



Factors Affecting the Use of Trichoderma by Rural Rice Farmers in Thailand

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Abstract Trichoderma is a genus of fungi that can help plants grow, resist disease, and improve nutrient uptake. It's often used as a biocontrol agent in agriculture and horticulture. The use of Trichoderma fungi to reduce the use of chemicals and maintain environmental balance is an alternative to control plant diseases in agriculture. For rice farmers, the use of Trichoderma is a viable alternative as they can save on the cost of chemical fertilizers, which preserve the environment. However, many farmers are aware of how effectively to use Trichoderma and as such may be resistant to its use. The objective of this research was to evaluate the socio-economic factors affecting the adoption and use of Trichoderma by rice farmers in North Thailand regions and the role of agricultural extension in influencing their decision. 172 farmers were interviewed for this research, Structured interviews were used for data collection. The statistics employed included frequency, percentage, mean, and standard deviation. The study's findings include: 1) most farmers were male, with an average age of 53.92 years, and with completion of primary school. Farmers received training regarding the use of Trichoderma from the District Agriculture Office, with an average of 2.67 training sessions per farmer. The average rice farming experience was 17.99 years, the average cultivated rice area was 11.94 rai, the average rice production cost was 31,453.33 baht per year, and the average income was 40,334.33 baht per year and 2) the factors that influenced farmers' adoption of Trichoderma in rice fields were statistically significant at the 0.05 confidence level and included the farmers' experience in growing rice, attendance at Trichoderma training, and their knowledge of Trichoderma.

Keywords Trichoderma, rice production, Thailand, organic

INTRODUCTION

Rice is an economically important food crop, and it is integral to national food security in Thailand. In 2022 - 2023, Thailand was self-sufficient in rice production, and it exported 7.69 million tons of rice, an increase of 22.1 percent over the previous year (21-22) valued at 138 billion baht. Rice exports were to key trading partners including China, the United States, the European Union, South Africa, and Oceania (Department of Foreign Trade, 2022). The Thai government encourages farmers to produce and export high-quality rice. To compete in the world market, domestic rice farmers face many challenges including high production costs due to the outbreak of diseases and more severe pests. Recent challenges related to climate change resulted in decreased rice production. Farmers bear the burden of debt from these increasing operational costs and agricultural inputs.

Rice cultivation in the lower northern region of Thailand covers 5 provinces: Phitsanulok, Sukhothai, Uttaradit, Phichit, and Tak. The total area of rice cultivation is 5.25 million rai (Office of Agricultural Economics 2, Phitsanulok, 2022). In 2022, rice production in the region was 3.09 million tons, with an average yield of 556 kilograms per rai (OAE, 2022). Production conditions in the northern lower region are facilitated and enhanced by irrigation from water sources. This allows farmers to cultivate rice in both the annual and second rice seasons. Farmers often focus on producing quantity rather than quality and farmers are essentially continuously cultivating rice without resting the soil which has resulted in an outbreak of rice weed disease and pest outbreaks. This is due in part to plant diseases, associated with the accumulation of pathogens in the soil that can cause root, vascular, and seedling rot. The health of the soil can affect how likely it is for plants to become infected. Plant disease outbreaks caused by fungi are now common including blight disease, sheath drying disease, and spotted seed disease (Rice Department, 2023). To combat this, farmers were using more agricultural chemicals resulting in chemical residues in the produce and with negative effects on the environment. The introduction of Trichoderma as an alternative to using chemicals to reduce disease outbreaks in plants was introduced in rice fields (Khempol, 2016). Trichoderma helps to inhibit growth, or it destroys the hyphae of plant pathogens (Jamsawang, 2013). It also stimulates plants to develop effective resistance to many common diseases. Therefore, the use of Trichoderma is another way to reduce the use of agricultural chemicals such as Bensulfuron-methyl (BSM), Chylapof-butyl, and Glyphosate-based herbicides (Daotak, 2014).

OBJECTIVE

The objective of this research was therefore to evaluate the social and economic factors influencing farmers' decision to use Trichoderma and the impact on agriculture extension on their decision-making process.

