ปัจจัยที่มีอิทธิพลต่อการตัดสินใจใช้ธาตุอาหารพืชรูปแบบใหม่ของเกษตรกรผู้ปลูกข้าวเขตอำเภอนครหลวง จังหวัดพระนครศรีอยุธยา

FACTORS INFLUENCING THE ADOPTION INTENTION OF MODERN PLANT NUTRITION FOR RICE FARMERS IN THE NAKORNLUANG DISTRICT, AYUTTHAYA PROVINCE

สุริยา สุริยกานนท์* และสก๊อตต์ เอส. รอช

Suriya Suriyakanont*, and Scott S. Roach

The Graduate School, Stamford International University

*corresponding author e-mail: suriyakanont@gmail.com

Received: 31 September 2019; Revised: 18 October 2019; Accepted: 24 October 2019

บทคัดย่อ

วัตถุประสงค์ของงานศึกษาวิจัยนี้ เพื่อหาปัจจัยจากตัวแปรภายนอกที่มีอิทธิพลต่อพฤติกรรมในการตัดสินใจเลือกใช้ธาตุอาหารพืชของชาวนา เช่น ก) ระดับองค์ความรู้ ข) ด้านระบบนิเวศทางสังคม และ ค) ผู้นำทางความคิด โดยเสนอกรอบแนวคิดในการศึกษาวิจัยเพื่อมุ่งหาองค์ประกอบ กระบวนการ รวมถึงการปฏิสัมพันธ์ภายในตัวแปรโครงสร้างของแต่ละปัจจัย ที่อาศัยพื้นฐานจากงานวิจัยต่าง ๆ ในด้านการแพร่กระจายแนวทางปฏิบัติตามการเกษตรทฤษฎีใหม่ การศึกษาด้านระบบนิเวศทางสังคม ร่วมกับทฤษฎีการแพร่กระจายนวัตกรรม การเลือกกลุ่มตัวแทนที่ตอบแบบสอบถามและวิเคราะห์ ใช้หลักงานวิจัยแบบผสมผสานร่วมกับการวิเคราะห์ทางสถิติเชิงปริมาณ เพื่อลดผลจากปัจจัยภายนอกอื่น ๆ เช่น อุปสรรคทางการค้า ชลประทาน และประเด็นด้านสิ่งแวดล้อม ผลจากการวิเคราะห์พบว่าปัจจัยที่มีผลเชิงบวกต่อพฤติกรรมในการตัดสินใจเลือกใช้ธาตุอาหารพืชของชาวนา สามารถเรียงลำดับจากมากไปน้อยได้ดังนี้ 1) ระดับองค์ความรู้ 2) ผู้นำทางความคิด และ 3) ด้านระบบนิเวศทางสังคม โดยชาวนาจะเลือกปฏิบัติตามการทำเกษตรทฤษฎีใหม่ถ้าได้เห็นจริงว่าสามารถเพิ่มผลผลิตได้มากกว่าปัจจัยด้านอื่น ๆ เช่น การสนับสนุน สินเชื่อ นอกจากนี้ การวิเคราะห์ทางสถิติยังชี้ให้เห็นว่ากรอบแนวคิดในงานศึกษาวิจัยสามารถอธิบายความเชื่อมโยงในตัวแปรที่สำคัญต่าง ๆ ได้อย่างมีนัยสำคัญ

คำสำคัญ: ผลิตภัณฑ์ธาตุอาหารพืช การแพร่กระจายนวัตกรรม ความอุดมสมบูรณ์ของดิน การตัดสินใจเลือกใช้นวัตกรรม ระบบนิเวศทางสังคม

Abstract

The objectives of study were to define the influential factors from the external variables i.e. (a) the level of knowledge, (b) the social ecological systems and (c) the opinion leaders toward farmer behavioral intention to adoption the modern plant nutrition as well as to apply the diffusion of innovation theory toward rice farmers' social system in the proposed farmers group in Thailand. The conceptual framework to find the relative importance of the components, processes, and interaction of each factor is based on the previous study related to modern agricultural practices diffusion, social-ecological study and the diffusion of innovation theory. The proposed respondents were selected and analyzed using a mixed method with the quantitative statistical analysis, to decrease disturbance of other external factors i.e. trade barrier, irrigation and environmental issues. The analysis was shown that the positive influence on the adoption intention of plant nutrition products and were ranked from the highly influence as follow; (1) the level of knowledge, (2) the opinion leaders and (3) the social ecological systems. The results were shown that farmers will follow the modern practices if they know the ways to increase their crop rather than the other factors i.e. credit support. The results from the statistical analysis were indicated that the model framework, was significant to explain the relation among variables.

