Measuring What Matters in Rice Systems:

TEEBAgriFood Assessment Thailand, focus on the Northeast region

Key messages, August 2022

The TEEBAgriFood assessment in Thailand sought to measure and make visible diverse costs and benefits of rice production as a means to identify options for promoting long term sustainability of production and management of rice landscapes. A scenario analysis was prepared to demonstrate the potential trade-offs generated as organic rice production practices in Thailand are extended over an increasingly large area over the period 2019-2035.

Scenarios assessed

Four scenarios were developed to understand potential future impacts of government policies, including the One Million Rai Organic Rice promotion policy, and Parliamentary targets for achieving sustainable agriculture by 2030. The timeframe for scenario analysis was 17 years, starting from 2019, short-term (2019-2025), medium-term (2019-2030), and long-term (2019-2035).

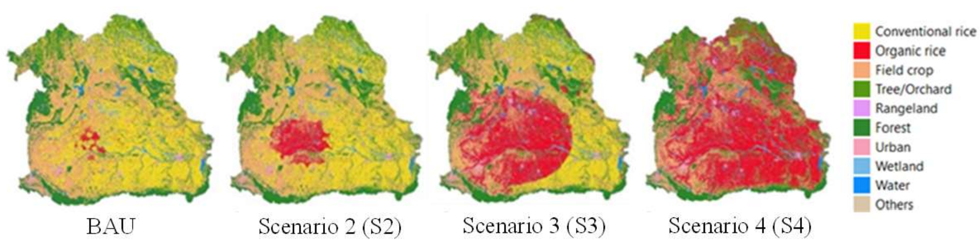
Business as Usual (BAU) assumed no new policy or interventions to support the expansion of organic rice area. The organic rice area of the Northeast region was projected to increase to 173,027 hectares by 2025 and remain constant at that level to 2035.

Scenario two (S2) assumed that the One Million Rai Organic Rice Program is continued every 5 years. The total organic rice area in the Northeast is projected to increase to 320,000 hectares by 2025, 480,000 hectares by 2030, and 640,000 hectares by 2035.

Scenario three (S3) assumed that additional policies are promoted along with the One Million Rai Organic Rice Program to support an expansion of organic rice area. The total Northeast region organic rice area is projected to expand to 800,000 hectares by 2025, 1,600,000 hectares by 2030, and 2,400,000 hectares by 2035.

Scenario four (S4) assumed a "transformation towards sustainability", i.e. that the organic rice area of the Northeast would expand to 829,000 hectares by 2025 and 5,120,000 hectares by 2030. This assumes that about 87 percent of rice fields in this region are converted to organic by 2030 and remain constant at that level to 2035.

Land cover NE Thailand - four scenarios for expansion of organic rice area, 2035



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This study is part of the UNEP TEEBAgriFood Initiative which is funded by the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag

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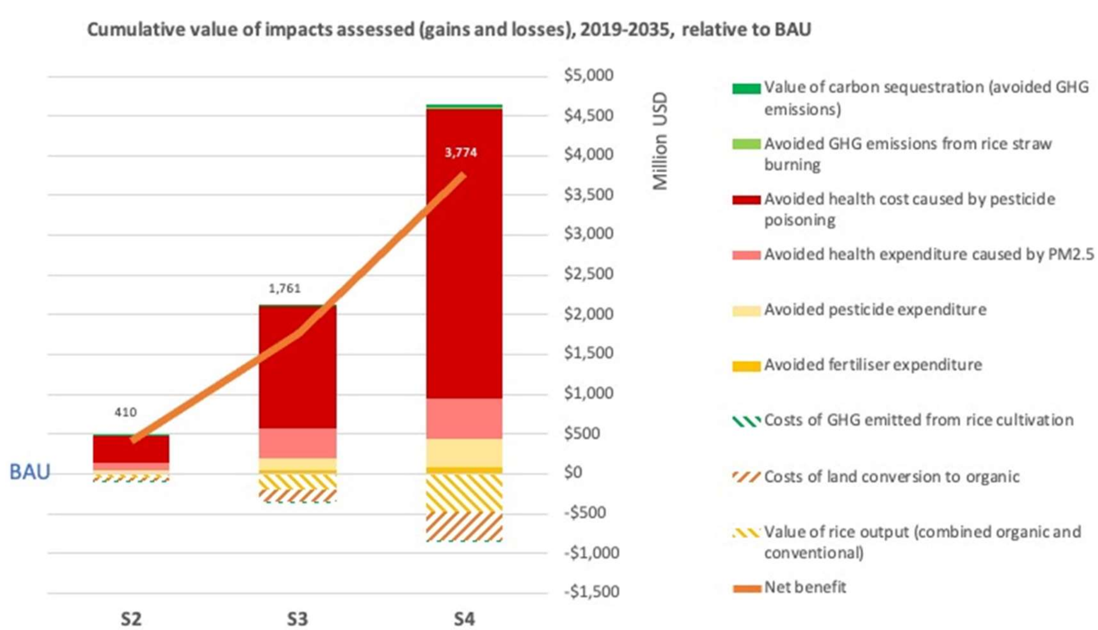
Key messages

