Research article

Contribution of Sustainability Rice Cultivation Practice for Farmers according to SRP Standard: A Case Study of Ubon Ratchathani Province, THAILAND

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Abstract: Sustainable rice cultivation is the goal of agricultural development in Thailand. With that in mind, the Thai rice department started the Sustainable Rice Platform (SRP) in Ubon Ratchathani Province, one of the most important jasmine rice production areas of Thailand. Previous studies have shown that most of the paddy fields were in the essential level or "working towards sustainable rice cultivation", the intermediate level of sustainability, while non-paddy fields achieved an overall Sustainable Rice Platform (SRP) score that allowed them to claim to be sustainable rice farms. The purpose of this study was to identify the significant factors that affected sustainability in the group of practices called "SRP theme" and the constraints of rice cultivation development. The study was conducted on 85 farmers in Det Udom district, Ubon Ratchathani Province, Thailand. Questionnaires and in-depth interviews were collected. The results showed that farm size had a significant effect on the Pre-planting theme (a group of pre-plating activities), water management and nutrient management for the SRP score; a larger farm can lead to higher scores. The integrated farming system had a significant effect on farm management, harvest and post-harvest theme. Paddy fields that used the integrated farming system accomplished higher scores. The certified rice program had a highly significant effect on farm management, pre-planting, harvest, and post-harvest theme, including the health and safety theme. Moreover, certified rice programs for farmers (Organic, Good Agricultural Practice - GAP and Sustainable Rice Platform- SRP farmers) enabled higher sustainability rice cultivation scores.

Keywords: rice, sustainability, organic, SRP, GAP, certification

INTRODUCTION

Rice production plays an important role in Thai economy. Thailand was a top-5 rice exporter in 2019 with about 10.3 million metric tons (Startista, 2020). However, this occupation is currently faced with multiple challenges such as global market competition (USDA. 2020), declining yields, the contamination of agrochemicals, biodiversity losses and greenhouse gas emissions (GHG) (G.S. Bhullar, 2015). Rice cultivation accounts for more than half of Thailand's agricultural GHG emissions (MNRE, 2013). As a result, Thailand is rated 20th of the world in terms of agricultural CO_2 emissions (FAO. 2018). It was found that farmers can reduce GHG emissions and make their paddy fields more sustainable by improving some farm activities. The activities that affect the conditions include changing the way to manage water on a farm, the selection of rice cultivars, nutrient management, and cultivation methods (H. L. Suihawati, 2018) that avoid the burning of rice residue (Noppol, 2017). The Rice Department in Thailand started a sustainable rice cultivation project in Ubon Ratchathani Province, one of the most important jasmine rice production areas of Thailand, by using the Sustainable Rice Platform (SRP). This standard was designed for farm-level impact at the smallholder level and consists of 8 sets of actions called SRP themes, each with several requirements, for a total of 46 types of requirements for sustainable rice production. These include: 1) Farm management, 2) Pre-planting, 3) Water use, 4) Nutrient management, 5) Pest management, 6) Harvest and postharvest, 7) Health and safety, and 8) Labor rights. Farmers who want to implement the program must be trained and improve their farming activities following the SRP standards. Within each theme, sustainability can be shown by a percentage score. To improve the sustainability of rice cultivation according to the SRP standards, there is a strong need to identify the factors that impact the SRP scores in each SRP theme in order to boost the farmer's sustainability in rice cultivation, not only reduce GHG emission but also to improve farming efficiency and economic aspects.

OBJECTIVE

This research aimed to identify the significant factors that affected the sustainability in the group of practices and the constraints of rice cultivation development in Det Udom, Ubon Ratchathani Province, Thailand.

METHODOLOGY

The researchers collected both quantitative and qualitative data by using a questionnaire as an interview guideline to assess the characteristics of farmers and their farms in October 2018. The sustainable scores were calculated by using SRP standard version 1.0 developed by SRP and IRRI. (Wyn, 2015) The sustainable scores came from 46 requirements based on farmer's activities. If the activity belonged to idealistic sustainable rice cultivation, the farmer would receive a high score on that requirement. In contrast, if the farm activities were not sustainable, the farmer would get a low or zero score. Total scores were calculated and presented in percentage to clarify the level of sustainable rice cultivation on farms. Stratified random sampling was used to select farmers from each of four types including SRP, organic, GAP and conventional farmer, according to the farmers' list of extension service centers in Det Udom district, Ubon Ratchathani. The total sample size of 85 farmers comprised 11.3% of the farmers on this list.