Keywords: plant nutrition products, diffusion of innovation, soil fertility, adoption intention of innovation, social ecological systems

Introduction

Agribusiness is in the sixth most important industrial cluster in developing country around the world, their annual historical exported value was more than 70% (World Bank_International Trade Department, 2009). In term of fertilizer, it's demand is higher each year at 200 million MT of world fertilizer consumption in 2018, rapidly increase 30% about 40 million MT compare to 2008 (FAO/Fertilizer Organizations Working Group, 2015).

Although, there are many opportunities of changes for Thai Agribusiness, Thai agricultural products, such as rice which is in the Asia general main dish, is facing the problems in low crop production yield, lack of premium rice quality and farmers' household income is below average level compare to other careers. The causes of problems may consist of many aspects, such as 1) Government Intervention Policy and subsidy program (Poapongsakorn, 2017). 2) Low quality of product and lack of understanding in better farming practice , ex GAP, IFOAM, etc (Paopongsakorn & Aroonkong, 2013). 3) Elderly society problem, Thailand agriculture cluster is entering to an elderly society problem (Kumpa,(2015); Poapongsakorn, (2017); Isvilanonta, (2010)). 4) Lack of better technology and automated mechanization to put into farmer social system, particularly the adoption and adaptation of modern farm technology (e.g., precision agriculture) (Poapongsakorn, 2017).

While, there are plenty of opportunities in domestic and global market (Lloyd, 2010), main agriculture production sector, particular rice farmers, must adapt to change the practices to be modern farming techniques about plant nutrition, and soil fertility concept by their perception which are entity and dissimilarity at the specific social group. The farming practice, particular soil fertility and plant nutrition product selection, which are the key factors to increase crop yield, as FAO mentioned (FAO, 2006), should be adapted to gain more production capacity and its' quality, to increase farmers' household income. Unfortunately, the change to adopt of these innovation perception of Thai farmers is put to slow, to increase the rate of adoption, the effective way to communicate toward the right process must be studied and researched within the specific social context of Thai farmers' social system, to clarify the factors influencing rice farmer decision to accept the practices

Thus, objectives of the study were; 1) to determine the relative importance from level of knowledge which affect to the adoption intention of modern plant nutrition concept, 2) to find the relative influence from rice farmers group opinion leaders and their roles as a role model in being as the early adopter

in modern plant nutrition products, 3) to find the significant factors from farmers social group which influence social perceived levels to create the adoption intention in modern plant nutrition concept, 4) to apply the diffusion on innovation theory and find the effective communication process for the modern plant nutrition adoption in the specific farmers social group.

The application of Innovation Diffusion Theory (IDT) (Rogers, 1983) and the influential constructs are applied to use in the conceptual model of research in adoption intention of plant nutrition products. The influential factors are adapted from the variables in the previous works (Bwambale, 2015; Chen, 2006; Feder et al., 1985; Reimer et al., 2012) which are (1) Level of knowledge construct, (2) Social and ecological systems, (3) Opinion leaders construct (Hogg, 2013; Rogers, 1983).

In summary, IDT theory and previous work related to the agricultural diffusion of innovation and practices which were conceptualized and operationalized to support the conceptual model. Referred to the previous works, three main hypotheses and its sub-hypotheses have been offered for testing. They include;

H1: Level of farming knowledge (LFK) as characterized by soil fertility knowledge, current practices in plant nutrition has a positive relation to the Adoption Intention of plant nutrition products (AI of PNP). There are sub-hypotheses for H1a, H1b, H1c which are Soil Fertility Knowledge(SFK), Current Practices in Plant Nutrition (CPPN) and New Way to Practices with Plant Nutrition Products(NWPPN) as the components of level of knowledge affects the adoption intention of the plant nutrition products.

H2: Social Ecological Systems (SES) as characterized by land tenure, labor availability, main household income, credit access and social interaction has a positive relation to the Adoption Intention of plant nutrition products(AI of PNP). There are sub-hypotheses for H2a, H2b, H2c, H2d and H2e which are Land Tenure (LT), Labor Availability (LA), Main Household Income (MHI), Credit Access (CA) and Social Interaction (SI) in terms of SES affects the adoption intention of the plant nutrition products

H3: Opinion Leaders (OL) as characterized by being a role model in the adoption intention has a positive relation to Adoption Intention of plant nutrittion products (AI of PNP). And H3a as a Role Model (RM) in adoption in term of OL affects the adoption intention of the plant nutrition products.