1. **To reach the aims of the Bio, Circular, and Green Economy model in Thailand of more sustainable growth and more environmental responsibility, a transition is needed towards fully sustainable rice production and sustainable landscape management.**
    a. Rice production is dependent on ecosystem services such as biological pest control, and soil nutrient cycling. Future food production will be placed at risk if attention is not paid to maintaining healthy and resilient ecosystems that provide the ecosystem services that are critical for food systems. There are some anthropogenic changes that are more global in nature (such as climate change) but others that stem from the local in-country loss of biodiversity and ecosystem degradation.
    b. Thailand applies the Bio, Circular, and Green Economy model as a strategic framework to promote food security, economic opportunity, environmental sustainability, and social viability. Rice production can and should be aligned with this model, and the results from the current study support that contention that the promotion of organic rice production fosters this alignment.
    c. Without intervention, that is, under business as usual (BAU) conditions, over the period to 2035, the models developed in this study predict that current levels of use of chemical fertilizer and pesticide in conventional rice practice would maintain current levels of rice output, but also induce the loss of biodiversity in paddy fields, reduce ecosystem service provisioning, and impose significant risks on human health.
    d. By comparing the values of these losses to ecosystem services and human health with the equivalent values from the alternative scenarios that promote organic production, a strong economic case can be made to support this shift to organic farming systems.

2. **The impact of changes needs to be assessed at the landscape level. Farm-level results give an incomplete picture because they fail to capture the full range of impacts, externalities and dependencies in the system.**
    a. Ecosystem services have a spatial dimension by definition. The structure of the rice landscape influences ecosystem service supply through natural processes such as stable temperatures, adequate and timely rainfall, and nutrient deposition.
    b. Rice fields cover almost half of Thailand's agricultural land. Around 62 percent of rice fields are located in the Northeast region. Changes in cultivation practices can impact the supply and demand of ecosystem services in rice systems, not only on-farm but also in the agricultural landscape more widely.
    c. A scope of analysis that is limited to changes on-farm (as opposed to at the landscape level) would fail to capture the full range of impacts, externalities, and dependencies in the system. Thus in this study, the evaluation of ecosystems and biodiversity in the rice system is assessed at the landscape level.