This study identified the factors that affected each SRP theme score. Eight regression analysis equations were operated based on the 8 SRP themes mentioned previously. All the dependent variables comprised the total score on each theme, while the independent variables were the characteristics of farms and farmers. All independent variables were entered into the equation at the same time, as shown in the following equation.

$$Y(1,2,..8) = a + b1x1 + b2x2 + b3x3 + b4x4 + b5x5 + b6x6 + b7x7 + b8x8 + b9x9 + e \quad (1)$$

Where Y1 = farm management scores, Y2= Pre-planting scores, Y3 = Water use scores, Y4 = Nutrient management scores, Y5 =Pest management scores, Y6 = Harvest and post-harvest scores, Y7 =Health and safety scores, Y8 = Labor right scores, X1 = the certified practice of rice farm (dummy variable: certified/ noncertified), X2 = education period (years), X3 = Level of integration on farm (dummy: 1 component integration), X4 = Level of integration on farm (dummy: 2 component integration), X5 = source of income (dummy: multiple income sources), X6 = labors on farm (person), X7 = yield (kg/Rai), X8 = farm size (Rai), X9 = income (Baht).

The data were evaluated and explained in the 8 equations using Statistical package for social science (SPSS) version 23. The demographic features and farming practices of sample respondents were determined using descriptive statistics and content analysis.

RESULTS AND DISCUSSION

Almost all the farmers in this study were descendants of farmers (98%). Over half of them were aged 40-59 years (63.52%). Most of them were full-time farmers and had more than 10 years of experience (88%). They learned agricultural techniques from their parents and grandparents and observed other techniques from neighbors as well as extension agents. A common cropping system in the area is integrated agriculture. They plant food plants such as basil, bananas, and weed grasses in home gardens and various vegetables as commercial field crops. The average rice yield was 352 kilograms/rai (0.16 hectare), while mean annual farm income was 117,936 baht. Moreover, half of the farmers' revenue (58.82%) came from their farms alone. The factors that give effects to the SRP theme scores are provided in Table 1.

Table 1 Effects of farmer and farm characteristics on average SRP scores for each theme

