FACTORS INFLUENCING THE ADOPTION OF SOIL TEST KIT TECHNOLOGY

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ABSTRACT

Fertilizer is majority expenditure of agriculture, however, Thai farmers faced counterfeit and expensive fertilizer. There is limited only formula fertilizers available in the market. To help farmer increase productivity and able to identify the propoerties of soil, in 1997 Dr. Tasnee Attanandana had researched a site-special nutrient management(SSNM), or called "Tailor-made fertilizer". In term of technology transfer, Dr. Prateep Verapattananirund disseminated a soil test kit to the public but the adoption rate was slow. Base on this circumstance, this study analyzes the factors affecting farmers' decisions by using Technology Acceptance Model (TAM) to measure the acceptance of a soil test kit. The study is conducted by using quantitative research, with 100 Thai farmers and concludes that social influence is not affect. Compatibility and training are influence to perceived usefulness while compatibility, trust and training are influence to perceived ease of use. Herein, perceived usefulness, perceived ease of use, and attitude toward using are influence to usage intention of a soil test kit. This result can also be used as a guideline for adoption plan of soil test kit technology.

KEY WORDS: Site-Specific Nutrient Management (SSNM)/ Soil Classification/ Soil test kit/Fertilizer recommadation/Technology Acceptance Model

49 pages

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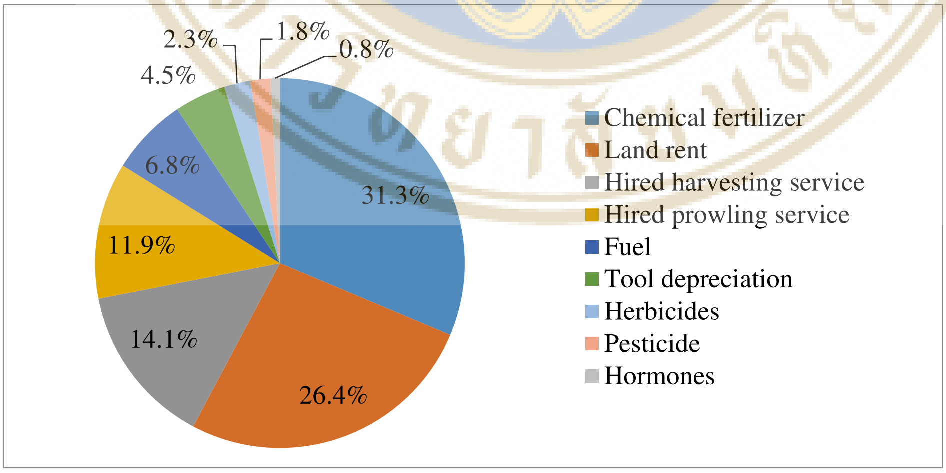
CHAPTER I
INTRODUCTION

As one of the top agricultural countries in the world, Thailand came lastly in farmer's income. The problem is bigger than just cost management.

The production of Thai rice is 38.0 million tons (BOT, 2013). However, it is fall down 0.3 percent from the previous year due to the reduction of plantation area according to drought weather in the first half of year 2013. The sales volume and value of exported Thai rice was also reduced because the price of Thai rice was high so it was declined ability to compete in the global market (BOT, 2013). Thai farmers economically suffered. How do they build the competitive ability in globalization?

The one of powerful solutions is cost saving. One of the main cost of producing rice is chemical fertilizers. It stands on top of production expenditure (Sukjai Tonpanya, 2011, p.49). Total consumption of chemical fertilizer in Thailand is about 6 million tons per year, 2.5 million tons for rice representing 20-30 percent of the total production cost (Verapattananirund P., 2014).

Table 1.1 Rice production Expenditure



Natural resource as soil is the foundation in rice production in addition to good quality seeds, water (rain/irrigation), moisture, temperature and management of farmers. These are the major factors that influence the growth and yield of the rice crop. Plants need 17 nutrient elements, 14 elements from soil and 3 elements from water and air. Nitrogen (N), Phosphorus (P) and Potassium (K) are generally focused on Chemical fertilizers. Plants need the complete nutrients for growing. Deficiency in any element will negatively affect plant growth.

If the soil is fertile, farmer can use less fertilizer. In nowadays, most farmers use fertilizers incorrectly. Chemical fertilizers play a vital role in raising agricultural productivity. It significance is now even more in the light of the steadily declining suitable area for agriculture in all regions of the country as well as the increasingly strong competition in the global market for agricultural goods. However, Chemical fertilizer industry in Thailand totally depends on imported raw materials from abroad which were in the form of basic N (Nitrogen rich) fertilizer, P (Phosphorus rich) fertilizer, and K (Potassium rich) fertilizer, or commonly call "Mae Pui". Producers of these 3 Mae Pui to make various fertilizer formulas that is in demand on domestic market. In point of view, the use of fertilizers is limited by fertilizer formula items in the market for example: 15-15-15, 16-20-0, 16-16-8, 16-8-8, 13-13-21 and etc., resulting in high cost and still has fertilizer recommendation broadly (Industry report published by Bangkok Bank, 2011).

Regardless of nutrients knowledge in the soil, Thai farmers have high possibility to over use of fertilizers, and face the counterfeit fertilizers and high fertilizer price. Therefore, farmers should have adaptation themselves in order to use technology from research to improve production process and quality of their products more and more. Meanwhile, the farmers' income growth cannot realize only one price that it will be the sustainable returns instead of mark down selling price. How do they increase production efficiency?

Precision agriculture is the key concept to transfer the technology to the farmers. Dr. Tasness Attanandana, Dr. Russell Yost and Dr. Prateep Verapattananirund (2007) pointed their hypothesis that the concept of precision agriculture and participatory action research has a similar philosophical basis and complement each other. They have adopted an approach of both empowering farmers and simplifying nutrient management technology to fit farmers need and enable this concept. It can imply that when they have knowledge that is useful, if they use it correctly, they can change some critical factors of production by themselves.

Many parties included The Thailand Research Fund (TRF), Eco-community Vigor Foundation and Kasetsart University had researched “tools” by using this difference of soil for consideration soil nutrient management one used actually which helps Thai farmers increase farming productivity and reduce accumulated chemical in the environment by tailor-made fertilizer application. They simplified technology includes a visual tool to identify soil series, soil test kit that brings the laboratory to the field and decision-aid which enables farmer leaders to interpret results from soil test kit data in light of soil series. This technology called “Tailor-made fertilizer technology”.

Currently, Eco-community Vigor Foundation has been continuously promoting soil test kit in many areas. From the past to the present, books had been published and distributed to farmer and local government offices. Hundreds of seminars talked about this technology. Many participated farmers already had seen soil test kit and got award of excellent agriculture technology in 2009. Why soil test kit of tailor-made fertilizer was still limited available in the market and does not adapt widespread in the farmers.

Hence, the researcher is interested in the factors that affect soil test kit acceptance among farmers who grow rice. This paper examines factors which influence the acceptance of soil test kit technology are used Technology Acceptance Model (TAM) with area focus and key construct in each element, perceived of usefulness and perceived ease of use. To note that apparent, quantitative survey was developed for data collection from target respondents in the central area of Thailand. What are the primary factors are truly affecting to soil test kit acceptance in order to be useful and guidelines for the researcher team and suppliers of soil test kit to application development and planning strategic marketing onward.

CHAPTER II
LITERATURE REVIEW

In this chapter, the review of literature for present study is organized:

Soil Taxonomy

A scientific taxonomy of soils is fundamental to evaluate scientifically for identifying information and using soil resources in multiple reasons such as increasing food production and food security, generating bio product, planning for conservation and ensuring environmental health. Soil scientists have been well-recognized since the beginning of the discipline, which probably can be traced to Russian scientists of the 19^{th} century. The various taxonomies of soil are available in the US Soil Taxonomy, the French System, the Brazilian System, or the Russian System. All provide a fundamental role in the organization and transfer of knowledge of soil science. Most modern GIS systems use soil maps and taxonomy as a base layer of their system. This contribution is essential and a tremendous help to all working with soils, soil-related sciences, and natural resources.

In Thailand, first general soil map was published in 1953, at a scale 1:2,500,000 (Pendleton, R.L. and S. Montrakun, 1957) and defined in soil survey manual (Soil survey staff, 1999). There were rather broad generalizations at level of the soil Great Groups. Subsequent maps were extended the classification of Great Groups into the subgroups, families, and then the technology was adopted countrywide to be current one as “Soil Series”. In 1987, a draft of the generalized soil map was made at a scale 1:1,000,000 (Moncharoen et al, 1987). Then, the Soil Management Support Services (SMSS) of USDA under the leadership of Dr. Hari Eswaran was developed so that all national maps would have a similar legend, which would permit a comparison of soils between countries. They had been changed a number in the Soil Taxonomy by Vijarnsorn, Eswaran, and Vearasilp. Finally, the legend of this map at a scale of 1:1,000,000 was revised basically included the soil map unit being classified at the great group level in accordance with the Soil Taxonomy published in 1999.

There are some circumstances, however, that point out the need for another option for organizing and transferring this information. This needs a special classification recognized by soil taxonomists when they describe both “natural” and “technical” classification systems. A “natural” system has the goal of grouping and differentiating soils in a way that reflects properties fundamental to nearly all the diverse uses of soils, while a “technical” classification system is designed for specific user groups and for specific uses of soils.