Material and Method

1. The conceptual framework model as shown in Figure 1, based upon the preliminary discussion and the conceptual model was suggested to use the IDT, will not concentrate on the influence of school education but will pay attention to their prior experience in terms of soil fertility knowledge and current practices, because most of the rice farmers in Thailand have similar formal education. Referred to the Bank of Thailand and the data from the National Statistic Office of Thailand, who reported that 94.5% of farmers have an educational level of primary and secondary schools (Tansri, 2012). The previous related research, also reported there were no significant effects from formal education level. Therefore, the current research will not use the formal education variable in the study model (Supaporn et al., 2013) (Sutjaritturakarn & Tanapanyaratchawong, 2010). The model will adopt and extend to examine the purposed group of rice farmers in the central part of Thailand by the specific methodology and research design by constructing the survey questionnaire. The study will not measure the actual use of plant nutrition; all three constructs are hypothesized to find the direction of effect on behavioral intention to use the plant nutrition products (Mtebe & Raisamo, 2014). In addition, this study will not investigate the effect of gender, age, numbers of experience because most of the farmers in Thailand are the same age (Tansri, 2012) and with small variations in modern plant nutrition experiences and the study do focus on the farmer' family instead of the individual or an individual.

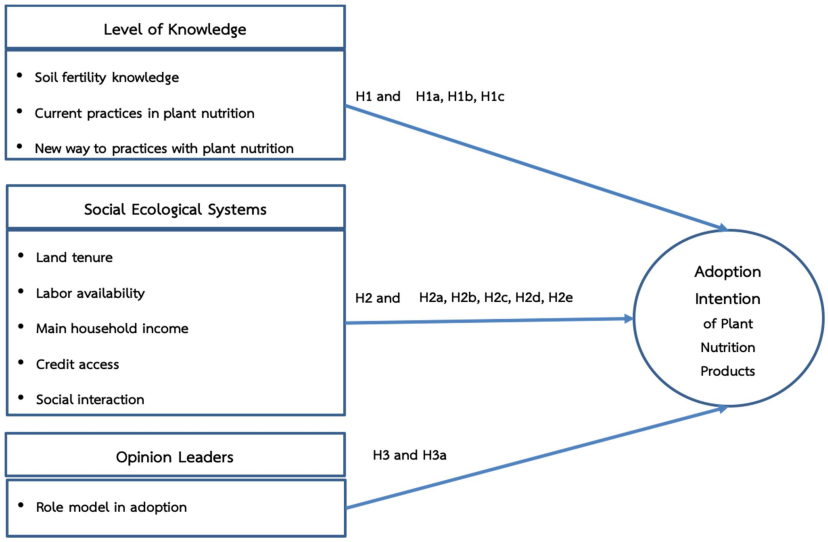


Figure 1 Conceptual Framework Model for The Adoption Intention of Plant Nutrition Products (AI of PNP)

2. Sample Size:

2.1 Use AgriMap from NECTEC, it indicated that Ayutthaya is the appropriated area.

2.2 Ayutthaya has irrigation system, nearby farming resources and trade market (Agricultural Statistics of Thailand, (2017); NECTEC, (2018)).

2.3 Nakornluang City is selected, to be the proposed population, biggest farming land use, but farmers have lower income than average (Income, (2015); Map, Ayutthaya Farmer, (2016)).

2.4 Select one of Nakornluang sub-city, which has rice cultivation are similar to the average land use of Nakornluang city to be the population. There are 118 farmers' families (Which is Pak-Chan sub city), as be shown in Figure 2.