Theme & Constant	Certified Practice (x1)	Education Period (x2)	Integration component 1 (x3)	Integration component 2 (x4)	Income Sources (x5)	farm Labor (x6)	Yield (x7)	Farm size (x8)	Income (x9)	R^2 & R^{adj}
Farm mgt (Y1) 29.36	19.08 (0.00)** (9.99-28.18)	0.30 (0.54) (-0.68-1.28)	3.25 (0.47) (-5.83-12.34)	-11.27 (0.02)* (-21.13-1.40)	2.98 (0.46) (-5.13-11.09)	0.73 (0.74) (-3.74-5.20)	0.10 (0.12) (-0.02-0.23)	0.03 (0.79) (-0.20-0.26)	-0.00 (0.90) (0.00-0.00)	0.27 0.18
Pre-plant (Y2) 43.17	21.66 (0.00)** (11.85-31.48)	-0.45 (0.39) (-1.52-0.60)	1.75 (0.72) (-8.07-11.54)	-5.55 (0.30) (-16.19-5.08)	4.14 (0.34) (-4.62-12.90)	-0.45 (0.85) (-5.28-4.37)	0.03 (0.66) (-0.11-0.17))	0.30 (0.01) * (0.05-0.55)	-0.00 (0.13) (0.00-0.00)	0.29 0.21
Water use (Y3) 60.99	-2.22 (0.62) (-11.18-6.74)	0.20 (0.67) (-0.76-1.17)	-3.51 (0.43) (-12.47-5.44)	-3.38 (0.49) (-13.10-6.33)	-4.42 (0.27) (-12.42-3.57)	-0.01 (0.99) (-4.42-4.39)	0.06 (0.30) (-0.06-0.19)	0.32 (0.00)** (0.98-0.55)	-0.00 (0.39) (0.00-0.00)	0.14 0.03
Nu mgt (Y4) 102.13	2.24 (0.69) (-9.13-13.62)	-1.01 (0.10) (-2.24-0.21)	-7.98 (0.16) (-19.36-3.39)	-8.97 (0.15) (-21.32-3.36)	6.69 (0.19) (-3.46-16.85)	0.04 (0.98) (-5.55-5.64)	-0.04 (0.61) (-0.20-0.12)	-0.31 (0.03)* (-0.06-0.02)	0.00 (0.56) (0.00-0.00)	0.13 0.03
Pest mgt (Y5) 88.72	1.04 (0.76) (-5.83-7.92)	-0.34 (0.35) (-1.09-0.39)	0.79 (0.81) (-6.08-7.67)	-5.37 (0.15) (-12.83-2.08)	-2.78 (0.36) (-8.92-3.35)	2.41 (0.16) (-0.97-5.79)	-0.01 (0.72) (-0.11-0.08)	-0.10 (0.25) (-0.27-0.07)	0.00 (0.24) (0.00-0.00)	0.10 0.00
Harvest (Y6) 55.81	9.23 (0.02)* (1.12-17.34)	-0.25 (0.56) (-1.13-0.62)	-2.76 (0.49) (-10.87-5.33)	-9.99 (0.02)* (-18.78-1.21)	3.70 (0.31) (-3.53-10.94)	1.71 (0.39) (-2.26-5.70)	0.05 (0.37) (-0.06-0.16)	0.00 (0.95) (-0.20-0.21)	-0.00 (0.68) (0.00-0.00)	0.13 0.03
Health (Y7) 57.21	9.61 (0.00)* (3.33-13.90)	0.08 (0.79) (-0.59-0.76)	1.52 (0.62) (-4.75-7.81)	-5.51 (0.11) (-12.33-1.30)	2.86 (0.31) (-2.74-8.47)	1.88 (0.22) (-1.21-4.97)	0.03 (0.46) (-0.05-0.12)	-0.09 (0.26) (-0.25-0.06)	-0.00 (0.71) (0.00-0.00)	0.17 0.07
Labor right (Y8) 91.69	0.10 (0.96) (-4.89-5.10)	0.17 (0.51) (-0.36-0.71)	0.38 (0.87) (-4.61-5.38)	-3.16 (0.24) (-8.58-2.26)	1.43 (0.52) (-3.03-5.90)	1.94 (0.12) (-0.52-4.39)	0.00 (0.83) (-0.06-0.07)	-0.08 (0.18) (-0.21-0.04)	0.00 (0.64) (0.00-0.00)	0.10 0.00

Source: Investigation by the author (2018)
*Note: mgt = management, *p-value >0.05, **p-value >0.01, 95% Confidence Interval*

The group of independent variables (x1-x9) statistically affected 6 of 8 dependent variables (SRP theme scores). All details are explained as follows:

Farm management Scores

$$Y1 = 29.36 + 19.08x1 + 0.30x2 + 3.25x3 - 11.27x4 + 2.98x5 + 0.73x6 + 0.10x7 + 0.03x8 - 0.00x9 \quad (2)$$

In terms of farm management scores, farmers were required to update their crop calendar throughout the crop cycle, keep recording of all fertilizers, pesticides, and machinery operations as well as calculated quantities of water use, seed variety, yield, and production cost. They also had to attend training or regularly seek professional advice on farm management. According to the Y1 equation, certified practice of rice farm (x1) and integration component on farm (2 component integration : x4) are the variables that contribute significantly to farm management scores. If farms or farmers use the certified rice practice (Organic, GAP or SRP rice practice), the farm management scores increase because farmers must attain training, report their crop calendar, and detail their agricultural activities (such as cost, yield, profit, timing of machine operation, etc.) to the inspectors of the government extension agent, while conventional farmers are not required to do the same. Furthermore, farmers who used integrated agriculture techniques will achieve higher scores on farm management, more component is more sustainable scores. In contrast, farmers who used a monocrop technique got lower farm management scores when compared to the integrated rice farmers.