In order to apply Soil Taxonomy concepts and to carry out the classification itself, one must be a trained soil scientist with background in soil chemistry and physics. It is not reasonable for everyone because they do not know detailed in the hierarchy of Soil Taxonomy since the Order, Suborder, Great Group, Subgroup, Family as well so that they have adopted in the Soil Taxonomy scheme of using locally relevant names for the soil. Therefore, a decision-aid was designed to empower farmers with soil science knowledge. It has been easily learned by farmers and was proposed by based on the soil series which was used to stratify and index the information needed (Attanandana et al., 1999). Representative climate data was prepared for each of typical levels of soil nitrogen, organic matter, and soil carbon.

Table 2.1 Physical and chemical properties of the important corn production soil series in the corn belt area of Thailand

Series	Classification 1998	pH	Soil color	Depth	Texture	Area (ha)	Regions
Takhli (Tk)	Entic Haplustolls	6.9	very dark grayish brown	shallow	clay loam	55,431	Central Plain
Lop Buri (Lb)	Typic Pellusterts	7.4	very dark gray	deep	clay	34,438	Central Plain
Pak Chong (Pc)	Rhodic Kandiustox	5.2	red	deep to clay	clay	27,440	Central Plain
Warin (Wn)	Typic Kandiustults	6.7	dark brown	deep	sandy loam	25,332	Northeast
Satuk (Suk)	Typic Paleustults	4.9	brown to dark brown	very deep	sandy loam	19,080	Northeast
Chai Badan (Cd)	Leptic Haplusterts	7.0	very dark gray	deep	clay	17,221	Central Plain
Chaturat (Ct)	Typic Haplustalfs	6.8	dark brown to brown	deep oam	silty clay	14,401	Northeast
Lam Narai (Ln)	Vertic Haplustolls	7.0	dark reddish brown	deep	clay	11,112	Central Plain
Tap Kwang (Tw)	Ultic Paleustalfs	6.9	brown to dark brown	deep	clay	10,625	Central Plain
Chok Chai (Ci)	Rhodic Kandiustox	5.2	red	very deep	clay	10,508	Northeast

Tailor-made Fertilizer Technology

Tailor-made Fertilizer Technology is a technology of site-specific nutrient management. It helps farmers use fertilizer in the right types; right quality and quantity to gain more efficient productivity.

The decision-aid of "Tailor-made Fertilizer" was studied from the main factors related to plant growth and yield response under the given environment which have considered together including sunlight, temperature, humidity, rainfall, soil series and available N - P - K in the soil at that time, etc. At the present, there are many mathematical equations that described the influence of soil properties and plant growth. To find the primary nutrient recommendation, crop modeling program such as software application DSSAT (The Decision Support System for Agro Technology Transfer) and PDSS (The Phosphorus Decision Support System) were used, and developed for Potassium which were used to calculate and evaluate the instructions of N-P-K accurately coupled with field experiments in order to increase the efficiency of nutrient management for each specific environment.

Therefore, in different soil series, even amounts of N - P - K in the soils are the same, the result in decision-aid of "Tailor-made Fertilizer" should be different. For example, Ayutthaya soil series and Manorom soil series got the same nutrient contents but their fertilizer recommendation are not equal. However, farmers should observe plant growth and yield response to justify the amount of fertilizers in their area to be more appropriate. It is implied that tailor-made shirts are more fit to our shape than dozen shirts.

Concept and benefit of site-specific nutrient management in Thailand

To develop technology for farmers use, the research project was focused on a low cost technology with high efficiency and easily followed by farmers. In the SSNM project, the costs of technology research for the decision-aids and soil test kits were supported by government. Only soil analysis is the additional production cost of the farmers. Analysis cost of each sample is 50 Bath (Attaya, 2014). However, when farmers use SSNM technology, it is either that the fertilizer cost is reduced, or the production yield increase, or both. These results shown higher economic returns for the farmers as follow:

- In 2007, the experimental results from using SSNM technology for rice in irrigation zone found that production cost reduced 510 baht per rai per crop season or 1,020 baht per rai per year. Thailand has the rice field in irrigation zone about 15 million rai. If the farmers use tailor-made fertilizer recommendation, their production costs will be reduced by more than 15,000 million baht per year.
- In 2009, the farmer leaders in Suphanburi province used SSNM technology for rice growing. Consequently, the profit increased 25% because the production cost was only 3,000 baht per rai compared to that of the farmers practice to 4,000-5,000 baht per rai per crop.
- In 2010, the farmer leaders in Saraburi province expanded SSNM technology to their 13 membership with the and total area of 571 rai. The results found that fertilizer cost was reduced to 50% at 506 baht per rai per crop, while the rice yields increased about 23% or 175 kg per rai. Moreover, the rice plants were strong and so did not fall down during crop seasons; the farmer did not use chemical pesticides which cost about 300 baht per rai per crop. In the first crop, they could reduce chemical fertilizers and pesticides more than 400,000 baht and the yield increased 100 tons of paddies. The results in 2011 were similar to that of 2010.
- In 2011, the farmers in Phitsanulok province used SSNM technology, compared to the rice field of farmer practice. The rice plants were lodging (Figure 2.1).

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

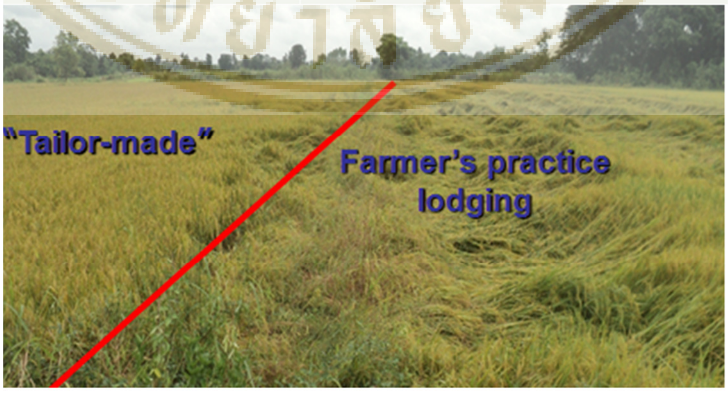


Figure 2.1 Comparison of fertilizer cost and yield by using tailor-made fertilizer and farmer's practice

Simplifying site-specific nutrient management for farmers

Regard to build farmer's capacity, SSNM technology was employed to fit with their needs so that they could learn basic knowledge and conduct field experiments with advice from researchers. Moreover, the interactive learning process was to empower the farmers are taught by testing example and by doing more than by only giving the concept to them. So, they could be self-reliant and more control their lives and business as smart farmers (Verapattananirund, 2007).

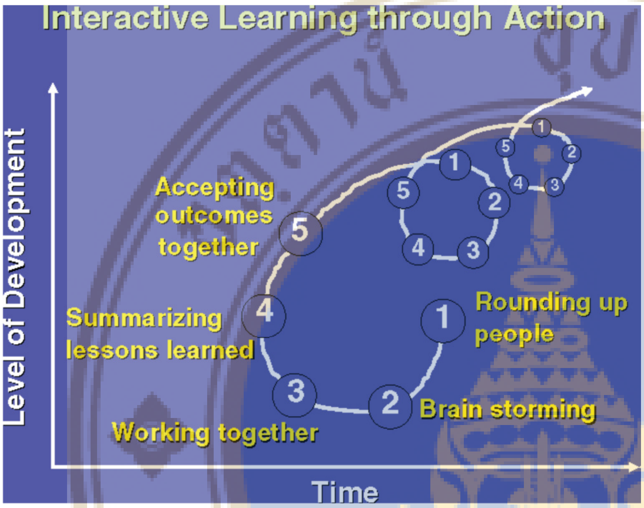


Figure 2.2 The step of Interactive learning

Interactive learning consists of 5 steps as the following:

1. Gather the relevant people in the same time at one place
2. Brain-storm the target problem, possible solutions and outcome
3. Work together as a team by selection the results from brain-storming
4. Summarize the lesson learned from working session
5. Accept the outcome together which are contained in first discussion in the group effort

The interactive learning process enabled the farmers to solve the problems by themselves. The lesson learned through action could be very empowering and help increasing their self-confidence, improve their self-management and re-establish relationship with in their community.

After simplification, there are 3 steps in the SSNM technology implementation as follows:

1. Soil classification

Refer to soil taxonomy, it is too complicated, non-intuitive, and difficult to use by non-expert person such as farmers. In Thailand, there are more than 200 soil series so that the concept is to simplify soil information for farmer. They do not understand the classification of soil series in details, but they need to know the name of soil series in their field.

The researchers developed a simple handbook of soil identification by categorize the soil properties which 5 soil characteristics as follows:

1. Soil color
2. Soil Texture
3. Coarse fragments
4. Soil pH
5. Soil depth

2. Soil test kits

Soil test kit was invented in 1998 in Thailand and patented in 2000 for use in tropical soils. With simplified laboratory procedures, farmers can determine soil pH and "N-P-K" by themselves within 30 minutes.

It is the analysis of a soil sample to determine plant nutrient and pH levels. A soil test kit can determine soil fertility, or the expected soil productivity which indicates nutrient deficiencies. The test is used to mimic the function of roots to assimilate minerals**.** Composite sampling can be performed by combining soil samples from several locations prior to analysis. This is a common procedure, but should be used judiciously to avoid skewing results. This procedure must be done so that government sampling requirements are met. A reference map should be created to record the location and quantity of field samples in order to properly interpret test results.