3. **It is important to make visible the connections between nature and rice food systems by quantifying the often-invisible flow of benefits from ecosystems to food systems and human well-being. This involves identifying where, how much, and to whom, nature provides benefits, showing the impacts of Business As Usual, and what would be the comparative impacts under alternative agri-environmental planning policy scenarios for the future.**
    a. Taking into account three dimensions (production, environment and health), the overall result of the scenario analysis is that the greater the organic rice area, the higher the net benefit (see Figure KM1).
    b. Scenario 2 (S2) and Scenario 3 (S3) generate net benefit of 410 million USD and 1,761 million USD respectively, relative to BAU. Scenario 4 projects the highest net benefit of rice production, representing a total of 3,774 million USD of accumulated value generated from 2019 to 2035, relative to BAU, as a result of the radical expansion of organic rice production in this transformative scenario.
    c. The value gains and losses, however accrue to different groups. Benefits of organic area expansion gained by farmers include **lower production costs, and health risk reduction**. Benefits to the Thai public include **higher productivity** and **lower expenditures associated with improved health outcomes** as well as **enhanced biodiversity**. Benefits to the international community include the **overall reduction in GHG emissions** from the expansion of organic rice area, due to the stubble burning prohibition and higher soil organic carbon accumulation.
    d. The value losses however fall on farmers, including a **loss in rice output** and the **investment costs** of land conversion to organic. While these are minor relative to BAU (see key message 3), they are significant relative to farming household incomes. Such projected outcomes illustrate the both the barriers to change, and the public benefits to be gained by overcoming such barriers.

Figure KM1: Total values for the three alternative scenarios of organic rice area expansion



Note: Changes in value are measured cumulatively over the period 2019-2035, and converted to net present value, at a discount rate of 5%.

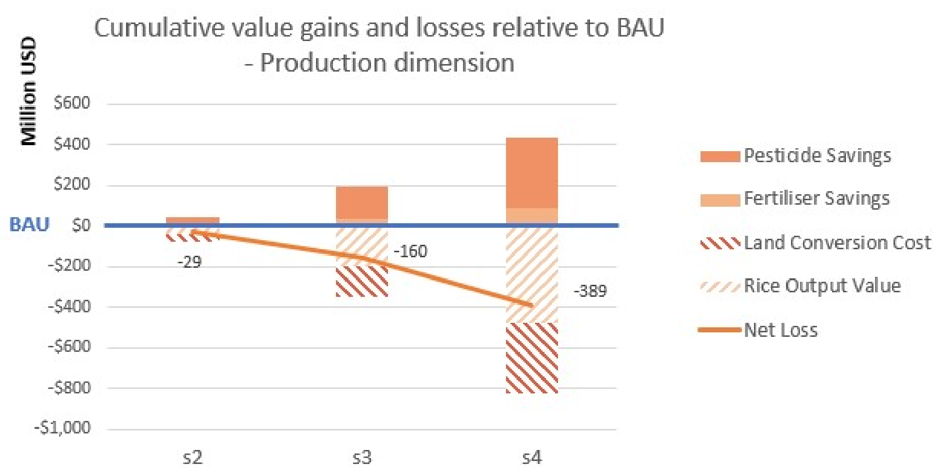
	Data table	2019-2035 S2	2019-2035 S3	2019-2035 S4
Gain	Avoided fertiliser expenditure	9	38	87
Gain	Avoided pesticide expenditure	37	154	350
Gain	Avoided health expenditure caused by PM2.5	99	375	518
Gain	Avoided health cost caused by pesticide poisoning	339	1,538	3,628
Gain	Avoided GHG emissions from rice straw burning	1	3	7
Gain	Value of carbon sequestration (avoided GHG emissions)	3	15	33
Loss	Value of rice output (combined organic and conventional)	(42)	(196)	(476)
Loss	Costs of land conversion to organic	(34)	(156)	(350)
Loss	Costs of GHG emitted from rice cultivation	(2)	(10)	(24)