2.5 For more precise work and survey information. There are 92 samples. Equation No. 1

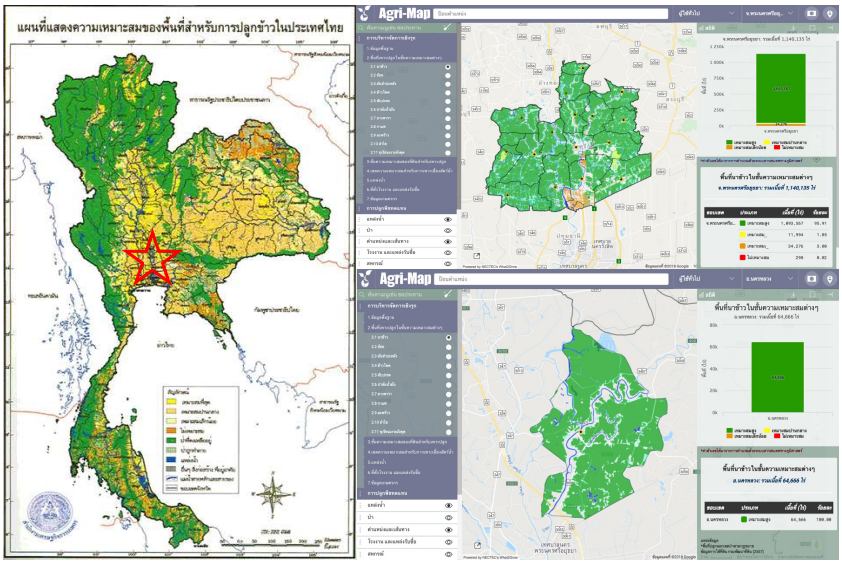


Figure 2 Sample Size Selection (left- the Central Part of Thailand, Right top-Ayutthaya Province, right bottom- Pak-Chan, NakornLuang)

Source: (NECTEC, 2018)

The quantitative sampling formulation from Equation of (Krejcie & Morgan, 1970) to minimize the samples to achieve the relevant analyze.

$$Samples = X^2NP(1-P) \div [d^2(N-1) + X^2P(1-P)] \quad ...(1)$$

Where: X^2 = the table value of chi-square for 1 degree of freedom at the desire confidential interval. (3.841), N = populations size, P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size) and d = the degree of accuracy expressed as a proportion (0.05).

2.6 Research Instruments Design and Reliability: The questionnaire was designed and tested the reliability by Cronbach's alpha technique, the questionnaire is adjusted and added the appropriated questions by construct validity from previous related work. The new questions after adjusted final Cronbach's alpha are in the four constructs dimension as, First Dimension 20 questions related to LK, Second Dimension 20 questions related to SES, Third Dimension 5 questions related to

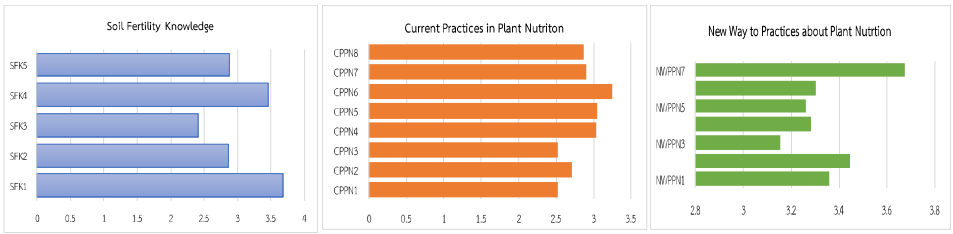
OL and Fourth Dimension 5 questions related to AI of PNP. The questions in the questionnaire will be forced to use the 4-point or a 4-point scale with a Likert scale concept start from “strongly agree” to “strongly disagree”. A neutral choice was carefully avoided because of the cultural differences from other nations of Thai society, particular kreng-jai (Holmes et al., 2003).

2.7 Validity of Test and Instruments: The evidential basis and previous research basis for interpreting tests involve the empirical study of construct validity, which is defined by Messick as the theoretical context of implied relationships to other constructs (Brown, 2000). The evidential basis for using tests involves the empirical investigation of both construct validity and relevance/utility, which are defined as the theoretical contexts of implied applicability and usefulness.

Results

1. Level of Knowledge Construct

Finding, as the value of soil fertility knowledge in Figure 3, suggested that, the analysis from three components of the level of knowledge construct was at significant. While soil fertility is important for rice farming crop yield showed the highest score of soil fertility knowledge component (SFK1). Whereas, learning to improve crop yield by from government agricultural support officer for rice farming showed the highest score of current practices component (CPPN6). The respondents will follow new ways that increase my rice yield if they can learn them, showed the highest score of the new way to practice (NWPPN7).