Figure 2.3 Soil test kit developed by Prof. Dr. Tasnee Attanandana

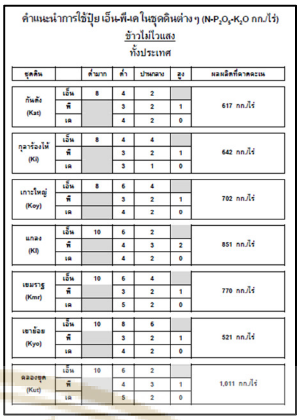
Soil testing is often performed by commercial labs that offer a variety of tests, targeting groups of compounds and minerals. The advantage associated with local lab is that they are familiar with the chemistry of the soil in the area where the sample was taken. This enables technicians to recommend the tests that are most likely to reveal useful information.

3. Decision-Aid

The process of participatory action research is self-direct learning by transferring the calibration of decision-aids on fertilizer knowledge to farmers. The purpose of decision-aid is taken soil series and soil testing results and developed a prediction of fertilizer requirements which are necessary. In the software, there are 3 nutrient calculation algorithms embedded in each for Nitrogen, Phosphorus and Potassium (2007). In order to enable extension to various users such as officers, farmers and other interest people, these algorithms were implemented in Thai and English version, moreover, both desktop and handheld computer.

Currently, the decision-aid program can be easily downloaded information from the website by using MS Access 2003 or higher for 3 major cash crops, namely rice (SimRice), corn (SimCorn) and sugarcane (SimCane) in the Northeast area.

This paper is focused on rice that the program can be instructed 2 particular type of rice including photo-sensitive and non photo-sensitive. The system was calculated and recommended the main composite fertilizer from the mother fertilizer as shown in figure 2.3.



คำแนะนำการใช้ปุ๋ย เอ็น-พี-เค ในชุดดินต่างๆ ($N-P_2O_5-K_2O$ กก./ไร่)
ข้าวไม่ไวแสง
ทั้งประเทศ

ชุดดิน		ต่ำมาก	ต่ำ	ปานกลาง	สูง	ผลผลิตที่คาดคะเน
กันตัง (Kat)	เอ็น	8	4	2		617 กก./ไร่
	พี		3	2	1	
	เค		4	2	0	
กุลาร้องไห้ (Ki)	เอ็น	8	4	4		642 กก./ไร่
	พี		3	2	1	
	เค		3	1	0	
เกาะใหญ่ (Koy)	เอ็น	8	6	4		702 กก./ไร่
	พี		3	2	1	
	เค		4	2	0	
แกลง (Kl)	เอ็น	10	6	2		851 กก./ไร่
	พี		4	3	2	
	เค		4	2	0	
เขมราฐ (Kmr)	เอ็น	10	6	4		770 กก./ไร่
	พี		3	2	1	
	เค		5	2	0	
เขาย้อย (Kyo)	เอ็น	10	8	6		521 กก./ไร่
	พี		3	2	1	
	เค		4	2	0	
คลองขุด (Kut)	เอ็น	10	6	2		1,011 กก./ไร่
	พี		4	3	1	
	เค		5	2	0	

Figure 2.4 SimRice program and Tailor-made fertilizer recommendation

Likely rely on their own, they will be the leader as researchers and use their rice field as "laboratory" by collecting and analyzing the data from their land.

Thus, site-specific nutrient management (SSNM) is simplified technology includes visual tool to identify soil series, soil test kit that bring the laboratory to the field, and decision-aid that farmers can interpret the soil test kit data in light of the soil series. These techniques included social mapping to identify farmer leader learned to implement SSNM or tailor-made fertilizer technology, sharing the knowledge to other farmers, capture and management for well-performed sustainable crop production, and scaling up the knowledge improvement and changing their behavior to work in group and help each other for increasing capability as well.

Technology acceptance

The term 'acceptance' is used with different background and approaches. Acceptance has been conceptualized as an outcome variable in a psychological process that users go through in making decisions about technology. In this literature, user acceptance is often the pivotal factors determine the success or failure of an information system (Davis, 1989) toward the objective of this research is to understand Thai farmer behavior intention to use soil test kit. Therefore, technology implementation is considered from 3 angles: IT usage, user satisfaction, and user performance (Woodroof & Kasper, 1998; Goodhue & Thompson, 1995).

The researcher provided an empirical assessment in this issue, analyzing the impact of the IT implementation processes on end users. In particular, this study examines the changes in end users' perceptions of structural dimensions (the level of centralization and formalization), the changes in end users' perceptions on IT attributes (belief compatibility, work compatibility, relative advantage, complexity, and observability), and the changes in end users' attitudes toward IT (attitude toward change, and computer related anxiety). This study examines both direct changes produced by these constructs and their indirect changes through IT usage, user satisfaction, and user performance as mediating variables (Darmawan, 2000).

Technology Attribute dimension

My point of view has defined the variables in various ways and has grouped them differently. Nevertheless, all of these approaches in one form or another considers the environmental, human, organizational, and the technological factors to be potential factors that affect the successful adoption. In spite of the importance of this domain, particularly for technological innovations, past research has been plagued with a number of conceptual and methodological problems as articulated (Tornatzky and Klein, 1982). One of the most comprehensive treatments of this subject area was conducted by Rogers (1983), his research was summarized in a variety of disciplines indicated the 5 most important attributes of innovations:

(a) Relative advantage
(b) Compatibility
(c) Complexity
(d) Trial ability
(e) Observability

- **Relative advantage** is depicts the degree to which an innovation is perceived or trust in particularities as being better than the existing it supersedes or superior to other competing alternatives, and the extent to which it can provide more benefits (Rogers, 1983).
- **Compatibility** refers to the degree of fit the innovation has adopted organizational unit and has been conceptualized to encompass two aspects: (a) fit or match with current technical and operational practices, and (b) fit with or conformance to the

prevailing beliefs, attitudes, needs of receivers and value system (Rogers & Shoemaker, 1971).

- **Complexity** is the degree to which an innovation that perceived as relatively difficult to understand and use" (Tornatzky & Klein 1982, p. 35). Most of the past research has demonstrated a negative effect of complexity on adoption and implementation of innovation (Fliegel & Kivlin, 1966).
- **Trial ability** is the degree to which an innovation may be experimented with on a limited basis (Tornatzky & Klein 1982, p. 38). Theoretically, innovation that can be tried on the installment plan is adopted and implemented more often and more quickly than less trial able innovations.
- **Observability** is the degree to which the results of an innovation are visible to others (Tornatzky & Klein 1982, p. 38). The more visible the results of an innovation, the more likely the innovation is quickly adopted and implemented.

Technology acceptance model: TAM

Technology Acceptance Model is one of the most popular theories that is used widely to explain to explain an individual's acceptance of an information system. The first purpose, this study has reviewed numerous models which are available in this area. The different studies in this area were evaluated to understand the modifications that were done on this model. The second purpose of the current study was to validate TAM with soil test kit technology as the users' application. The second purpose was to identify the relation of ease of use and usefulness. Doing so could identify features of soil test kit that might contribute to it ease of use and usefulness. Thus, it could provide implications about ease of use and usefulness for developers so on.

Refer to the theoretical background, TAM was described the acceptance as 'Users decision about how and when they will use technology'. Davis has applied the theory of attributed reason, TRA (Ajzen and Fishbein, 1980), about reasoned action to show that beliefs influence attitudes which lead to intentions, and generate behaviors Therefore, a basic concept explains the connection shown TAM can explain the usage of information technology (Davis, 1989).

Davis thus conceived that TAM's belief–attitude–intention–behavior relationship predicts user acceptance of IT. He asserted that perceived usefulness and ease of use represent the beliefs that lead to such acceptance.

Perceived usefulness (PU) is the degree to which a person believes that a particular information system would enhance his or her job performance i.e. by reducing the time to accomplish a task or providing timely information and the perception that it is easy to use (Perceived Ease of Use). To increase capacity and efficiency in work to more that people recognize that you use technology that benefit and offer an alternative values for the same performance as well as if the use of technology.

Perceived ease of use (PEOU) is the degree to which a person believes that using a particular system would be free of effort. The perception that it is easy to use is a variant of primary importance, TAM vulnerabilities which means that users expect to level of technology is the target to use to ease and freedom from effort. Even it is not used often, but they can apply it simple. Thus, any technology would be concerned convenient, not complicated. Perceived ease of use directly influenced the acceptance or the intention to use and indirect effects on transmission behaviors used by acceptance (Agarwal and Prasad 1999; Venkatesh, and Davis 2000).

TAM's dependent variable is actual usage. It has typically been a self-reported measure of time or frequency of employing the application so 2 other constructs in TAM are attitude towards use and behavioral intention to use.

Attitude towards (A) use is the user's evaluation of the desirability of employing a particular information systems application.

Behavioral intention to use (BI) is a measure of the likelihood a person will employ the application.

Some authors have considered additional relationships. Some have ignored intention to use or attitude, and instead studied the effect of ease of use or usefulness directly on usage. Findings about the effects of attitude and intention have not always been significant. Hence, to maintain instrument brevity and permit the study of the antecedents of ease of use and usefulness, the current research similarly studied the direct effect of ease of use and usefulness on usage. Thereby, the propose TAM model in this study is shown in figure 5 (Davis et al., 1989).