METHODOLOGY

This research utilized a survey to investigate the factors affecting the use of Trichoderma by rice farmers in the five provinces in the lower northern region of Thailand. Sampling was done by a population of 300 members who registered with the Department of Agricultural Extension in 2022 were the target group (DOAE, 2023). Of this population, 172 interviews use structured questionnaires. The selection of the sample size was based on the Taro Yamane formula with an error value of 0.05. The questionnaires used for the structured face-to-face interviews comprised questions focused on: demographics (age, household composition, gender, farming experience), economics conditions (income, earnings, production cost, land ownership status), usage of fertilizers and practices, and level of training received in the use of Trichoderma (type and frequency). The questionnaire was first piloted amongst 30 farmers who provided feedback on how the final questionnaire could be modified including the removal of terms (Chemical names, pest names, disease names) that were not understandable to farmers and specific details about what was covered during 'extension' training. As highlighted above, the final interviews were done face-to-face with farmers in the 5 provinces with a concerted effort to do this proportionately (approximately 36 in each province). Statistics used were frequency, percentage, mean, standard deviation, and multiple regression. w) Descriptive Inferential statistics were done to test the research hypothesis by multiple regression analysis to analyze the factors affecting the use of Trichoderma by rice farmers by farmers in the lower northern region. The forecast equation is as follows.

$$Y_i = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 \quad (1)$$

Where Y_i refers to farmers' acceptance of Trichoderma fungus use, a means constant, b means the coefficient of the relationship between the independent variable and the dependent variable, X means independent variables, including age (X_1), the experience of rice cultivation (X_2).

Period of being a member of the Community Pest Management Center (X_3) Receiving training on Trichoderma (X_4) Using Trichoderma in farming (X_5) Level of engagement with training (as a proxy for 'knowledge of the use of Trichoderma' About farmers' Trichoderma fungus (X_6) and the promotion of Trichoderma use (X_7).

RESULTS AND DISCUSSION

Social and Economic Conditions of Farmers

The basic information about the social and economic conditions of farmers ($n=172$) reveals that there was almost an equal amount of male and female farmers with an average age of 53.96 years and who had completed primary school. The average number of agricultural workers in the household was 2.39 people, the average rice cultivation experience was 17.99 years, the average duration of membership in the community plant management center was 3.53 years, and the average number of training sessions on Trichoderma was 2.67 times. Most farmers received training about Trichoderma from the District Agriculture Office.

From the study results, it was found that 51% of the farmers were male and 49% female, which reflects the general approach in rural communities of rice farming involving family units (wife and husband teams). As highlighted above, most farmers were over 50 years of age, with only 17.4% below 30 years of age. This reflects the national trend, where farmers are starting to enter an aging society, and the younger generation is less involved in farming. The aging population in farming means knowledge of good practices has been lost and continuing need for training is required in Trichoderma use is needed (Seerasarn et al., 2020). This finding is similar to (Seerasarn et al., 2020) and (Samritnok, 2017), who studied the factors influencing the adoption of Trichoderma for pest control in rice fields among farmers in the San Sai District, Chiang Mai Province. They found that farmers had an average age of 58.66 years and an average rice cultivation experience of 27.59 years. Farmers received training on Trichoderma in the community an average of once times. Farming was often done as a husband-wife household activity, with both working together. This is also similar to Sudprasert (2010), who studied the use of biological agents to prevent and eliminate crop pests among farmers in Phitsanulok Province, where it was found that farmers had an average of 2.24 workers in their households for farming.

When farmer's land ownership, production, and earnings were explored it was found that 89.70% of farmers owned land. The average rice cultivation area was 11.94 rai, with an average rice production cost of 31,453.33 baht per year and an average rice production income of 40,334.33 baht per year. The average rice yield per rai was 753.50 kilograms. Farming has been passed down from ancestors, and the land has been divided among children and grandchildren to make a living. This is similar to the results of a study by Daotak (2014) on the adoption of Trichoderma for plant disease prevention among rice farmers in Mae Hong Son Province, which found that farmers had an average rice cultivation area of 7.14 rai. Similarly, Samritnok's study (2017) found that farmers had an average rice production income of 24,427.51 baht from rice cultivation, as most farmers grow rice for household consumption. Any surplus is sold, which results in limited income from rice sales. First of all the growing of rice for personal consumption meant farmers were more keen to produce rice with fewer chemicals, so were more willing to engage in training in the use of Trichoderma "General statements from farmers such as "the chemical affected by breathing and health when applying to the field" and "I don't want my kids to eating too much food with some chemical, it is not good". Secondly, the small amount that farmers make from their rice production means they would rather not spend on chemicals, which are expensive and can put them in debt. Any alternative, particularly where it saves money and is good for the environment and their health, they are more willing to try.