SFK Mean=3.0565, S.D.=0.82570, p-value=<0.001 (W-test)

CPPN Mean=2.8573, S.D.=0.85243, p-value=0.043(W-test)

NWPPN Mean=3.3540, S.D.=0.79773, p-value=<0.001 (W-test)

Figure 3 Analysis of Significant Level of Level of Knowledge Construct

2. Social Ecological Systems Construct

As revealed in Figure 4 findings, suggested that the analysis from five components of social ecological system construct were at significant. While their most farming land is a rental land (LT2), was the highest score for land tenure component. Whereas the change in farming practices is a difficult task to deal with the local farm service labor (LA3), was the highest score for labor availability component. Referred to the respondents' answer farm income represents the largest contribution to family income (MHI1) showed for the main household income component. Findings also suggested that if respondents can borrow money, and do not have to pay until the harvest their crop, would decide to buy farming resources easier (CA3) represented the highest score in term of credit access components. And the respondents with social interaction component, pointed that there is the farming practice training, they usually apply to be participant, showed the highest significant level (SI1).

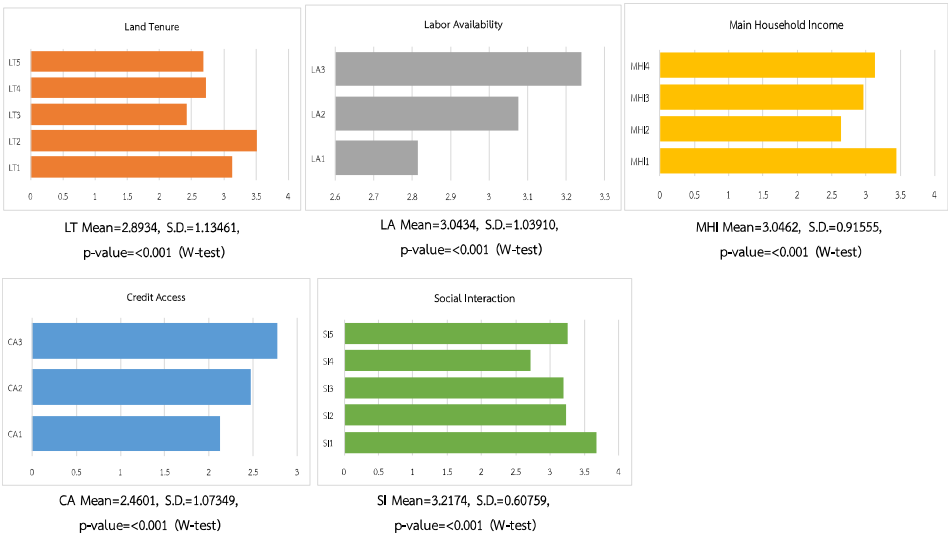
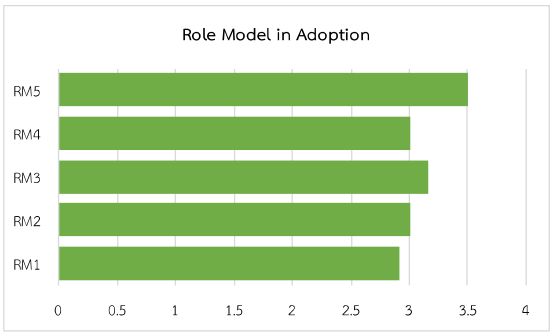


Figure 4 Analysis of Significant Level of Social Ecological Systems Construct

3. Opinion Leaders Construct

As be shown in Figure 5, suggested that the role model in adoption as it is the component of opinion leaders construct was at significant level. While they will follow the good practices that produce higher, if they know how to do these things, showed the highest level (RM5).

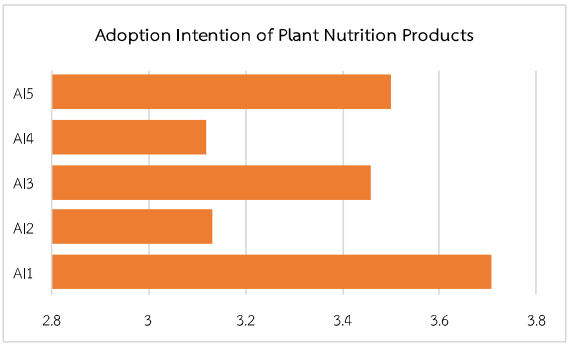


OL Mean=3.1173, S.D. =0.85495, p-value=<0.001 (W-test)

Figure 5 Analysis of Significant Level of Opinion Leaders Construct

4. Adoption Intention of Plant Nutrition Products (DV)

as the value in Figure 6, suggested that, the adoption intention of plant nutrition products was at significant level. While they intend to use the plant nutrition products in the future, showed the highest significant level (AI1): I intend to use the plant nutrition products in the future at Mean = 3.7065.