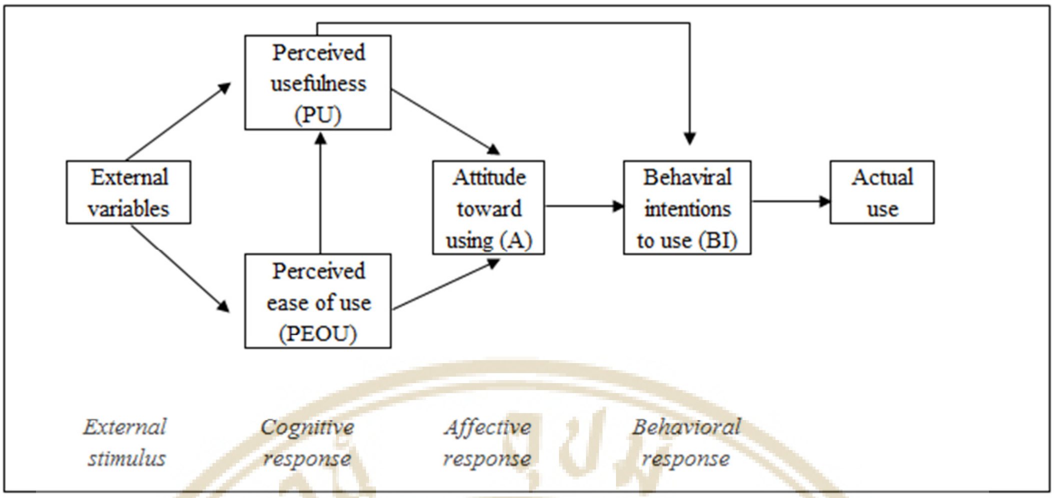


Figure 2.5 Technology Acceptance Model (TAM)

The importance of the antecedents to usefulness and ease of use were suggested that what makes the technology useful and easy to use? Therefore, in addition to employing previous measures of ease of use and usefulness, antecedents' specific to the technology was sought.

In addition, it was found that the perceived ease of use influence the perceived benefits (Agarwal and Prasad 1999; Venkatesh, and Davis 2000). The figure explains perceived useful is influenced by the perception that easy to use by PU and PEOU and attitudes toward using refer to the assessment of user satisfaction with the system. In addition A and PU are also the factors influencing the intention to use and behavioral intention to use by using the system.

To summarize, previous literature has given on basic information of fertilizer, history intention and measurement capability of soil test kit and described many points of view how Thai farmer's acceptance affects soil test kit using. Therefore, technology acceptance model (TAM) will be applied by measuring user's intention, perceived usefulness, and perceived ease of use towards this technology. Moreover, there are many studies presented herein a number of external factors that can affect a user's perceptions that will be adapted to research framework in the next chapter.

CHAPTER III
METHODOLOGY

In this chapter, the methodology applied for this research is quantitative. This is the best suit to this subjected study. There are research method, research measurement are data collection. The detail will be explained in the following paragraph.

Research method

The research starts by exploring the idea determinants of technology post adoption intention, by reviewing related literature and interviewing one manager and one officer of Eco-Community Vigor foundation respectively. This interview is discussed the relevant information which is beneficial for this research. Refer to the interviewees suggestion, the farmers are not comfortable to read many questions. Therefore, the questionnaire has to be precise and easy to understand.

Then, the primary data collection is by sending questionnaire to officer of Eco-Community Vigor foundation and target respondent in order to know their perspective in realistic view releated to this topic and the questionnaire can be developed for further clarification. Thus, it is modified and translated into Thai version.

Research measurement

To answer the research question, quantitative techniques are adopted as concrete information that the researcher can carry out number of people with limited affect to its validity and reliability and can be analyzed more scientifically and objectively which can link to hypothesis more than other forms of research. Regarding above reason, quantitative research is proper to the respondent participation and easily answers closed-end questions with 4 Likert scales which were ranged from strongly agree to strongly disagree respectively.

In order to cover the issues stated in the study framework into 2 parts as the follows.

<u>Part 1</u>: General information which was collected from the respondents.

Independent variables are gender, age, residential location, education level, social status, averaged field area and personal experience in information technology. It can be used to analyze the demographic profile of the respondents by descriptive statistics. Moreover, there are 3 questions for data screening.

<u>Part 2</u>: Factor affecting the decision to use soil test kit technology

The questionnaire is consisted of 27 items. It studies the relation between external factors which are independent factors and farmer's perception. Both factors are usefulness and ease of use of technology are affected to attitude toward using and dependent factor is intention of using soil test kit technology.

In this research, it will use TAM as a base of theory to determine how each external factor affects farmer's perception and measure use acceptance of technology as described in the previous chapter. Therefore, figure 6 illustrates the integrative framework used in this study.

The left side illustrates the external factors which are independent factors and are separated into 4 factors relating to their characteristics.

The right side demonstrates both user's perceived usefulness and perceived ease of use which are dependent factors. In this framework, there are continuously influences to attitude toward using this measurement device and is indicated link to user intention to use soil test kit.

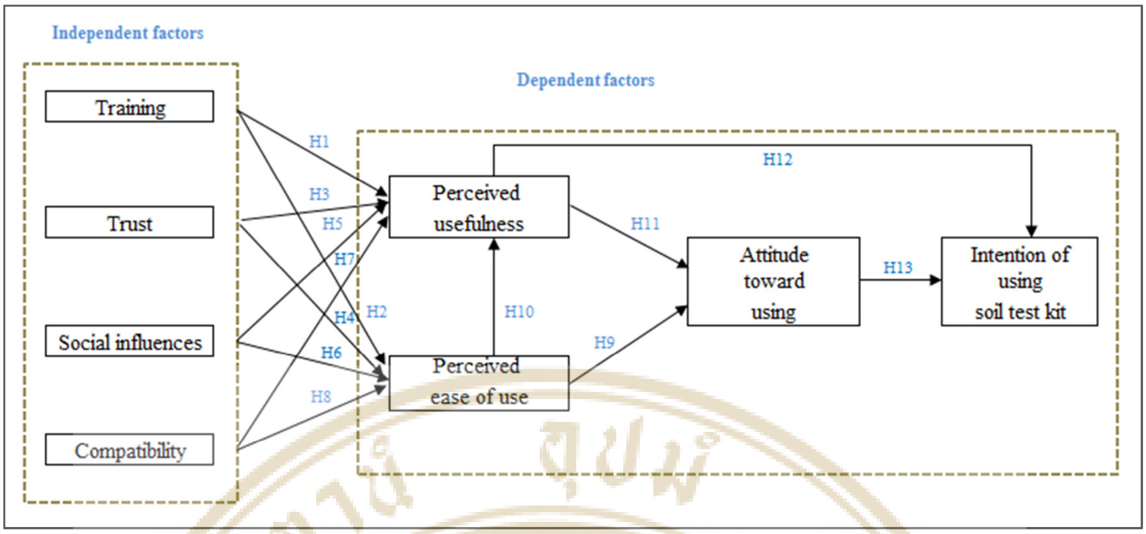


Figure 3.1 Research framework

Hypothesis were based on related point of view of user. Each external factor is shown the relation between its characteristics which are developed to ensure the reliability of the research and divided into 4 factors include training, trust in technology, social influences and technology compatibility. The hypotheses of each factor tend to have capabilities to influence intention of using soil test kit variably which are determined as below:

Table 3.1 The hypothesis in this study

Factor	Code	Hypothesis
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.*

Table 3.1 The hypothesis in this study (cont.)

Factor	Code	Hypothesis
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	*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	*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 Collection

According to difficult approach to the farmers in each field, data was collected sample particularly in soil festival and exhibition in October-November, 2014. The sample size is 100 farmers who are located in Saraburi or Ayutthaya province. All of them must know or have never heard the soil test kit before.

Figure 3.2 The registration zone and conference about SSNM technology

To encourage participation and mitigate non-response bias of farmers, researcher started with a letter describing the purpose of this study to the farmer before doing questionnaire after finish joining in soil festival.

CHAPTER IV
FINDING

This chapter begins by elaborating on the method of analysis. It follows by describes the descriptive data, exploratory reliability and validity analysis, and then, confirmatory factor analysis was summarized through the hypotheses verification stage and estimated the regression coefficient values in justifying how well the data can support the hypothesized model as well.

Data analysis

Hypotheses are constructed based on prior research and quantitative research which was used to collect the empirical data. Firstly, primary data from quantitative research was been screening by verifying and cutting off only the target respondent into analysis by using IBM SPSS Statistics 21.0 model. Secondly, the appropriate data and potential factors were identified by summarizing the percentage of respondent's demographics ranking.

Table 4.1 Summary of respondent's Demographics ranking

Question	Categories	Number	Percentage
Gender	Male	69	69%
	Female	31	31%
Age	Less than 30	2	2%
	30-49	49	49%
	50-69	46	46%
	70 and above	3	3%
Resident location	Ayutthaya	30	30%
	Saraburi	70	70%
Education level	Secondary school	51	51%
	High school	31	31%
	Diploma	10	10%
	Bachelor degree	7	7%
	Above bachelor degree	1	1%

Table 4.1 Summary of respondent's Demographics ranking (cont.)

