Factors Influencing the Acceptance of Soil Test Kit Technology

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Abstract

The cost of fertilizer is considered a major expenditure in the agriculture sector. Thai farmers have been encountering three major problems related to limited choices of fertilizers that fit with arable land, counterfeits and expensive products. Existing researhes aim to improve farming productivity by providing a site-specific nutrient management (SSNM), the so-called "tailor-made fertilizer." In order to properly use the fertilizer, a soil test kit was developed and disseminated. However, the public adoption rate of such a kit is still very limited. Based on this circumstance, this study aimed to analyze the factors affecting farmers' acceptance of the soil test kit by using the Technology Acceptance Model (TAM). The study employed quantitative research methodology, using questionnaire surveys with 100 Thai farmers. Data were analyzed using descriptive statistics and multiple regression analysis. The results revealed that compatibility and training had an impact on the perceived usefulness of the kit. On the other hand, compatibility, trust and training had an impact on the perceived ease of use of the kit. Perceived usefulness, perceived ease of use and attitude toward the use of the kit had an impact on usage intention of the kit, whereas social influence exhibited no effect on both the perceived usefulness and perceived ease of use of the kit.

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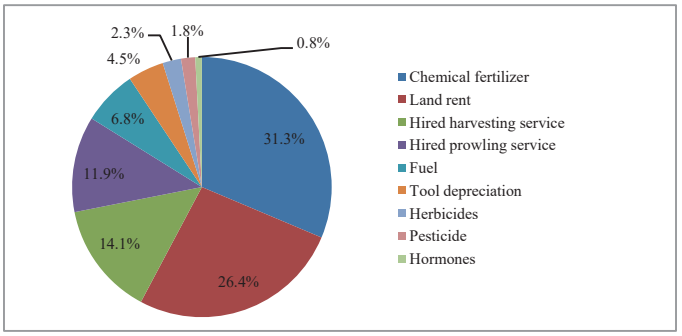
บทคัดย่อ

ต้นทุนค่าปุ๋ยถือเป็นค่าใช้จ่ายหลักในภาคเกษตรกรรม ทั้งนี้ เกษตรกรไทยประสบปัญหาสำคัญ 3 ประการที่เกี่ยวข้องกับปุ๋ย ได้แก่ ข้อจำกัดในการจัดหาปุ๋ยสูตรที่เหมาะสมกับพื้นที่เกษตรกรรม เรื่องปุ๋ยปลอมและเรื่องปุ๋ยมีราคาแพง ด้วยเหตุนี้ จึงมีการศึกษาการเพิ่มประสิทธิผลด้านการเกษตรด้วยวิธีการจัดการธาตุอาหารพืชเฉพาะพื้นที่ ซึ่งเกษตรกรสามารถเข้าถึงและจัดการธาตุอาหารพืชด้วยการใช้ “ปุ๋ยสั่งตัด” ซึ่งในการใช้ปุ๋ยสั่งตัดนั้นจำเป็นต้องใช้ชุดตรวจสอบดิน อย่างไรก็ตาม อัตราการยอมรับของเกษตรกรต่อชุดตรวจสอบดินยังจำกัดอยู่มาก สถานการณ์ที่เกิดขึ้นนี้นำมาสู่การศึกษาปัจจัยที่มีผลต่อการยอมรับเทคโนโลยีชุดตรวจสอบดินของเกษตรกรโดยใช้แบบจำลองการยอมรับเทคโนโลยี (Technology Acceptance Model-TAM) ทั้งนี้ ใช้ระเบียบวิธีการวิจัยเชิงปริมาณ เก็บข้อมูลด้วยการแจกแบบสอบถามเพื่อสำรวจเกษตรกรไทย 100 คน วิเคราะห์ผลที่ได้ด้วยสถิติเชิงพรรณนาและการวิเคราะห์ถดถอยพหุคูณ พบว่า ความเข้ากันได้และการฝึกอบรมเป็นปัจจัยที่มีอิทธิพลต่อการรับรู้ประโยชน์ของชุดตรวจสอบ ความเข้ากันได้ ความไว้วางใจ และการฝึกอบรมเป็นปัจจัยที่มีอิทธิพลต่อการรับรู้ถึงความง่ายในการใช้งานของชุดตรวจสอบ ส่วนการรับรู้ประโยชน์การรับรู้ถึงความง่ายในการใช้งาน และทัศนคติเป็นปัจจัยที่มีอิทธิพลต่อความตั้งใจใช้ชุดตรวจสอบ ในขณะที่อิทธิพลทางสังคมไม่มีผลกระทบต่อทั้งการรับรู้ประโยชน์และความง่ายในการใช้งาน