Pre-planting Score

$$Y2 = 43.17 + 21.66x1 - 0.45x2 + 1.75x3 - 5.55x4 + 4.14x5 - 0.45x6 - 0.03x7 + 0.03x8 - 0.00x9 \quad (3)$$

To achieve high scores in pre-planting, farmers must have the documents to prove that the soil is safe from heavy metal and there is no risk of soil salinity. Their farms must not be in primary forest; the farmland must be flat or be sufficiently leveled. There can be no invasive species and the rice seed must be pure and certified or traceable. Y2 equation shows that the certified practice of rice farm (x1) and farm size (x8) is a statistically significant factor that can increase the sustainability of the pre-planting theme. Certified rice farmers have the condition to check the safety of soil and the quality of rice seed. Further, they are not allowed to cultivate in primary forest areas. This enables certified farms to have higher sustainability scores while conventional farmers have higher risk to achieve lower scores. Additionally, the farmers with bigger farm size (x8) can raise their sustainability in pre-planting of rice farms. If farmers want to develop the sustainability of the pre-planting process, they must check soil quality, adopt land conservation practices such as cover cropping, install erosion barriers or laser land leveling to adjust farm area to fit in the appropriate slope at least every 3 years. This condition increase the production costs on land preparation among smallholder farmers and transform into the constraints of sustainable rice farm development for small scale farmers. Bigger size farm plots will deliver price efficiency compared with smaller farms and provide higher sustainability scores.

Water Use Score

$$Y3 = 60.99 - 2.22x1 + 0.20x2 - 3.51x3 - 3.38x4 - 4.42x5 - 0.01x6 + 0.06x7 + 0.32x8 - 0.00x9 \quad (4)$$

The sustainability of water use is focused on the efficiency of water management, which is consisted of water quality check, timely and appropriate crop establishment, and sufficient irrigation system and safety water drainage. It was found that farm size (x8) had a significant effect on the water use score of the Y3 equation. According to the geography of Det Udom district, which uses a rain-fed rice production system, one of the most challenging factors is the amount of rain used for rice cultivation. Even though the farmers in this area have a good understanding of the local climate and plan well about timing the operation of rice crops, only the farmers who have larger farm areas have enough space to keep rainwater in a pond or other system for supplementary irrigation. Regarding this factor, the sustainability scores for water use theme increased as the size of rice farms increased.

Nutrient Management Score

$$Y4 = 102.13 + 2.24x1 - 1.01x2 - 7.98x3 - 8.97x4 + 6.69x5 + 0.04x6 - 0.04x7 - 0.31x8 + 0.00x9 \quad (5)$$

The scores for nutrient management depend on the efficiency of soil fertility enhancement. Farmers should use crop rotation techniques, as well as apply fertilizer based on the result of soil analysis and split the application of nitrogen fertilizers or use slow/controlled release / deep placement fertilizers. Organic fertilizer must be the first choice to improve soil quality and must be applied in the non-flood areas. In the Y4 equation, it was found that a larger farm size (x8) can help farmers achieve higher sustainable scores on nutrient management. Based on the interviews of the farmers, they prefer to apply the organic manure on wetland or flooding periods of their rice farms. They believe that it's easier and more effective than a deep placement fertilizer technique. For the farmers who have a large farm area (and for who have the rainwater storage pond), however, flooding their paddy field only for fertilizer leads to higher production costs. They choose to apply the fertilizers on dry land instead for economic reasons. Even though it is not based on a complete understanding of nutrient management, the action's result is appropriate for the situation. Furthermore, when it comes to fertilizers, a larger farm size provides more economies of scale, both in terms of cost and wage. For all these reasons, large farms achieve higher scores.

Pest Management Score

$$Y5 = 88.72 + 1.04x1 - 0.34x2 + 0.79x3 - 5.37x4 - 2.78x5 + 2.41x6 - 0.01x7 - 0.01x8 + 0.00x9 \quad (6)$$

On pest management, farmers should understand and adopt the Integrated Pest Management (IPM) technique for principal pest control on their farms. If farmers use a non-chemical methodology to control weed, insect, disease, mollusk, and avoid killing rodents and birds, they achieve high scores. In serious cases, pesticide and chemical substances are allowed to be applied carefully in the target area following the label instructions. Pesticide application equipment should be calibrated and maintained within the current crop cycle. According to the Y5 equation, there is no independent variable on this equation that significantly affects the pest management scores.