Data Analysis Using Inferential Statistics to Test Research Hypotheses

The results of testing the linear relationship of the independent variables (Table 1) found that the correlation coefficient for each pair of independent variables was not greater than 0.80. This indicates that variables $X_1 - X_7$ can be used as independent variables in multiple regression analysis without creating issues of multicollinearity among the independent variables.

Table 1 Correlation matrix

Variable	X1	X2	X3	X4	X5	X6	X7
X1	1	.541**	.122	.082	.193*	.122	-.100
X2		1	.179	.202*	.350**	-.027	-.106
X3			1	.565**	.302**	.306**	-.246**
X4				1	.528**	.311**	.020
X5					1	.138	-.055
X6						1	-.079
X7							1

An analysis of the factors affecting the use of Trichoderma by rice farmers in the lower northern region was conducted using a multiple regression model with variable reduction (Table 2).

Table 2 Factors affecting adoption of Trichoderma in rice fields of farmers

Variable	Coefficient	t-statistics	Prob.
a	1.650	2.192	0.030*
X_2	- 0.017	- 2.430	0.017*
X_4	0.105	2.400	0.018*
X_6	0.046	2.015	0.046*

Note: * Significant at $P < 0.05$

The results of the multiple regression analysis in Table 2 found that the factors affecting the use of Trichoderma among rice farmers in the lower northern region were as follows.

- 1) The coefficient of the variable rice growing experience (X_2) was equal to -0.017, meaning that with 1 year more experience growing rice, it will not result in acceptance of the use of Trichoderma fungus in rice fields. Farmers increased by 1.7 percent, with statistical significance at the 0.05 level.
- 2) The coefficient of the variable receiving training about Trichoderma (X_4) was equal to 0.105, meaning that when farmers received training about Trichoderma one more time, as a result, farmers' acceptance of the use of Trichoderma in rice fields increased by 10.5 percent, with statistical significance at the 0.05 level. Most of the training is delivered through agricultural extension, which is developed to be accessible to farmers with a basic primary school education, The training is very practical and participatory, giving farmers hands-on experience, rather than based on too much theory.
- 3) The coefficient of the variable knowledge about Trichoderma among farmers (X_6) was equal to 0.046, meaning that when farmers' knowledge about Trichoderma increases by 1 point, it will affect acceptance of the use Trichoderma fungus in rice fields by farmers increased by 4.6 percent, with statistical significance at the 0.05 level.

The results of the research analyzed in Table 2 found that training on Trichoderma and farmers' knowledge about Trichoderma showed no significant difference in experience in growing rice. Therefore, if farmers receive more information about Trichoderma fungus, and continuously. It will also increase farmers' knowledge about Trichoderma. Affects farmers' adoption of the use of Trichoderma in rice fields. Consistent with the study of (Seerasarn et al., 2020) and (DOAE, 2023), it was found that experience in growing rice labor within the household participating in activities related to Trichoderma awareness of news about Trichoderma within the community and attitudes towards the use of Trichoderma. It was the main factor affecting farmers' adoption of the use of Trichoderma for pest control in rice fields. Therefore, agricultural extension officers or relevant agencies should organize training to transfer knowledge about Trichoderma to farmers on a basis, to increase the use of Trichoderma fungi in rice fields.

CONCLUSION

Most farmers are male, have an average age was 53.92 years and completed primary school. Because in the past it was basic education. Most household members consist of husband and wife, their rice cultivation area of less than 10 rai, and the average income from selling rice products was 40,334.33 baht/year. Since most of the rice production was consumed within the household, there was not much income. Most farmers received training on Trichoderma from the District Agriculture Office but still lack skills and knowledge on some issues resulting in farmers a moderate level of knowledge about Trichoderma in rice fields. Factors affecting farmers' acceptance of the use of Trichoderma in rice fields.

Including experience in growing rice training on Trichoderma and farmers' knowledge about Trichoderma and factors that did not affect farmers' adoption of using Trichoderma in rice fields including gender, age, and time period as a member of the community pest management center. Number uses of Trichoderma in farming and a source for receiving information about Trichoderma. Therefore, agricultural extension officers should regularly train and transfer knowledge on the properties and benefits of Trichoderma to farmers. Including gathering groups of farmers to produce and grow Trichoderma. To increase farmers' knowledge about Trichoderma fungi. There was increasing expertise in producing Trichoderma fungus for use in controlling plant diseases in rice fields. The farmers were more knowledgeable about Trichoderma fungus. This will result in a higher use of Trichoderma fungus in farmers' rice fields.

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