1. Introduction

In Thailand, agriculture is recognized as a highly competitive sector and it has been a key part in the national development policy. Due to drought, the production of Thai rice declined. The sales volume and value of exported Thai rice have also declined as a result of the higher price of Thai rice in the global market [1]. Meanwhile, the rice production expenditure has been increasing continually and chemical fertilizers was counted as the highest proportion at 31.3% of total expenditure (see Table 1) [2]. Consequently, many farmers have been attempting to cut their expenditure on chemical fertilizers.

Table 1 Rice production expenditure [2]



Growing plants need good soil with appropriate nutrient. Researchers pointed their hypothesis that the concepts of precision agriculture and participatory action research complement each other. Researchers focused on both approaches of empowering farmers and simplifying nutrient management technology to fit farmers' needs [3]. Several instruments were developed including a visual tool to identify soil series, a soil test kit that brings a laboratory to a field and decision-aid kit which enables farmers to interpret results from the soil test kit data. This instrument was referred as "Tailor-made fertilizer technology". The adoption of soil test kits was still very limited, even though the test kit has won the national award of excellent agriculture technology at the time.

Moreover, the availability of soil test kit for tailor-made fertilizer is still limited in the market and not widely adopted has become the key issue. This paper aims to examine the factors influencing the acceptance of soil test kit technology by applying Technology Acceptance Model (TAM). The model determines two key constructs including *"perceived of usefulness"* (PU) and *"perceived ease of use"* (PEOU). The quantitative survey was conducted with the primary data from target respondents in the central area of Thailand.

2. Literature review

2.1 Concept and Benefit of SSNM in Thailand

A site-special nutrient management (SSNM) project focuses on a low-cost technology with high efficiency. The analysis costs around 50 Baht [4]. Farmers expect that the analysis results would lead to fertilizer cost reduction, production yield increases, or both. In 2011, the farmers in Phitsanulok province used SSNM technology, compared to the rice field of farmer practice. The rice plants were lodging (see Figure 1).

SSNM has been implemented in 3 steps:

1) Soil Classification: The researchers developed a simple handbook supporting soil identification by categorizing the soil properties and then informing to farmers.

2) Soil Test Kit: Previously, soil analysis could be performed only in laboratories. For simplification, a soil test kit was invented in Thailand in order to bring a laboratory to a field (see Figure 2) [4]. Therefore, farmers could determine soil pH and "N-P-K" (the proportion of three plant nutrients in order: nitrogen (N), phosphorus (P) and potassium (K)) by themselves within 30 minutes.

2011	"Tailor-made"	Farmer's practice
Yield (kg/rai)	961	792
Fertilizer cost (THB/rai)	362	598

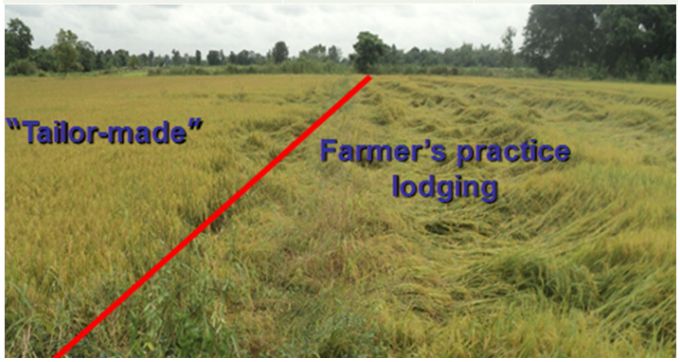


Figure 1 Comparison of fertilizer cost and yield between using tailor-made fertilizer and farmer's practice [5]

3) Decision-Aid: Farmers can easily download software from website and interpret soil test kit data in order to analyze the fertilizer requirements.