AI of PNP Mean=3.3826, S.D. =0.67781, p-value=<0.001 (W-test)

Figure 6 Analysis of Significant Level of Adoption Intention of Plant Nutrition Products (DV)

3.5 Linear Regression Model:

Multicollinearity Test by VIF All variation inflation factor (VIF) of independent variables in model 4 was lower than the threshold 5.00. Therefore, it was indicating that multicollinearity is not a major concern (Hair et al., 2014) as in Table 1. The Regression Variate: Prediction

$$Y=b_0 +b_1V_1 +b_2V_2 + b_3V_3 \quad \text{..... (2)}$$

Table 1 Descriptive statistic, normality test and correlation analysis of independent variables regression equation, significant at p-value < 0.05

Variables	Descriptive Statistic-Normality test				Correlation Matrix(VIF)		
	Skewness	Kurtosis	95%CI	W-	LK_CFA1	SES_CFA	OL
LK_CFA1	-0.536	-0.480	±0.2070941	0.934*	1.000		
OL	-0.462	-0.456	±0.2070941	0.939*	1.019	1.541	1.000

Table 2 Multiple linear regression for AI of PNP, the independent variables (predictors) LK, SES and OL

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% CI	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.848E-16	.085		.000	1.000	-.169	.169
	LK_CFA	.321	.127	.321	2.535	.013*	.069	.572
	SES_CFA	.226	.103	.226	2.195	.031*	.021	.430
	OL_CFA	.257	.120	.257	2.151	.034*	.020	.495

Remark *Dependent Variable: AI_CFA = AI of PNP, *sig-value at $p < 0.05$, t-value at df(90) = 1.987, df(80) = 1.990

AI of PNP = 1.848E-16 + 0.321*LK +0 .226*SES + 0.257*OL, at Sig. <0.05 .....(3)

The AI of PNP can be predicted the influential from three factors of the level of knowledge construct, the social ecological construct and the opinion leaders construct, referred to the measurement data from the respondents as the

KMO, (df) and p-value showed in Figure 7. They met the significant statistic criteria, when be considering the conceptual framework of this study.

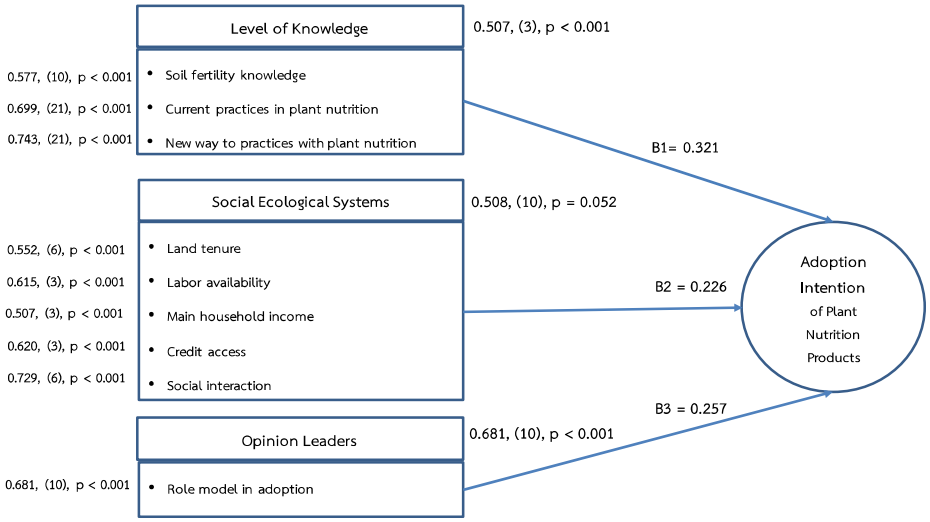


Figure 7 The framework model with the influential coefficient from regression method of sample, the correlation among variables showed the factor loading, (df), p-value from CFA