Question	Categories	Number	Percentage
Social status	Organization leader	30	30%
	Group leader	16	16%
	None of above	54	54%
Right of the land	Own the land	62	62%
	Rent the land	36	36%
	Not identify	2	2%
Area	Less than 15 rai	28	28%
	16 – 25 rai	26	26%
	26 – 50 rai	35	35%
	51 – 100 rai	9	9%
	More than 100 rai	2	2%
Family member	< 3 persons	27	27%
	3 – 5 persons	36	36%
	More than 5 persons	37	37%
Farming workforce Per family	1 persons	34	34%
	2 persons	52	52%
	3 persons	10	10%
	More than 3 persons	4	4%
Farming activity	Only rice plant	69	69%
	Rice plant and others (i.e. farming, fielding working, cattling, etc.)	31	31%
Location of training center	Same village	39	39%
	Same province	57	57%
	Other province	4	4%
Soil test kit training experience	Have even trained about soil test kit	84	84%
	Have not even trained about soil test kit	16	16%
Soil test kit using experience	Have even used about soil test kit	69	69%
	Have not even used about soil test kit	31	31%

From the table 4, it is shown the summary respondents from 100 farmers by demographics. Two-three of respondents are male (69%), and one-three of respondents are female (31%). Average ages are 30-49 and 50-69 year old which showing majority percentage at 49% and 46% respectively and 70% of their residents are located in Saraburi province and 30% are in Ayutthaya province. A half of respondents had educated in secondary school level (51%) and percentage of respondent is become lower when education level upper. In terms of social status, works position of organization leader (30%) and group leader (16%). While 62% are the owner but 32% are tenant the land for rice growing, whereas, 2% are not identify. Majority of farming area is 16-50 rai (61%), thereby; most of them have medium size to be large family size. Opposite with farmer's workforce that mostly has only 2 persons per family (52%). It is implied that one farmer would be taken care of farming area at least 10 rai or more that above figure mentioned.

In order to be more confident about respondent's background relating with soil test kit experience, the preliminary data was done by screening only respondents who have even known soil test kit before. The result shown the training places were located in the same village 39%, different village but same province 57% and different province 4%. Furthermore, almost all have training experience about soil test kit 84% and using experience 69%.

Measurement model

The accuracy assessment of the measurement model is the important step to ensure whether these constructs are valid that have high factor loadings on one construct and low loadings on all other constructs (Stevens, 1996) and adequate to reflect the underlying theoretical construct. The reliability of measurement indicates the stability and consistency with which the instrument is measuring the concept (Sekaran, 1992), how closely related a set of variables are in a group.

Though the questions used in this research, TAM instrument was first tested for its validity and reliability by based upon previous the empirical study, the internal consistency reliability of the scales in each construct is measured by the Cronbach's alpha coefficient. Therefore, reliability of questionnaire refers to extent a measurement is free from random error and has the consistent results of the scale (Cooper and Schindler, 2000). Below table 5 represents the tools using for data analysis in this research.

Table 4.2 Tool for data analysis

Tools	Purpose
Data preparation stage	
· Descriptive statistics (Frequencies)	To examine and present the sample profile
· Visual banning	To create and define name of new categorical variable
· Cronbach's Alpha coefficient	To measure the internal consistency and investigate how closely related a set of variables are as a group
· Construct validation	To ensure that the measures in the construct are valid and adequate to reflect the underlying theoretical construct
Hypothesis verification stage	
· Multiple regression	To indicate the strength of the relationship between the dependent and independent variables; and estimate of the regression coefficient values which represent the amount of variance in the dependent variable explained by the independent variables

Result of hypotheses testing

In this research, Cronbach's alpha coefficient is range from 0.768-0.799 which all result of the alpha value is large above 0.70 hence satisfactory means that the measures are adequately reliable (Straub, 1989).

Table 4.3 Reliability of constructs

Factor	Cronbach's alpha
Training	0.781
Trust	0.791
Compatibility	0.775
Social influences	0.799
Perceived usefulness	0.768
Perceived ease of use	0.779
Attitude toward using	0.786

Construct validity means whether the items chosen are true constructs which are described the event or merely artifacts of the methodology itself (Straub, 1989). Construct validity was completed by examining its discriminant validity.

Therefore, the questionnaire was tested by Bivariate analysis, specifying Pearson product moment correlation coefficient, to measure whether there was less correlation across different methods. The result that discriminant validity indicated correlations across each method as equal to, or lower than 0.7 ($R \leq 0.7$), which means there is high construct validity because correlations equal to 0.7 or lower are acceptable (Ping, 2002).

Table 4.4 External factors and TAM

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

From the results of these analysis, the research model is shown accordingly. In addition to ensure the validity of the data, linear regression technique is applied to measure the correlation between the individual variables and independent variables by using enter method into the model any two-way interaction. Multiple regression models were appropriated suggested to explore the interaction effect (Kalaya, 2001) which was set at 0.05 ($\propto = 0.05$) for significance level of high difference variable.

Referring statistical analysis, standard coefficients (β) which was considered to answer the question of which of the independent variables have a greater effect on the dependent variable in a multiple regression analysis by arranging from the most to least effect of all factors are described as following:

1. Perceived usefulness

1.1 The regress coefficient between perceived usefulness and perceived ease of use is equal to 0.490 (β = 0.490) at significant level (Sig. = 0.000) which is smaller than 0.05 indicates highly statistical significance. Thus, H10 is affected.

1.2 The regress coefficient between perceived usefulness and technology compatibility is equal to 0.370 (β = 0.370) at significant level (Sig. = 0.001) which is smaller than 0.05 indicates statistical significance. Thus, H7 is affected.

1.3 The regress coefficient between perceived usefulness and training is equal to 0.184 (β = 0.281) at significant level (Sig. = 0.002) which is smaller than 0.05 indicates statistical significance. Thus, H1 is affected.

1.4 The regress coefficient between perceived usefulness and social influence is equal to 0.184 (β = 0.184) but not satisfy at statistical significant level (Sig. = 0.051) because value is larger than 0.05. Thus, H5 is not affected.

1.5 The regress coefficient between perceived usefulness and trust is equal to 0.113 (β = 0.113) but not satisfy at statistical significant level (Sig. = 0.223) because value is larger than 0.05. Thus, H3 is not affected.

2. Perceived ease of use

2.1 The regress coefficient of technology compatibility is equal to 0.304 (β = 0.304) at significant level (Sig. = 0.002) which is smaller than 0.05. Thus, H8 is affected.

2.2 The regress coefficient of trust is equal to 0.243 (β = 0.243) at significant level (Sig. = 0.014) which is smaller than 0.05. Thus, H4 is affected.

2.3 The regress coefficient of training is equal to 0.193 (β = 0.193) at significant level (Sig. = 0.042) which is smaller than 0.05. Thus, H2 is affected.

2.4 The regress coefficient of social influence is equal to 0.064 (β = 0.064) but lack of significance at significant level (Sig. = 0.543) because value is extremely larger than 0.05. Thus, H6 is not affected.

3. Attitude toward using

3.1 The regress coefficient of perceived ease of use is equal to 0.270 (β = 0.270) at significant level (Sig. = 0.024). Thus, H9 is affected.

3.2 The regress coefficient of perceived usefulness is equal to 0.239 (β = 0.239) at significant level (Sig. = 0.011). Thus, H11 is affected.

4. Intention of using soil test kit

4.1 The regress coefficient of attitude toward using is equal to 0.255 (β = 0.255) at significant level (Sig. = 0.010). Thus, H13 is affected.

4.2 The regress coefficient of perceived usefulness is equal to 0.123 (β = 0.123) at significant level (Sig. = 0.000). Thus, H12 is affected.

Therefore, H1, H2, H4, H7, H8, H9 H10, H11, H12 and H13 are a positive direct affect, whereas H3, H5 and H6 are not affected. The overall correlations between each factor are shown in figure 4.1.

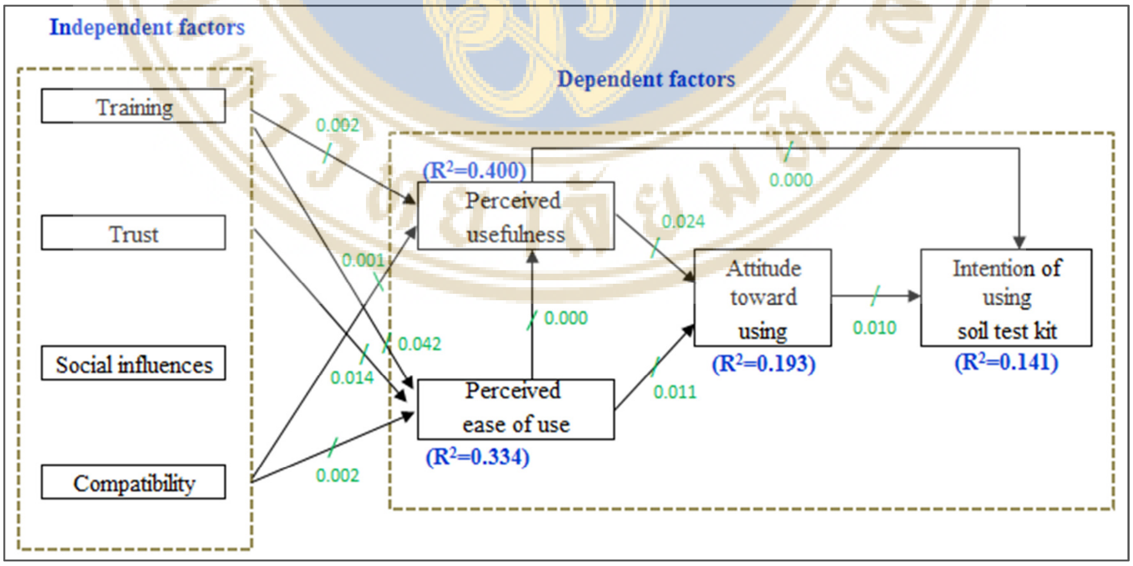


Figure 4.1 Research Finding

The result indicates that the combination of perceived ease of use, technology compatibility, and training can predict 40.0 percent of the variance in perceived usefulness (adjusted R^2=0.400) at the significant level (Sig. = 0.000).

