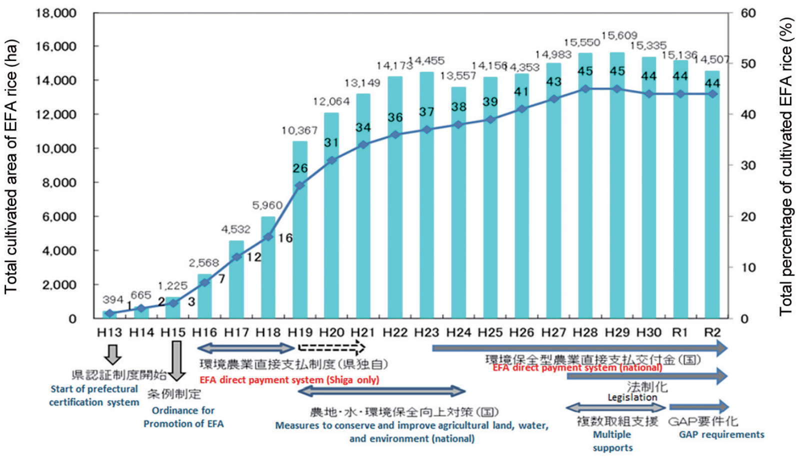

Figure 4.5 Change in the cultivated area of EFA and key policies in Shiga.
Source: (Shiga Prefectural Government Report 2022)

(4) Environmentally Friendly Agriculture (EFA) and Direct Payment Subsidy Policy in Shiga Prefecture

According to the report from MAFF (2019), EFA significantly reduces approximately 143,393 tons of CO_2 equivalent per year. Combining multiple practices simultaneously with organic agriculture cropping systems is increasingly common to achieve economic and environmental viability such as suppressing weeds, pests, and disease pressure; meeting crop nutrient demands; and optimizing overall crop productivity. Table 4.3 shows the main EFA farming methods in Shiga Prefecture and the direct payment subsidy for each farming method.

Table 4.3 Direct payment subsidy for EFA farming methods

Activities	**Direct payment subsidy (JPY/ha)**	**Cultivated area (ha)**	**Reduction amount of GHG emissions per unit (ton CO_2/ha/year)**
IPM practice, manual weeding on ridges and long-term integrated pest management	40,000	5,996	3.87
Use of slow-release fertilizer and long-term mid-drying	40,000	5,005	2.19
Applying compost	44,000	697	2.26
Organic farming	30,000–120,000	346	0.93
Ecosystem-friendly weed management	40,000	243	-
Planting cover crops	60,000	181	1.77
Fish cradle paddy rice	30,000	148	-
No pesticide or chemical fertilizer use	60,000	122	-
Living mulch	32,000–54,000	67	1.02
Others		170	-
Total		**12,987**	

Source: (MAFF 2020) and (Shiga Prefectural Government Report 2022)

According to surveyed data, here is a brief comparison of the profitability between EFA rice and conventional rice. EFA rice has a higher profitability at 15,400 Japanese yen/ha (≈102.4 USD/ha) which includes the direct payment subsidy amount, but it becomes unprofitable when the labor cost (i.e., both hired and family labor) is included (Table 4.4).

Table 4.4 An example of cost and benefit of EFA rice, Shiga Japan.

Item	**Environmental-friendly rice**	**Conventional rice**
Average yield (ton/ha)	5,000.95	5,000.98
Selling price (JPY/60kg)	10,700	10,400
Sale (JPY/ha)	891,670	866,670
Direct payment subsidy (JPY/ha)	**40,000**	0
Total income (JPY/ha)	**931,670**	**866,670**
Labor (man-hours)	124	21
Seeds and seedlings cost (JPY/ha)	164,434	164,434
Fertilizer cost (JPY/ha)	112,000	62,400
Agricultural chemical cost (JPY/ha)	28,800	28,800
Herbicide cost (JPY/ha)	25,000	25,000
Cost for using drying facility (JPY/ha)	145,660	145,660
Total cost (JPY/ha)	**475,800**	**426,200**
Profitability (JPY/ha)	**455,870**	**440,470**

Source: (Shiga Prefectural Government Report 2022)

According to the Shiga Prefecture Report and the present study's survey (2022), Shiga rice farmers have a high awareness of sustainable agriculture. Their motivations for implementing sustainable agriculture are to protect Lake Biwa, add to the value of rice on the market, and produce safe products. However, there are several challenges to developing sustainable agriculture, especially for sustainable rice production: (1) It is time- and labor-consuming, (2) profitability is low if the labor cost is included, and (3) there is an aging agricultural population and shortage of labor force in the agricultural sector.