4. **Rice yields are affected by cultivation practices and environmental condition *inter alia*. Often, when considering whether a switch to organic from conventional is viable and desirable, it is assumed that rice yield under organic production will be diminished in the short to medium term. However, the findings of this study project relatively minor losses, both in terms of volume output and dollar value, as a result of adopting the alternative scenarios relative to BAU.**
   a. The study developed a Denitrification-Decomposition (DNDC) model to predict rice yields under conventional and organic practices over 2019-2035. Predictions took into account relevant climate ecological zones and different soil textures, as well as changes in temperature and rainfall anticipated by the medium climate stabilisation pathway (RCP 4.5).
   b. With respect to volume output, the difference in average organic and conventional rice yield in the Northeast region between 2019 and 2035 was projected to be marginal. In the BAU scenario, the cumulative total rice production in the Northeast region over 2019-2035 is projected to be 262 million tons of rice. The expansion of organic rice area presented by S4, would decrease the cumulative total rice production in the Northeast region to 259 million tons. This is around a 1 percent decline over 2019-2035.
   c. The analysis did not cover potential additional yields or marketed outputs from rice fields, which could be significantly impacted by the expansion of organics:
      - Rice fields also generate usable secondary products such as rice straw. Rice straw can be used for cattle feed, soil amendments, and processed for industrial uses which might be explored further. This study did not measure or value rice straw.
      - The wild foods and medicines from rice fields are significant in the Northeast Thailand. This study did not measure or value the other foodstuffs arising as outputs from rice fields, other than the rice crop.
   d. With respect to net farm revenues from rice, the BAU scenario is projected to generate about 57 billion USD during 2019-2035 in net present value, using a 5% discount rate. Scenarios 2 and 3 generate losses in net revenues relative to BAU, of 29 million USD and 160 million USD, respectively. Scenario 4 represents the highest cumulative loss, a loss of 389 million USD in net revenue during 2019-

2035 when compared to BAU (see Figure KM2). Putting this in perspective, this loss is less than 1 percent of the total BAU scenario projection of net revenue of 57 billion USD.

e. The price of organic and conventional rice output is conservatively assumed to have the same price for the purposes of this assessment. The loss of income from the marginally lower yield for organic farmers would be directly offset as long as farmers can sell their organic rice at a modest premium price (see key message 10).

Figure KM2: cumulative changes in value, 2019-2035, relative to BAU, in relation to production revenues and costs



Note: Changes in value are measured cumulatively over the period 2019-2035, and converted to net present value, at a discount rate of 5%.
Rice output is priced at US $328 per ton for both organic and conventional rice
Unit: Million US Dollars

5. **The emission of greenhouse gases (GHG) from rice fields is generated by cultivation practices (organic fermentation), post-harvest practices (stubble burning), and mitigated by soil carbon sequestration. Overall, the expansion of organic rice area is projected to reduce overall GHG emissions from rice fields, due to prohibition of stubble burning and higher soil carbon accumulation.**

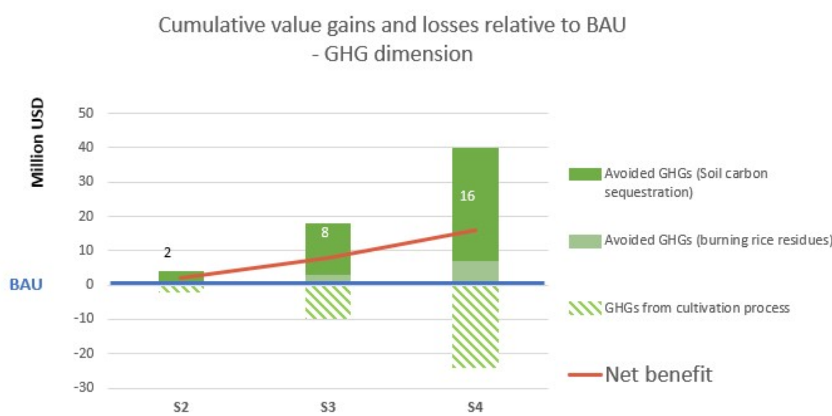
   a. The sources of GHG emissions from rice production are from organic fermentation, particularly during flooding, and from post-harvest stubble burning.

   b. Based on the DNDC model results, the organic rice fields tend to generate higher GHG emissions in cultivation process, compared with conventional rice practice, producing an annual average of 15.54 and 14.59 tons of CO_2 equivalent per hectare, respectively.

   c. Post-harvest, it is estimated that around a fifth of rice residues in the NE is burned, which releases GHG on average around 0.19 tCO_2eq per hectare, whereas stubble burning is prohibited in organic practice.