Meanwhile, the combination of technology compatibility, trust and training can predict 33.4 percent of the variance in perceived ease of use (adjusted R^2=0.334) at the significant level (Sig. = 0.000). 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. It gots 14.1 percentage (adjusted R^2=0.141) at the significant level (Sig. = 0.001).

Thereby, perceived usefulness and attitude toward using are influence through the technology adoption which is continuance usage intention of soil test kit.

CHAPTER V
CONCLUSION AND RECOMMENDATION

TAM motivational variables include attitude toward using, perceived usefulness, perceived ease of use and external factors are fully mediate effected the characteristic of the system when influence user's perception differentiation.

In this research, Thai farmer's acceptance was successful by the user's intention to use soil test kit technology. The outcome from TAM constructs shows the attitude toward using soil test kit powerful impact on behavior intention more than perceived usefulness. The correlations of both usefulness and ease of use has a significant impact on Thai farmer's attitude toward using soil test kit, however, ease of use is higher effected toward attitude more than usefulness. Additionally, perceived ease of use was found to have a significant correlation with perceived usefulness.

Regarding theoretical research, the usefulness construct may reflect considerations of both benefit and cost of using the target system (Einhorn, Hogarth, 1981; Johnson, Payne, 1985). Ease of use may be seen as 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 (Davis, 1989). It is implied that when soil test kit technology is perceived to be useful, users will have a positive attitude toward its benefit. In the meantime, when users perceive soil test kit technology is easy to use; the cost perception on this information technology was decreased. The reason is that users perceive that they put less effort into using this technology. Regarding to the result, the perception of increasing benefit and decreasing cost would lead to an increase in positive perception toward soil test kit technology which would eventually lead to a higher intention to use soil test kit technology and further improve.

In term of external factor, there are 3 external stimulus affecting usefulness of soil test kit technology: ease of use, compatibility, and training. While there are 3 external stimuli affecting to ease of use soil test kit technology which are compatibility, trust and training. In comparison, these external factors can be explained an intention-based factors of Thai's farmer which is influenced by external factors involving all 3 main factors: compatibility, trust, training, except social influence which is hypothesized in the research framework. It can be summarized that training is the factor that have small influence to perceived usefulness and ease of use. Conversely, the technology compatibility is greater positive influence on perceived usefulness and ease of use which this factor has high capability of affecting in Thai farmer's perceptions and acceptance of use.

As a result, technology compatibility will be the key assistance in adoption technology. The soil test kit has developed by Kasetsart University which is efficient, quick & easy as well as cheap. Currently, it has been simplified the standard laboratory soil analysis to enable agriculture officer and farmer leader to analyze the soil by themselves. It takes approximately 30-45 minutes, without delay. The basic step is to extract soil sample by acid, then used various reagents for analysis the solution and compared with the color chart. The results (nitrate, ammonium, phosphorus, potassium and soil pH) from analyses are classified into five quality level. The farmers said that this soil test kit is easy to use (Attanandana, Yost and Verapattananirund, 2007). In order to increase the compatibility, soil identification and decision-aids have to simplify and be fit with farmer's operation practice together with simplifying soil test kit for more effectiveness.

In conclusion, this study is provided helpful guidelines for understanding the information technology acceptance in soil test kit in Thai farmer. The use of TAM will also offer a better understanding of user's perception; both perceived ease of use and perceived usefulness. The research implications will help the organization design the appropriate way to encourage Thai farmer to use this technology, moreover, it can be applied the business direction that strengthen capacity in technology compatibility in the further plan.

"The technology cannot develop at all if nobody uses and tries to learn from problems". In the present stage, my recommendation is to build a small team of farmer in every village. Due to the step of soil testing, farmer has to collect the soil and make it dry before analyze. Even if soil test kit was designed the simple testing procedure and has the color chart for easy interpretation as well. One farmer may hesitate to buy a new set of soil test kit individually because their sense of awareness toward the technology is very less and the quantity of soil test kit used per time is very small. One set of soil test kit can test the sample at 50 times in planting crop season just one a year. Therefore, adaptation of the technology should be synergized with farmer empowerment. Farmer should create farmer-centered development by forming a team of farmers which has knowledge and able to facilitate other farmers. Another is to create participatory learning or interactive learning, for instance, brain-storming after harvesting in order to plan the procurement soil test kit and fertilizer in the next crop season. Increasing the buying power, it should have farmers' networking. When they combine the consumption of each people, soil test kit was used worthwhile in one time. Moreover, they also have high bargaining negotiation with the fertilizer shop to find out N-P-K-rich fertilizer, or "Mae Pui".

Finally, in my of point view, technology would be adopted to match with behavior of farmer, for example, how well to develop technology more compatibility, how to reduce the experiment process of soil testing and also to expand the research study and service business to fruits and other agriculture products. Eventually, to change farmer behavior in Thailand, it is not easy. It is so widely adoption topic of fertilizer best management practice. It is not only change the adoption process but also change mind set of Thai farmer to be more precise in agriculture. Hence, this topic needs the collaboration supports in national policy level.

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APPENDICES

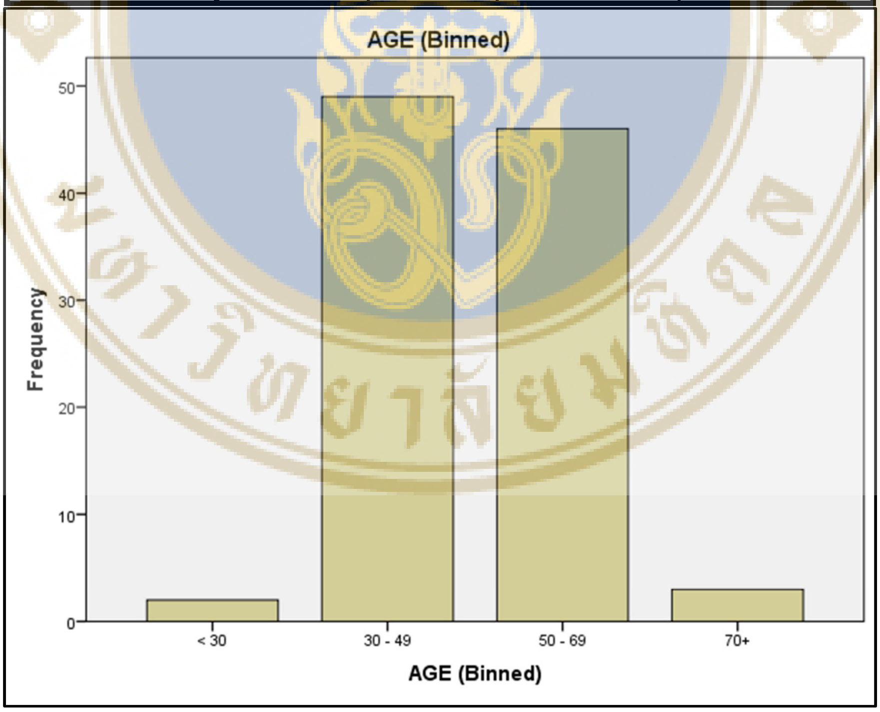
Appendix A Descriptive Statistics

GENDER

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALE	69	69.0	69.0	69.0
	FEMALE	31	31.0	31.0	100.0
	Total	100	100.0	100.0	

AGE (Binned)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 30	2	2.0	2.0	2.0
	30 - 49	49	49.0	49.0	51.0
	50 - 69	46	46.0	46.0	97.0
	70+	3	3.0	3.0	100.0
	Total	100	100.0	100.0	



LOCATION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ayutthya	30	30.0	30.0	30.0
	Saraburi	70	70.0	70.0	100.0
	Total	100	100.0	100.0	

EDUCATION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Secondary school	51	51.0	51.0	51.0
	High school	31	31.0	31.0	82.0
	Diploma	10	10.0	10.0	92.0
	Bachelor's Degree	7	7.0	7.0	99.0
	Higher Bachelor's degree	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

STATUS

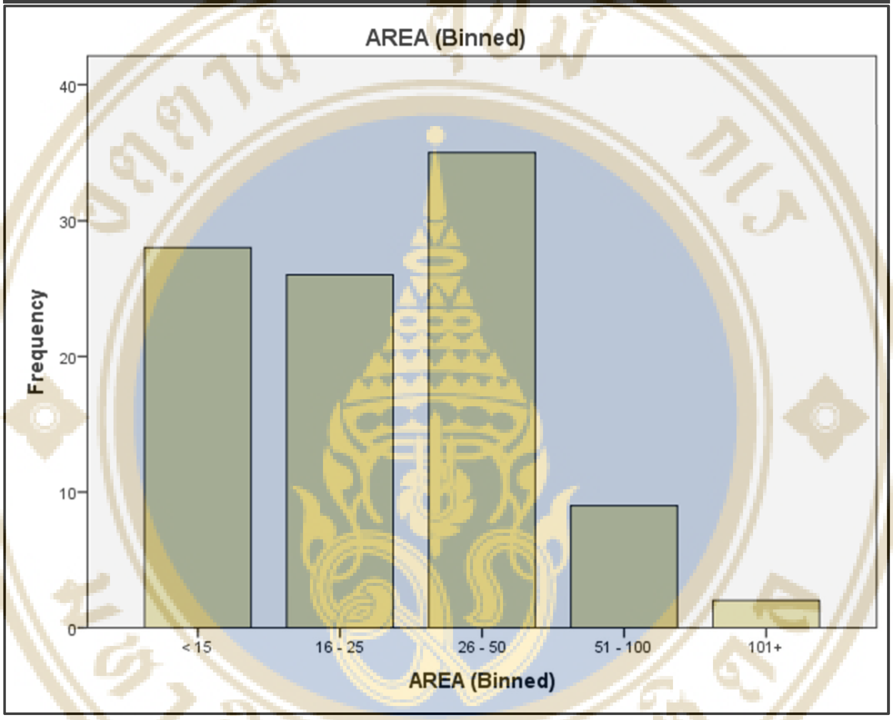
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Goverment	30	30.0	30.0	30.0
	Cooperative	16	16.0	16.0	46.0
	None	54	54.0	54.0	100.0
	Total	100	100.0	100.0	