Harvest & Post-harvest Score

$$Y6 = 55.81 + 9.23x1 + 0.08x2 + 1.52x3 - 5.51x4 + 2.86x5 + 1.88x6 + 0.03x7 - 0.09x8 - 0.00x9 \quad (7)$$

Harvest and post-harvest scores are focused on the timing of the harvest; the rice moisture content should be 21%-24%. All machines and equipment should be cleaned to prevent contamination. Rice should be transported to the drying facilities within 12 hours and stored away from hazardous substances. Rice stubble and rice straw should not be burned to mitigate GHG emissions. On the Y6 equation, the certified practice of rice farm (x1) and level of integration on the farm (2 component with rice: x4) are the independent variables that significantly affected the scores. Farmers that employ organic, GAP, or SRP rice programs must abide with the rules, which include not permitting farmers to burn their rice straw or using contaminated harvesting machines. The conventional farmers in this study burned their rice fields to save their production costs. However, it caused them to achieve lower scores in this sustainable theme. Farmers who use the integrated cropping system will have various kinds of agricultural commodities. To get their products, many activities will happen on their farmland and some of them can cause dirt or contamination in rice products. In that case, farmers become more concerned about the effect on their harvest and post-harvesting activities. This will help to increase the scores as well as the sustainability of the SRP. In contrast, farmers used the monocrop system and there was less concern about contamination, though it may cause lower sustainable scores.

Health & Safety Score

$$Y7 = 57.21 + 9.61x1 + 0.08x2 + 1.52x3 - 5.51x4 + 2.86x5 + 1.88x6 + 0.03x7 - 0.09x8 - 0.00x9 \quad (8)$$

To achieve high scores, farmers should prepare safety instructors for all farm laborers, prevent related accidents and disease work. Further, first-aid kits should be available on the farms. Calibration and maintenance of all equipment should be done within the crop cycle. Training for agricultural chemical uses is needed if farmers use chemical elements on the rice farms. According to the Y7 equation, the certified practice of rice farm (x1) was statistically significant to the health & safety scores. Participation in certified rice programs enables farmers to learn the effects of chemicals on human health and to learn how to protect themselves.

Labor Rights Score

$$Y8 = 91.69 + 0.10x1 + 0.17x2 + 0.38x3 - 3.16x4 + 1.43x5 + 1.94x6 + 0.00x7 - 0.08x8 + 0.00x9 \quad (9)$$

Labor rights scores focus on how farmers address human rights, including the wage and safety conditions for laborers on their farms. Under this theme, no children below the minimum age can work on farms or be around hazardous work. Further, employers must provide education for children. There can be no forced, prison or bonded labor. Laborers must have the right to join or establish an association or organization to negotiate their needs, received wages, and other benefits according to local and national laws. On the Y8 equation, independent variables on this equation did not have a statistical effect on labor rights scores.

CONCLUSION

The results of the analysis showed that there were three important independent factors that affected the sustainability scores of rice cultivation, consisting of 1) Certified program of the farm, 2) Integrated component of the farm, and 3) farm size. The use of certified rice programs has a substantial impact on 4 SRP themes connected to document certification and training which are the important part to be the certified farmers. Certified farmers have already received extensive training, allowing them to better manage their farms, comprehend the importance of farm preparation, and harvest rice in a sustainable manner. Integrated components affected the management of farms. More farm components would encourage farmers to focus on their management, which will be reflected in their farm management score and harvesting activities. While farm size affected the rice production in pre-planting, water use and nutrient management which is related with farm investment. The larger the farm, the better the chances of being a sustainable rice farm. All significant factors suggested that two major issues need to be addressed to improve the sustainability of rice cultivation, 1) All farmers require adequate knowledge and sustainable rice farming techniques, and the simplest way to achieve this is to urge them to become certified farmers. 2) Farm size cannot be changed easily; therefore, the government should assist farmers in making more profit in the same way, which is through cost reduction. Farmers must participate in the cost-cutting initiative in order to improve their farms sustainable. However, this study was limited in sample size and needed to improve the equation. Future studies should apply this topic with additional budgeting to devise more accurate equations.

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