Discussion

Prior to the actual survey, the pretest for reliability conducted by using SRS method (Simple Random Sample) from 30 respondents in Nakornluang, Pak-Chan city that similar the target population, the overall Cronbach's alpha = 0.813, and average Variance 0.4281. After the questionnaire was adjusted the meanings, reverse questions, delete and add new questions, the measurement questionnaire was completed by 92 respondents. The data analysis was performed using SPSS V.23, then the complex correlations were examined. Referred to the analysis findings, (1) *Level of Knowledge*: The results had shown that the level of knowledge was a positive affective to AI of PNP at highest significant level. It supported the H1 with t-value in Table 2 and Equation 3, t-value = 2.535 > 1.990, it means the level of knowledge has a positive relation and could predict AI of PNP at significant level < 0.05 df = 80 with the correlation coefficient to predict at 0.321 as related to the

previous work from Bwambale (2015), Chen (2006), Feder et al., (1985) . *(2) Opinion Leaders:* The results had shown that the opinion leaders construct was a positive affective to AI of PNP at high significant level in the second ranked. It supported the H3 with the t-value in Table 2 and Equation 3, t-value = 2.151 > 1.990, it means the opinion leaders have a positive relation and could predict AI of PNP at significant level < 0.05 df = 80 with the correlation coefficient to predict at 0.257 as studied by Hogg (2013) and found in IDT from Rogers (1983). *(3) Social Ecological Systems*: The results had shown that the social ecological was a positive affective to AI of PNP at high significant level in ranking number three. It supported the H2 with the t-value in Table 2 and Equation 3, t-value = 2.195 > 1.990, it means the social ecological has a positive relation and could predict AI of PNP at significant level < 0.05 df = 80 with the correlation coefficient to predict at 0.226 as related to the previous work Reimer, Weinkauf & Prokopy (2012) and Feder et al., (1985).

Conclusion

Farmers are ready to change the way to practice to gain their crop and reduce the cost of plantation if they get the chance to see the better ways. The change will be faster if farmers get support from academic knowledge with the right direction from the related organization because they have experience in rice cultivation. While, the results indicated, the soil fertility knowledge is the keys that farmers are going to practice, if they know “how to”, therefore the priority policy should focus on the strategies of modern practices and knowledge diffusion into the social ecological systems of farmers, which influential components, i.e. soil fertility knowledge, new way to practices and role modeling, according to the research model framework. The consideration of results, the social ecological systems had lowest influence power, the respondents had low scores therefore the authorized organizations should provide the support for the farmers group the knowledge about the modern agriculture which has the role modeling by the members’ opinion leaders.

Limitations and Scope of the study, this study proposed the model framework to the study of adoption intention of plant nutrition products, which consider studying the social learning and perception of the new plant nutrition products. The rice farmers group in Thailand has a large scale, greater than 50% of total farmers, is rice farmers. Therefore, the limitations of the study are the limited number of farmers' population. The study selected the proposed respondents, by eliminating the environmental factor, trade barrier, irrigation system and rice and fertilizer commodity price factors. These above important issues, should be verified carefully.

Suggestion for future research, the statistical analysis indicated that the model may have others' relation from the data regression. For example, the research findings showed that the current practices in plant nutrition have non-significant effect on the adoption intention of plant nutrition products, therefore, future studies should be conducted to explain the reason for this variable. The analysis results have shown that the prediction equation may differ from this study which significant value by separating the current practices about plant nutrition component from the level of knowledge, and/or extracting the SES construct components based on their EFA.

Acknowledgment

The research expressed deep gratitude to Professor Dr. Scott S. Roach who is my research advisor, Committees and Academic Team for careful and guidance, enthusiastic encourage and helpful critiques during this research study. Researcher also like to thank to my team and staffs of the Plant Nutrition Business, Factory and R&D team for their help on the data collecting and run the useful activities to the farmers social group. It is not only beneficial for the research, though it is very helpful to the farmers' social group themselves and long term competitiveness of the rice business cluster in Thailand, especially the original material from farming. This will be the beginning of change the modernization in farming practices. Finally, researcher wish to thank my family for support and encouragement throughout my study.

References

Agricultural Statistics of Thailand. *Agricultural Statistics of Thailanf 2016.* Office of Agricultural Economies, Ministry of Agricultural and Cooperative of Thailang. Bangkok: Agricultural Statistics of Thailand; 2017.

Brown JD. *What is Construct Vallidity.* (University of Hawai'i at Manoa). Hawai'i: JALT Testing & Evaluation SIG Newsletter, 2000; 4(2); 8-12.

Bwambale N. Farmers' Knowledge, Perceptions, and Socioeconomic Factors Influencing Decision Making For Integrated Soil Fertility Management Practices in Masaka and Rakai Districts, Central Uganda. *Master Degree Thesis*. Iowa, USA: Iowa State University; 2015.