LAND

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owner	62	62.0	62.0	62.0
	Rent	36	36.0	36.0	98.0
	No identify	2	2.0	2.0	100.0
	Total	100	100.0	100.0	

AREA (Binned)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 15	28	28.0	28.0	28.0
	16 - 25	26	26.0	26.0	54.0
	26 - 50	35	35.0	35.0	89.0
	51 - 100	9	9.0	9.0	98.0
	101+	2	2.0	2.0	100.0
	Total	100	100.0	100.0	



No. of Family (Binned)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 3	27	27.0	27.0	27.0
	3 - 5	36	36.0	36.0	63.0
	5+	37	37.0	37.0	100.0
	Total	100	100.0	100.0	

No. of Farmer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	34	34.0	34.0	34.0
	2	52	52.0	52.0	86.0
	3	10	10.0	10.0	96.0
	4	3	3.0	3.0	99.0
	5	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

Only Rice Farmer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	69	69.0	69.0	69.0
	NO	31	31.0	31.0	100.0
Total		100	100.0		

Location of Training Center

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Locate same village	39	39.0	39.0	39.0
	Locate same province	57	57.0	57.0	96.0
	Locate different province	4	4.0	4.0	100.0
	Total	100	100.0	100.0	

Soil Test Kit Training Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	84	84.0	84.0	84.0
	NO	16	16.0	16.0	100.0
	Total	100	100.0	100.0	

Soil Test Kit Using Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	69	69.0	69.0	69.0
	NO	31	31.0	31.0	100.0
	Total	100	100.0	100.0	

Appendix B Reliability of Constructs and Correlations

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Training	20.7095	2.902	.554	.376	.781
Trust	20.6712	3.042	.492	.314	.791
Compatibility	20.8312	2.776	.582	.413	.775
Social	20.9112	2.830	.478	.316	.799
PU	20.6142	2.929	.639	.434	.768
PEOU	20.8037	3.101	.593	.370	.779
A	20.7562	2.922	.524	.374	.786

Correlations

		Training	Trust	Compatibility	Social	PU	PEOU
Training	Pearson Correlation	1	.345**	.364**	.257**	.479**	.403**
	Sig. (2-tailed)		.000	.000	.010	.000	.000
	N	100	100	100	100	100	100
Trust	Pearson Correlation	.345**	1	.243*	.454**	.368**	.411**
	Sig. (2-tailed)	.000		.015	.000	.000	.000
	N	100	100	100	100	100	100
Compatibility	Pearson Correlation	.364**	.243*	1	.379**	.506**	.456**
	Sig. (2-tailed)	.000	.015		.000	.000	.000
	N	100	100	100	100	100	100
Social	Pearson Correlation	.257**	.454**	.379**	1	.423**	.335**
	Sig. (2-tailed)	.010	.000	.000		.000	.001
	N	100	100	100	100	100	100
PU	Pearson Correlation	.479**	.368**	.506**	.423**	1	.490**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	100	100	100	100	100	100
PEOU	Pearson Correlation	.403**	.411**	.456**	.335**	.490**	1
	Sig. (2-tailed)	.000	.000	.000	.001	.000	
	N	100	100	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix C Coefficients between External factors and TAM factors

Coefficients between External factors and Perceived Usefulness

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	1.075	.331		3.251	.002		1.075	.331
	Training	.247	.077	.281	3.185	.002	.479	.247	.077
	Trust	.106	.086	.113	1.225	.223	.368	.106	.086
	Compatibility	.247	.072	.307	3.434	.001	.506	.247	.072
	Social	.137	.069	.184	1.973	.051	.423	.137	.069

a. Dependent Variable: PU

Coefficients between External factors and Perceived Ease of use

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
2	(Constant)	1.355	.303		4.464	.000		1.355	.303
	Training	.147	.071	.193	2.063	.042	.403	.147	.071
	Trust	.197	.079	.243	2.495	.014	.411	.197	.079
	Compatibility	.212	.066	.304	3.212	.002	.456	.212	.066
	Social	.039	.064	.060	.610	.543	.335	.039	.064

a. Dependent Variable: PEOU

Coefficients between Perceived Usefulness, Perceived Ease of use and Attitude toward using

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
3	(Constant)	1.225	.466		2.632	.010			
	PU	.278	.121	.239	2.286	.024	.371	.226	.208
	PEOU	.362	.140	.270	2.580	.011	.387	.253	.235

a. Dependent Variable: A

Coefficients between Perceived Ease of use and Perceived Usefulness

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
4	(Constant)	1.670	.349		4.791	.000			
	PEOU	.566	.102	.490	5.566	.000	.490	.490	.490

a. Dependent Variable: PU

Coefficients between Attitude toward using and Behavior

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
5	(Constant)	2.575	.434		5.932	.000			
	A	.325	.125	.255	2.611	.010	.255	.255	.255

a. Dependent Variable: Behavior

Coefficients between Perceived Usefulness and Behavior

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
6	(Constant)	1.834	.507		3.617	.000	.828	1.834	.507
	PU	.518	.140	.350	3.700	.000	.240	.518	.140

a. Dependent Variable: Behavior

BIOGRAPHY

NAME	Ms. Shine-napa Somboon
DATE OF BIRTH	November 19th
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PUBLICATION / PRESENTATION	-

Appendix D Questionnaire (English version)

Questionnaire

This research is a part of the master degree program; Management college, Mahidol university. The result from this research will be used in studying about farmers' factor and attitude which can be used to develop and improve company service accordingly.

This questionnaire contains 2 parts; 1. General information 2. Perception and suggestion about soil test kit information

Instructions

Please draw a ✓ in the selected box ☐ and write down your opinion where indicated

Part 1 Farmer's general information

1. Name.. Gender ☐ Male ☐ Female Age ....years old

2. House number.............. Section....... Sub-district...................... District..........................Province.............................

   Mobile phone number ……………………….....……..

4. Education ☐ Secondary school ☐ High school ☐ Diploma

   ☐ Bachelor degree ☐ Higher than bachelor degree ☐ Other (please indicate)...............................

5. Social status

   ☐ Organization leader

   ☐ Group leader

   ☐ None of above

6. Right to the land ☐ Own the land ☐ Rent the land

   Area: .... Rai .... Ngarn

7. Family member ....person Farming workforce ....person

8. Farming activity (can be chosen more than 1)

   ☐ Rice plant ☐ Farming .... ☐ Fielding..........................

   ☐ Working ☐ Cattling .... ☐ Other (please indicate).........................

9. The location of Tailor-made fertilizer network or Soil clinic that you've been participating with

   ☐ Same village ☐ Same province ☐ Other province

10. Have you ever heard about soil test kit before?

    ☐ No ☐ Yes (please indicate your source).......................................

11. Have you ever join Tailor-made fertilizer network or Soil clinic before?

    ☐ No ☐ Yes (please indicate your participating time).......................................

12. Have you ever use soil test kit before?

    ☐ No ☐ Yes (please indicate your participating time).......................................

Part 2 Perception and suggestion about soil test kit information

Choose the number to evaluate each topic

4 = mostly agree 3 = agree 2 = disagree 1 = mostly disagree

Topic	The benefit indicator			
	4	3	2	1
Benefit perception				
1. Soil test kit helps reduce the fertilizer cost				
2. Soil test kit helps inform me about soil nutriment of my land with the accurate result				
3. Soil test kit helps reduce of using too much fertilizer				
4. Soil test kit helps improve farm & field management				
5. I think soil test kit is useful for me				
Easy to use perception				
6. The process of collecting soul to analyze is simple and clear				
7. The procedure of using soil test kit is simple and clear				
8. It's easy and take less time to use the soil test kit				
9. I think soil test kit is easier to use than waiting for the lab result				
Training perception				
10. I think the soil test kit usage workshop is important				
11. I can analyze and interpret the data better after the workshop				
12. I'll be more confident to use the soil test kit if I attained the workshop before				
Trust in technology perception				
13.I think the soil test kit helps me select the right fertilizer for my field				
14. I believe I can analyze my own field				
Compatibility perception				
15. The timing of soil collecting and usage of soil test kit is appropriate with the planting time				

Topic	The benefit indicator			
	4	3	2	1
16. It's easy to buy the customized fertilizer after get the analytic				
17. I can relate the result of soil test kit with the government handbook				
18. I can use the customized fertilizer than before				
Attitude toward using perception				
19. I want to learn more about how to use the soil test kit				
20. I think the usage of soil test kit is benefit to an improvement of my produce amount				
Social influences perception				
21.I think the soil test kit is good if it was recommended from the one I respected				
22. Because my neighbor use the soil test kit and get a better result so I want to use it too				
Intentions to use perception				
23. I think this soil test kit is very useable				

24. If your soil test kit is ran out, will you buy it again?

☐ Yes ☐ No Because..