2.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) has been widely used for modeling user acceptance for over two decades. It provides an explanation of the determinants of technology acceptance and the prediction of system use. In the literature, TAM can be applied by measuring user's intention, perceived usefulness, and perceived ease of use towards this technology as shown in Figure 3 [6]. There are many studies investigating a number of external factors that can affect user's perceptions [7-10]. One of the most comprehensive treatments of this subject area was conducted by Rogers [11] which addressed the

Figure 2 Soil test kit [4]

5 most important attributes of innovations: Relative advantage/ Compatibility/ Complexity/ Trial ability/ Observability. Thus, it will be adapted to research framework as follows.

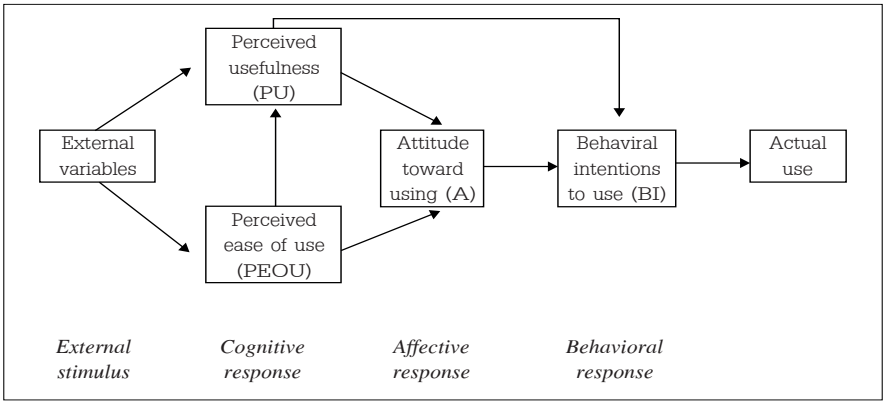


Figure 3 Technology Acceptance Model (TAM)

3. Research Methods

The research started by exploring the determinants of technology adoption intention by interviewing managers and officers of Eco-Community Vigor foundation, respectively. Then, the questionnaire survey was developed to reach out wider group of farmers. The questionnaire is divided into 2 parts.

Part 1: General information

This section contains questions representing demographical characteristics of respondents.

Part 2: Factor affecting the decision

This section contains 27 questions representing farmers' perceptions. A set of questionnaire survey was designed using 4 Likert scales which were ranged from strongly agree to strongly disagree. Four external stimuli factors were covered including training, trust, social influences and compatibility. Figure 4 displays the relationships between variables as referred in the research framework. The hypotheses of this study have been listed in Table 2.