Chen JH. The Combine Use of Chemical and Organic Fertilizers and/or Biofertilizer for Crop Growth and Soil Fertility. *International Workshop on Sustained Management of the Soil-Rhizosphere System for Efficient Crop Production and Fertilizer Use*, 2006; 1-11.

FAO. *Plant Nutrition for Food Security: A Guide for Integrated Nutrient Managment.* Rome: FAO; 2006.

FAO/Fertilizer Organizations Working Group, F. *World fertilizer trends and outlook to 2018.* Rome: Food And Agriculture Organization of the United Nations; 2015.

Feder G, Just RE, Zilberman D. Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Chnage*, 1985; 1-77.

Hair JF, Black WC, Babin BJ. et al. *Multivariate Data Analysis International*. 7th ed. Harlow , Essex, England: Pearson Education Limited; 2014.

Hogg D. Application of Groupthink to Generation Y Decision Making Process within a Professional Services Context in New Zealand. *International Journal of Business and Management,* 2013*;* 8(8): 69-78.

Holmes H, Tangtongtavy S, Tomizawa R. *Working with the Thais, A Guide to Managing in Thais.* 2nd ed. Bangkok, Thailand: White Lotus Co., Ltd.; 2003.

Income M. *Fundamental Agricultural Information of Ayutthaya.* Ayutthaya: Ayutthaya Agricultural Office; 2015.

Isvilanonta S. *Thailand Agriculture: The Country s profiles and Current Status.* Knowledge Network Institute of Thailand (KNIT). Bangkok: Agri benchmark Cash Crop Conference 2010; 2010.

Krejcie RV. Morgan DW. Determining Sample Size for REsearch Activities. *Educational and Psychrological Measurement*, 1970; 30: 607-610.

Kumpa L. *Sustainable Agriculture and Food Security in Thailand: National Government Perspectives & Policies.* National Economic and Social Development Board (NESDB). Bangkok: Presented at Higher Education for Sustainable Agriculture and Food Security in Thailand and Southeast Asia, School of Agriculture Resources (CUSAR); 2015.

Lloyd R. *An Analysis of Fertilizer Markets in BRIC Countries.* Philipines: Administrative Issues Journal; 2010.

Map, Ayutthaya Farmer. *DOAE Ayutthaya Farmer Map*. Agricultural Support Office, Information Technology and Communication. Ayutthaya: Ayuthaya Statistic Website; 2016.

Mtebe JS. Raisamo R. Investigating students' behavioural intention to adopt and use mobile learning in higher education in East Africa. *International Journal of Education and Development using Information and Communication Technology (IJEDICT),* 2014; 10(3): 4-20.

NECTEC NM. 2018. *http://agri-map-online.moac.go.th/login*. Retrieved from Agri-Map: http://agri-map-online.moac.go.th/login

Paopongsakorn N. Aroonkong D. *Fertilizer Policy in Thailand.* TDRI, At Apsara Angkor Resort & Conference Center. Siem Reap: TDRI; 2013.

Poapongsakorn N. *Transformation of the Thai agriculture in the last three decades.* Thailand Development Research Institute, Project of Leibniz University Hannover. Bangkok: A regional conference organized by RESAKSS-Asia; 2017.

Reimer AP, Weinkauf DK, Prokopy LS. The influence of perceptions of practice characteristics: An examination of agricultural best management practice adoption in two Indiana watersheds. *Journal of Rural Studies,* 2012; 2: 118-128.

Rogers EM. *Diffusion of Innovation* 3^{ed}. Newyork, N.Y., USA: The Free Press A Division of Macmillan Publishing Co., Ltd.; 1983.

Supaporn P, Kobayashi T, Supawadee C. Factors Affecting Farmers' Decisions on Utilization of Rice Straw Compost in Northeasern Thailand. *Journal of Agriculture and Rural Development in the Tropics and Suntropics,* 2013; 114(1): 21-27.

Sutjaritturakarn W, Tanapanyaratchawong J. Factors Influencing the Adoption of Production Techniques abd Applications of Organic Fertilizer for Farmers in Hatyai District, Songkhla Province. *Suranaree Journal of Science and Technology,* 2010; 4(1): 29-44.

Tansri K. *Labor and Agriculture Changing in Thailand.* BOT, Bank of Thailand. North Easthern: BOT; 2012.

World Bank_International Trade Department, T. W. *Clusters for Comppetitiveness: A Practical Quide & Policy Implications for Developing Cluster Initiatives.* Washington: Prem The World Bank; 2009.