4. Conclusion

Climate change and coping strategies are emerging concerns in agriculture, especially in developing countries. In Vietnam, climate change responses are beneficial for rice farmers in avoiding losses of yield, improving profitability and income, and reducing fertilizer use. There is a need to improve rice quality (i.e., rice variety, safety) and its stability. Sustainable agricultural practices with certification are still limited in Vietnam. Also, there is a need to design an appropriate policies to promote sustainable agriculture, especially rice.

In Japan, current agricultural policies effectively promote sustainable agriculture and add to the value of Japanese rice. Nevertheless, new challenges may arise from the situation of depopulation and aging in rural communities, a decline in the total area of cultivated rice, a shortage of labor, and a decline in rice consumption due to changes in dietary habits. Therefore, policies for promoting sustainable agriculture should pay attention to the public concern over the economic impacts on the quality of the global commons. In order to make agriculture sustainable smart agriculture should be considered to assist in solving the problem of the shrinking labor force and improving efficiency. In addition, adopted policies should include conversion to other strategic crops such as wheat, soybeans, rice for processing, and also keeping livestock. Moreover, innovations and technologies developed in Japan such as digital tools and pest management should be considered for countries facing the same challenges, especially developing countries like Vietnam.

References

Deb, P. and P. K. Trivedi. 2006a. Maximum Simulated Likelihood Estimation of a Negative Binomial Regression Model with Multinomial Endogenous Treatment. *The Stata Journal*, 6(2), pp. 246–255.

———. 2006b. Specification and Simulated Likelihood Estimation of a Non-Normal Treatment-outcome Model with Selection: Application to Health Care Utilization. *The Econometrics Journal*, 9(2), pp. 307–331.

GSO. 2018. Social and Economic Situation in 2017. Vietnamese General Statistics Office. <https://www.gso.gov.vn/en/data-and-statistics/2019/10/report-social-and-economic-situations-in-2017/>

Guo, S., and M. W. Fraser. 2015. *Propensity Score Analysis: Statistical Methods and Applications* (Advanced Quantitative Techniques in the Social Sciences). Los Angeles, CA.: SAGE Publications, Inc.

Ministry of Agriculture, Forestry, and Fisheries (MAFF). 2018. *FY2017 Summary of the Annual Report on Food, Agriculture and Rural Areas in Japan*. <https://www.maff.go.jp/e/data/publish/attach/pdf/index-93.pdf>

———. 2019. Direct Payments for Environmentally Friendly Agriculture. <https://www.maff.go.jp/e/policies/env/sustainagri/directpay.html>

———. 2020. Statistics. <https://www.maff.go.jp/e/data/stat/index.html>

Nishizawa, E. 2015. Agri-environmental Policies of Japan and Shiga Prefecture. *Journal of International Economic Studies*, 29, pp. 23–34.

Shiga Prefectural Government Report. 2022. Chapter 3-12 Environmentally-friendly Agriculture. <https://www.pref.shiga.lg.jp/file/attachment/45609.pdf>

Yusuf, A. A., and H. Francisco. 2010. *Climate Change Vulnerability Mapping in Southeast Asia*. Laguna, Philippines: Economy and Environment Program for Southeast Asia (EEPSEA).

Dr. Thanh Tam HO

Chapter 4. Rice Production for Sustainable Agriculture: Case Studies in Vietnam and Japan

Dr. Thanh Tam Ho is a Senior Researcher at the Ritsumeikan Asia-Japan Research Organization. She received her Ph.D. in Economics at Ritsumeikan University. Her research focuses on climate change adaptation and mitigation, sustainable agriculture policies, and behavior analysis. Her dissertation, "An Economic Analysis of Climate Change Response and Rice Farmers' Behavior in the Mekong Delta of Vietnam," explored farmer's decision-making on multiple climate change responses and the economic performance in rice farming. Currently, she is conducting a research project related to sustainable agriculture and promotion policy in Japan.