d. In relation to carbon sinks, organic rice practices are more effective at storing carbon in the soil than regular rice cultivation practice (42.46 and 38 tons of C per hectare, respectively). In this way, soil carbon sequestration, increases as the organic area is expanded.
e. Based on the scenario analysis, the average annual volume of GHG emissions from rice over the period 2019-2035 are relatively stable in all four scenarios. Meanwhile in relation to GHG mitigation, soil carbon sequestration increases as the organic area is expanded. Thus, the expansion of organic rice area as projected in the alternative scenarios 2, 3 and 4 would reduce overall GHG emissions.
f. With respect to the estimated dollar values associated with the projected reduction in net greenhouse gas emissions, a proxy value was applied of $1.67 per ton CO2eq, based on the prevailing market for carbon emission reductions in Thailand.
g. On this basis, during 2019-2035, the emissions generated by the BAU scenario is valued at 1,558 million USD in net present value, using a 5% discount rate. Relative to BAU, S2 would generate a cumulative net benefit of 2 million USD from emissions reductions, S3 would generate a benefit of 8 million USD, while scenario 4 provides the highest cumulative net benefit of avoided GHG emissions of 16 million USD (see Figure KM3).

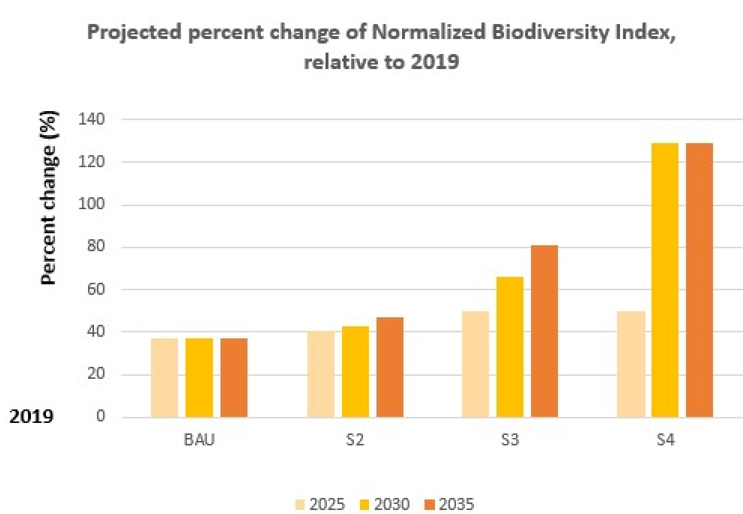
Figure KM3 Cumulative changes in value, 2019-2035, relative to BAU, in relation to climate change



Note: Changes in value are measured cumulatively over the period 2019-2035, and converted to net present value, at a discount rate of 5%.
Value based on prevailing Thai market price of carbon credits $1.67 per ton Co2eq
Unit: Million US Dollars