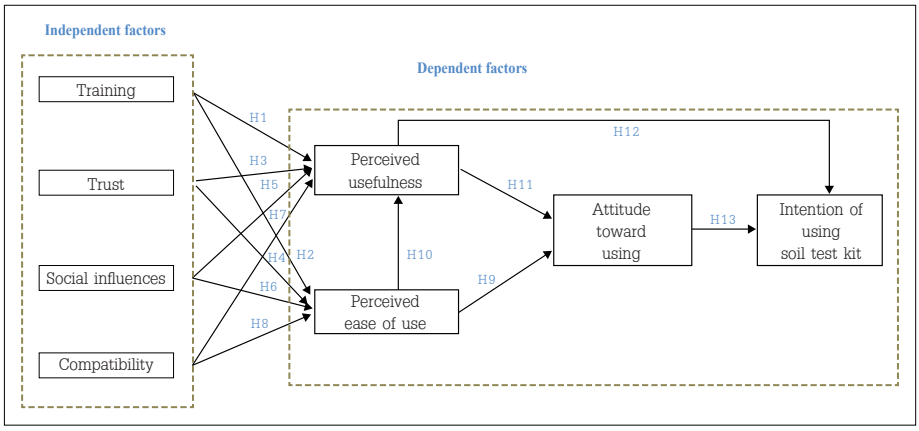


Figure 4 Research framework

Table 2 The hypotheses in this study

Factor	Code	Hypotheses
Training	*H1*	*Training experience will have a positive direct effect on perceived usefulness in soil test kit.*
	H2	*Training experience will have a positive direct effect on perceived ease of use in soil test kit.*
Trust	*H3*	*Trust in technology will have a positive direct effect on perceived usefulness in soil test kit.*
	H4	*Trust in technology will have a positive direct effect on perceived ease of use in soil test kit.*
Social influences	*H5*	*Social influences will have a positive direct effect on perceived usefulness in soil test kit.*
	H6	*Social influences will have a positive direct effect on perceived ease of use in soil test kit.*
Compatibility	*H7*	*Technology compatibility will have a positive direct effect on perceived usefulness in soil test kit.*
	H8	*Technology compatibility will have a positive direct effect on perceived ease of use in soil test kit.*
Perceived ease of use (PEOU)	*H9*	*Perceived ease of use will have a positive direct effect on attitude toward using soil test kit.*
	H10	*Perceived ease of use will have a positive direct effect on perceived usefulness in soil test kit.*
Perceived usefulness (PU)	*H11*	*Perceived usefulness will have a positive direct effect on attitude toward using soil test kit.*
	H12	*Perceived usefulness will have a positive relationship on using intention soil test kit.*
Attitude toward using	*H13*	*Attitude toward using will have a positive relationship on using intention soil test kit.*

Data was collected particularly with respondents who joined soil festival and exhibition. The sample size was 100 farmers who reside in Saraburi and Ayutthaya provinces. 69% of respondents were male. The average ages were 30-49 (49%) and 50-69 (46%) years old. A half of respondents had education in secondary school level (51%). In terms of social status, 30% respondents were organization leaders and 16% were group leaders. 62% of respondents were a landowner and the majority of farming area was 16-50 rai (61%). 32% of respondents grew rice.

In order to be more confident about respondents' background related with the experience of using a soil test kit, the preliminary data was further analyzed with respondents who know soil test kit. Almost all respondents have training experience about soil test kit (84%) and using experience (69%).

4. Research Finding and discussion

The statistical analysis indicates that Cronbach's alpha coefficient is ranged from 0.768-0.799 and all alpha values are above 0.70 which means that the measures are adequately reliable [12]. Construct validity is satisfied because correlations equal to

0.70 or lower are acceptable [13]. In addition to ensure the validity of the data, linear regression technique was applied to measure the correlation between individual variables and independent variables by using two-way interaction. Multiple regression models were suggested to explore the interaction effect [14] which was set at 0.05 ($\propto$=0.05) for significance level of high difference variable.

For a multiple regression analysis, standard coefficient (β) indicates how independent variables affect dependent ones. The regression coefficient between factors smaller than 0.05 indicating statistical significance. The overall correlations between each factor are shown in table 3 below:

Table 3 Statistical analysis result

Dependent variable	Independent variable		Standard coefficients (β)	t	Sig.
Perceived usefulness	Training	(H1)	0.281	3.185	0.002
	Trust	(H3)	0.113	1.225	0.223
	Compatibility	(H7)	0.307	3.434	0.001
	Social influences	(H5)	0.184	1.973	0.051
	Perceived ease of use	(H10)	0.490	5.566	0.000
Perceived ease of use	Training	(H2)	0.193	2.063	0.042
	Trust	(H4)	0.243	2.495	0.014
	Compatibility	(H8)	0.304	3.212	0.002
	Social influences	(H6)	0.064	0.610	0.543
Attitude toward using	Perceived usefulness	(H11)	0.239	2.580	0.011
	Perceived ease of use	(H19)	0.270	2.286	0.024
Intention to use	Attitude toward using	(H13)	0.255	2.611	0.010
	Perceived usefulness	(H13)	0.123	3.700	0.000

H1, H2, H4, H7, H8, H9 H10, H11, H12 and H13 have positive direct effects, whereas H3, H5 and H6 are not affected. According to Figure 5, The combination of PEOU, technology compatibility, and training can predict 40.0 percent of the variance in PU (adjusted R^2=0.400). While the combination of compatibility, trust and training can predict 33.4 percent of the variance in PEOU (adjusted R^2=0.334). Moreover, the variance in attitude toward using is 19.3 percent (adjusted R^2=0.193) at the significant level (Sig.= 0.000) by combining PU and PEOU. The last point is the variance intention to use which is 14.1 percentage (adjusted R^2=0.141) at the significant level (Sig. = 0.001). Thereby, PU and attitude toward using are influenced through the technology adoption which is continuance usage intention of soil test kit.