25. If your village didn't have/use the soil test kit yet, will you encourage your neighbor to use it?

☐ Yes ☐ No Because..

Suggestions

....

....

Thank you for your answering

****

Appendix E Questionnaire (Thai version)

แบบสอบถาม

งานวิจัยนี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาโท วิทยาลัยการจัดการ มหาวิทยาลัยมหิดล ผลของการวิจัยในครั้งนี้เพื่อเป็นประโยชน์ทางการศึกษาปัจจัยและทัศนคติของเกษตกรและสามารถนำไปเป็นแนวทางปรับปรุงคุณภาพการให้บริการหรือพัฒนาระบบงานของบริษัทฯ ต่อไป

<u>คำชี้แจง</u> โปรดเขียนเครื่องหมาย ✓ ลงใน ☐ และกรอกข้อความลงในช่องว่างตามความคิดเห็นและความเป็นจริง

ส่วนที่ 1 ข้อมูลทั่วไปของเกษตรกร

1. ชื่อ-สกุล.. เพศ ☐ ชาย ☐ หญิง อายุ ....ปี

2. บ้านเลขที่.............. หมู่ที่ .... ตำบล..................... อำเภอ.......................... จังหวัด.............................

โทรศัพท์มือถือ ....

4. ระดับการศึกษา ☐ ประถมศึกษา ☐ มัธยมศึกษา ☐ อนุปริญญา

☐ ปริญญาตรี ☐ สูงกว่าปริญญาตรี ☐ อื่นๆ (ระบุ) ....

5. สถานภาพในชุมชน

☐ ผู้นำองค์กรการปกครอง เช่น กำนัน ผู้ใหญ่บ้าน ผู้ช่วยผู้ใหญ่บ้าน สมาชิก อบต.

☐ ผู้นำกลุ่ม เช่น กลุ่มสหกรณ์ กลุ่มเกษตรกร ฯลฯ

☐ ไม่มีสถานภาพการเป็นผู้นำทางชุมชน

6. ที่ดินใช้เพื่อการเกษตร ☐ เป็นของตนเอง ☐ เช่า

ระบุพื้นที่ .... ไร่ .... งาน

7. จำนวนสมาชิกในครอบครัว .... คน จำนวนแรงงานในภาคการเกษตร.................. คน

8. กิจกรรมการเกษตรที่ทำ (ตอบได้มากกว่า 1 ข้อ)

☐ ปลูกข้าว ☐ ทำสวน ระบุ........................... ☐ ทำไร่ ระบุ...........................

☐ รับจ้าง ☐ เลี้ยงสัตว์ ระบุ........................ ☐ อื่นๆ (ระบุ) ....

9. ที่ตั้งศูนย์เครือข่ายโครงการปุ๋ยสั่งตัดหรือคลีนิกดิน ที่ท่านเข้ารับการฝึกอบรมอยู่ใน

☐ หมู่บ้านเดียวกัน ☐ จังหวัดเดียวกัน ☐ อยู่ต่างจังหวัด

10. ท่านรู้จักชุดตรวจดินมาก่อนหรือไม่

☐ ไม่รู้จัก ☐ รู้จัก ทราบจากใคร (อบต./เพื่อนบ้าน/ญาติ)อื่นๆ (ระบุ).......................................

11. ท่านเคยเข้ารับการฝึกอบรมโครงการปุ๋ยสั่งตัด หรือเข้าโครงการคลีนิกดินมาก่อนหรือไม่

☐ ไม่เคย ☐ เคย หากเคย ล่าสุดเข้าร่วมในเดือน........................... ปี............

12. ท่านเคยใช้ชุดตรวจดินมาก่อนหรือไม่

☐ ไม่เคย ☐ เคย หากเคย ล่าสุดเมื่อไหร่ ระบุ เดือน..................... ปี............

ส่วนที่ 2 ข้อมูลเกี่ยวกับข้อคิดเห็นที่มีต่อการยอมรับและข้อเสนอแนะต่อชุดตรวจดิน(Soil test kit)

ให้ท่านเลือกตัวเลขเพื่อประเมินการยอมรับ ในแต่ละหัวข้อมีความหมายดังนี้

4 = เห็นด้วยอย่างยิ่ง 3 = เห็นด้วย 2 = ไม่เห็นด้วย 1 = ไม่เห็นด้วยอย่างยิ่ง

ประเด็นพิจารณา	**ระดับการรับรู้คุณภาพที่ได้จากการใช้**			
	4	3	2	1
1. ชุดตรวจดินช่วยให้ประหยัดค่าปุ๋ยในการทำการเกษตรได้				
2. ชุดตรวจดินช่วยให้ทราบธาตุอาหารในดินที่ต้องการเฉพาะพื้นที่เพาะปลูกของฉัน ผลตรวจจึงมีความถูกต้อง แม่นยำ				
3. ชุดตรวจดินช่วยลดความผิดพลาดในการใส่ปุ๋ยเกินความจำเป็น				
4. ชุดตรวจดินช่วยให้การจัดการดินในไร่นามีประสิทธิภาพขึ้น				
5. ฉันคิดว่าชุดตรวจดินมีประโยชน์กับงานของฉัน				
6. ขั้นตอนการเก็บตัวอย่างดินเพื่อมาวิเคราะห์ธาตุอาหาร มีความชัดเจน เข้าใจง่าย				
7. ขั้นตอนการใช้ชุดตรวจดิน มีความชัดเจน เข้าใจง่าย				
8. การใช้ชุดตรวจดินเพื่อมาวิเคราะห์ธาตุอาหาร ไม่ต้องใช้เวลาและความพยายามมาก				
9. ฉันคิดว่าชุดตรวจดินใช้ง่ายกว่าแบบเดิมที่รอผลจากห้องปฏิบัติการ				
10. ฉันเห็นว่าการอบรมวิธีการใช้ชุดตรวจดินมีความจำเป็น				
11. เข้าใจการวิเคราะห์และอ่านค่าดินมากขึ้นหลังได้อบรม				
12. ถ้าได้รับการอบรมก่อน จะทำให้ฉันมีความมั่นใจในการใช้ชุดตรวจดินมากขึ้น				
13. ฉันเชื่อว่า ชุดการตรวจดินช่วยให้เลือกซื้อปุ๋ยได้ฉลาดขึ้น				
14. ฉันเชื่อมั่นว่า ฉันวิเคราะห์ดินเองได้				
15. การเก็บตัวอย่างดินและการใช้ชุดตรวจดิน มีความเหมาะสมกับช่วงเวลาการเพาะปลูก				
16. หลังจากทราบผลวิเคราะห์ดิน สามารถเทียบหาปุ๋ยสั่งตัดได้ไม่ซับซ้อน				
17. ฉันสามารถเชื่อมโยงผลจากชุดตรวจดิน โดยตรวจสอบชุดดินจากแผนที่ดินของกรมพัฒนาที่ดินหรือคู่มือคำแนะนำปุ๋ย				

ประเด็นพิจารณา	ระดับการรับรู้คุณภาพที่ได้จากการใช้			
	4	3	2	1
18. ฉันสามารถหาซื้อสูตรปุ๋ยได้ตามต้องการมากขึ้น				
19. ฉันสามารถทำความเข้าใจ อยากเรียนรู้การใช้ชุดตรวจดินนี้				
20. ฉันมองว่าการใช้ชุดตรวจดินส่งผลดีในการทำงานและเพิ่มผลผลิตของฉัน				
21. ฉันเชื่อว่าใช้ชุดตรวจดินดี เมื่อคนที่ฉันนับถือแนะนำ				
22. เพื่อนฉันใช้ชุดตรวจดินแล้วผลผลิตดีขึ้น ฉันเลยอยากใช้บ้าง				
23. ฉันยอมรับว่าชุดตรวจดินนี้น่าซื้อ น่าใช้				

24. เมื่อน้ำยาและสารเคมีในชุดตรวจดินหมดแล้ว ท่านอยากซื้อชุดตรวจดินใหม่อีก 1ชุด หรือไม่

☐ อยากซื้อ ☐ ไม่อยากซื้อ เพราะ...

25. ถ้าในหมู่บ้านของท่านยังไม่มีชุดตรวจดิน ท่านจะซื้อหรือสนับสนุนให้คนในหมู่บ้านท่านซื้อหรือไม่

☐ ซื้อ ☐ ไม่ซื้อ เพราะ...

26. อะไรที่อยากให้ปรับปรุงมากที่สุด (เลือกมาแค่ 1 ข้อ)

☐ วิธีเก็บตัวอย่างดิน ☐ วิธีตรวจสอบธาตุอาหารในดิน ☐ วิธีตรวจสอบกรด-ด่างในดิน

☐ เอกสารเทียบชุดดิน ☐ รูปแบบและเนื้อหาที่ใช้อบรม-สาธิต ☐ ผู้ให้การอบรม-สาธิต

☐ สถานที่บริการตรวจดิน ☐ สถานที่ขายแม่ปุ๋ย ☐ อื่นๆ (ระบุ) ....

ข้อเสนอแนะอื่นๆ

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ขอขอบคุณท่านที่เสียสละเวลาในการตอบแบบสอบถาม

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