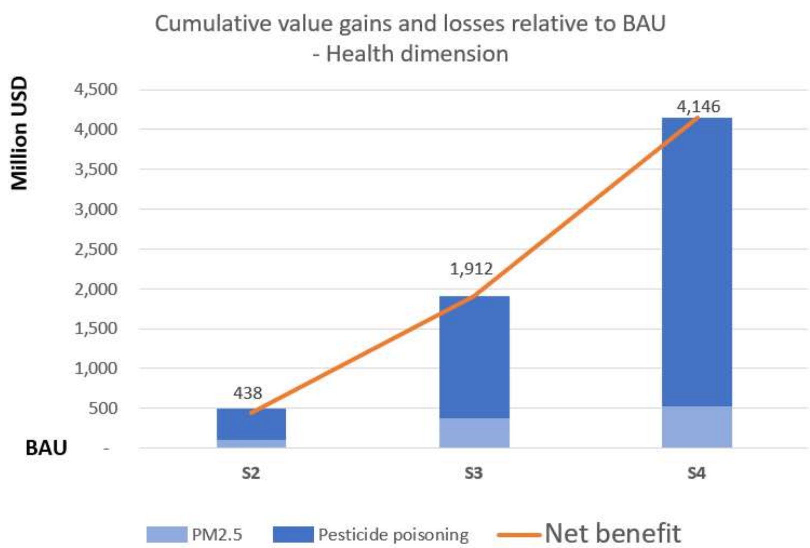
6. **Biodiversity is affected by cultivation practices. With expansion of organic rice, agro-biodiversity increases, especially insect varieties, at landscape level, which promotes natural pest control.**
    a. Some species such as insects like firefly larvae (Lampyridae) and water boatman (Belostomatidae) are less abundant in conventional rice systems as compared with organic systems. Conventional rice production sustains lower biodiversity across multiple taxonomic groups.
    b. From 2019 to 2035, the biodiversity index is projected to increase as the area of organic rice farming increases. The projected change in the biodiversity index in 2035 modelled according to S4 compared to 2019 is 129% (see Figure KM4).
    c. Scenarios 2, 3 and 4 have respectively higher rates of biodiversity improvement than in BAU throughout this period.
    d. Pesticides are capable of terminating beneficial species as well as crop pests. Organic practice prohibits applying pesticide in rice fields. This promotes biodiversity and sustains the population of beneficial insects, which function as natural pest control in the rice field.
    e. In this study, the benefits in relation to biodiversity enhancement were not attributed a dollar value.
    f. It is possible to consider the avoided expenditure on pesticide as a proxy for the benefit of increased biodiversity as a result of organic practice. Household survey results indicated that around 17 USD per hectare per year was saved by organic rice farmers, due to the avoidance of pesticides, reaching a benefit of 350 million USD in reduced costs from 2019-2035 in S4 relative to BAU. However, for the purposes of this assessment, pesticide savings are reported only in the production dimension reported above (see key message 4)

Figure KM4 Percent change of Normalized Biodiversity Index projected from 2019 to 2035 in each scenario compared with 2019



7. **A shift to organic rice production in the Northeast of Thailand would reduce the negative health externalities associated with conventional rice production, through reduced exposure to pesticides and air pollution.**
    a. The scenario analysis estimated the human health benefits of a shift to organic production by considering a reduction in two major health threats posed by conventional production: pesticide poisoning and exposure to air pollution.
    b. The expenses in medical treatment for acute symptoms of pesticide poisoning reported by conventional rice farmers in the Northeast equates to approximately 1.17 million USD annually. Such expenses can be considered a minimum estimate of the annual costs associated with pesticide poisoning in rice farming. The full impacts would include longer-run, less visible impacts not treated via short-term expenditure, such as chronic diseases affecting internal organs such as the liver and neurological system. However, data limitations did not permit valuation of medical costs for long term illnesses associated with pesticide use in rice fields.
    c. A choice experiment was conducted to calculate the value that farmers placed on the reduction of the risk of fatality from pesticide poisoning, using a value of statistical life (VSL) method. In this way, the estimated value of health benefits from reduced pesticide poisoning was assessed at 3,628 million USD over 2019-2035 in Scenario 4, relative to BAU.
    d. Air pollution from post-harvest burning of rice residues is a second major health negative externality of rice production. Residue burning is prohibited in organic rice practice. The economic health impacts of exposure to PM2.5 fall on the public health system and on economic productivity. The Amended Human Capital (AHC) approach was applied to estimate the loss in productivity, measured through gross provincial product, caused by exposure to PM2.5 from rice field burning. In this way, it was estimated that the expansion of organic rice area projected in S4 could bring substantial benefit to the Northeast of 518 million USD, over 2019-2035.
    e. More generally, improved health outcomes can also enhance societal human capital by contributing to happiness and people's sense of well-being. These are challenging to measure explicitly.
    f. A monetary estimate of the negative externalities caused by exposure to PM2.5 and pesticide poisoning during 2019-2035 was projected to be about 10 billion USD, using a 5% discount rate, under the Business as Usual scenario.
    g. Under the alternative scenarios for promoting organic rice production, such costs are projected to be dramatically reduced over time. With expansion of organic rice cultivation under S2, S3 and S4, the cumulative annual reduction in monetary value of health externalities between 2019-2035 was estimated to decrease, by 438 million USD, 1,913 million USD, and 4,146 million USD respectively, relative to BAU. These figures represent monetary estimates of some of the health-related benefits associated with a shift to organic (see Figure KM5).