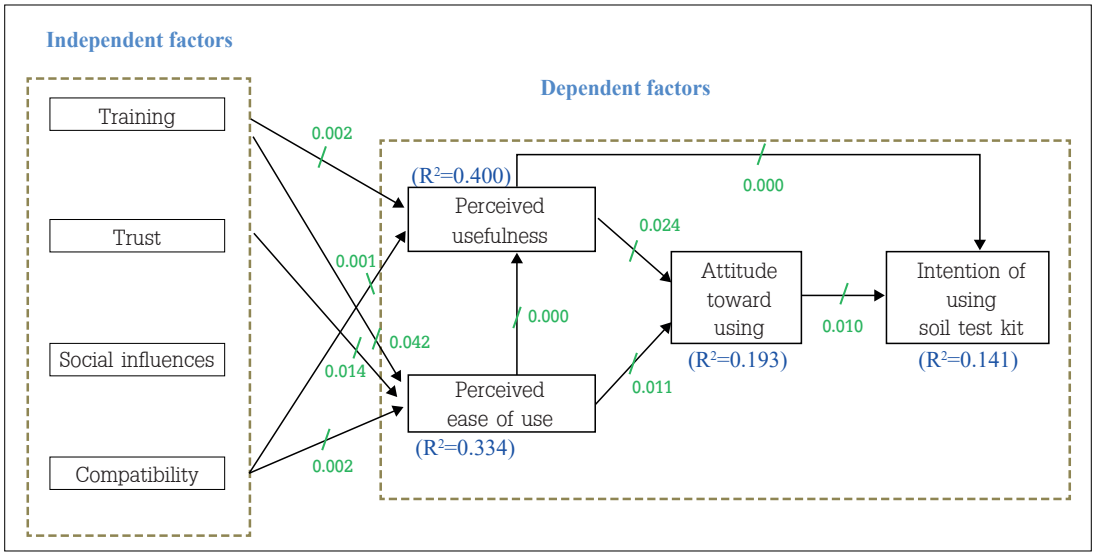


Figure 5 Research findings

5. Conclusion

The research outcome contributes to Technology Acceptance Model (TAM) discipline as follows. First, 3 external stimuli affecting to ease of using a soil test kit are compatibility, trust and training. Training has small influence to PU and PEOU. On the other hand, compatibility is greater positive influence on PU and PEOU which has high capability of affecting in Thai farmer's perceptions and acceptance of use. It has a significant impact on Thai farmer's attitude toward using soil test kit. However, PEOU is higher affected toward attitude than PU. Additionally, PEOU has a significant correlation with PU.

Second, the finding from TAM constructs shows that the attitude toward using soil test kit has an impact on behavior intention more than PU. The correlations of both PU and PEOU have a significant impact on Thai farmer's attitude toward using a soil test kit, however, PEOU is higher effected toward attitude than PU. Additionally, PEOU has a significant correlation with PU.

The findings from previous researches indicate that the PU may reflect considerations of both benefit and cost of using the target system [15]. PEOU may be seen as a part of the cost using system from the user's perspective. Then, the linkage between user's perception and intention can be explained from a cost-benefit perspective [6]. It implies that when soil test kit technology is perceived to be useful, users will have a positive perspective on cost-benefit. Also, when users perceive that a soil test kit is easy to use, the perception on cost-benefit is also improved. The reason is that users perceive that they put less effort into using this technology. In conclusion, the users' perception of increasing benefit and decreasing cost would lead to an increase in positive attitude toward the use of soil test kit which would eventually lead to a higher intention to use soil test kit.

Finally, this study provides a helpful guideline for understanding the technology acceptance in soil test kit among Thai farmer. This research is

expected to help an organization to design the appropriate way to encourage Thai farmer to use this technology.

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