Figure KM5 – cumulative changes in value, 2019-2035, relative to BAU, in relation to health costs



Note: Changes in value are measured cumulatively over the period 2019-2035, and converted to net present value, at a discount rate of 5%.
Health cost from exposure to PM2.5 is based on valuation by Amended Human Capital (AHC) approach
Health cost from exposure to pesticides is based on Value of Statistical Life (VSL) value from choice experiment of US$ 251.67 per ha
Unit: Million US Dollars

8. **Organic rice production generates other benefits to human well-being for society, food, and culture.**
    a. The impacts on social capital under different rice practices are assessed in social relations, including the outcomes of cooperation, trust, and prosocial behavior.
    b. Organic rice farmer groups were found to engage in more cooperation, trust, and pro-social behavior that led to social capital improvement. Organic farmers reported greater levels of volunteering than conventional farmers. Evidence of pro-social behavior toward others in the community was evidenced by a higher rate of participation in local group activities by organic rice farmers compared with conventional rice farmers for both male and female farmers.
    c. There is evidence that organic rice production contributes to women's empowerment. Female organic rice farmers participate more in group and community activities than conventional rice farmers. Amongst organic farmers, female farmers worked alongside male farmers in community and farmer group activities. This pattern could not be clearly found for female conventional rice farmers.

9. **Farmers' decision to adopt and/or continue to grow rice organically depends on policy support, particularly during the transitional period, and price incentives.**
    a. Adopting organic rice practice requires immediate additional investments such as labour, machinery, and organic fertilizer. In addition, according to the household survey information, the majority of farmers are concerned about the loss of yield,

most especially during the early period of converting from conventional practice to organic practice.

b. Our analysis suggests that the perceptions/assumptions on yields of organic versus conventional farming may be pessimistic. There are however up-front costs for farmers, and access to capital is often limited.

c. Farmers are unwilling to bear these up-front costs for an uncertain future gain resulting in low rate of adopting organic rice practice even when long-term benefits of organic rice practice outperform their conventional counterpart. Hence, to induce farmers to adopt organic practice, temporary risk transfer mechanism such as cost or income subsidy during transition period from conventional to organic practice is necessary.

d. To encourage farmers to continue practicing organic rice after transition, data from our household survey suggests that the following factors are important, availability of a secure organic rice market with premium price, lowering of barriers for getting organic certificate, and extension support to enhance organic rice yield.

10. Policy recommendations

a. The main subsidy policies in agriculture have been focused on reducing farmers' financial hardship, but this does not encourage farmers to adopt more sustainable practices. To induce farmers to adopt organic practice, subsidies need to be reoriented, conditional on adopting sustainable agricultural practice. Initiatives, for example, such as One Million Rai Program (2017-2021) should be scaled up and enhanced.

b. On average, organic rice yields are lower than conventional rice yields, but not significantly so. The loss of income from the marginally lower yield for organic farmers would be directly offset as long as farmers can sell their organic rice at a price that is least 3.5 percent higher than that of conventional price.

c. Organic rice practice generates positive externalities through health and environmental improvements. However, when these positive externalities cannot be completely included or realized by market system, government should step in to minimize market distortion to ensure the public still benefits from positive externalities generated by organic rice farmers activities. In addition, organic rice farmers receive not only positive returns from cultivation cost reduction and health improvement but also generate positive return to their local community and wider society.

d. Exporting organic rice to international market requires different certifications depending on countries. To share cost of getting certification to ensure profitability for farmers, policies aimed to enhance more organic rice production should focus on promoting the grouping of farmers into discreet areas that can be certified as organic instead of at individual level.