

Determinants Influencing Vietnamese Farmers' Intention in Applying New Technologies in Agricultural Farming

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Abstract

This paper used survey data from 273 farmers planting fruit trees in 23 provinces to assess the impact of some factors on the intention of applying new technologies to agricultural production of Vietnamese farmers. Research results have identified and measured a number of factors that have a positive impact and some negative factors hinder farmers' intention to apply new technologies. These findings are the basis to recommend policies and solutions to promote Vietnamese farmers to apply new technologies.

Keywords: Agricultural farming; Applicability, Belief; Benefit; Market demand; Communication

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1. Introduction

Even though Vietnam's agricultural sector has undergone many development achievements in recent years, fragmented agriculture with millions of farmer households is generally predominant. The era of industrial revolution 4.0 has brought countless new technologies that can be applied in the agricultural production process, including mechanization, automation, information technology, use of new materials, Biotechnology and high-yield and high-quality crop varieties, fertilizers and pesticides enable farmers to achieve high economic efficiency per unit of cultivated area and develop sustainable production. New technologies in agriculture can be applied through models of integrated technology or applying specific technological elements.

New agricultural technology is not only modern technology, but it also includes small innovations in farming methods that bring high efficiency to farmers. Therefore, the application of technological innovation in agricultural production is considered a way out of poverty for farmers. In fact, the development of Vietnam's agriculture relies on whether millions of farmers apply technological innovations. However, the adoption rate of technological innovation among farmers is still low. Promoting the application of technological innovation in agricultural production is an urgent issue for Vietnam's agriculture. The question of how millions of farming households in Vietnam having a small area of arable land with a very small production scale can apply new technologies to production to improve productivity, quantity of products as well as increase income, and improve their standard of living. As a result, this paper focuses on the determinants that influence (promote or hinder) farmers from adopting new technologies in agricultural production, thereby proposing policies and solutions to promote the application of new technologies in agricultural production.

2. Theoretical framework and hypotheses

The adoption of new agricultural technology is not an immediate action but rather a thinking process of the farmer from the recognition of that technology to the intention to apply and implement public application in reality. The basic approach is conducted before some major technologies are utilized by farms, they initially experience a stage of forming an intention to accept the application of the agricultural innovations. This is the intention to use new technology in agricultural production of farmers in the near future. In order to formulate the intention, farmers will evaluate determinants such as benefits, application conditions, compatibility, risks, testability, consumer market... when they apply the technologies to production.

The fundamental theory of determinants affecting adoption of new technology has been of great interest to many researchers. Davis (1985) proposed a technology acceptance model that called the TAM model. This model has been widely used by many researchers, and it is the most reliable and influential model in evaluating users' technology acceptance. The main purpose of the TAM model is to provide a basis for examining the impact of external determinants on internal determinants as trust, attitudes and intentions. Rogers (2010) developed an IDT model to explain innovation and customers benefit from that innovation, thereby accepting innovation. Venkatesh and Davis (2000) also developed a theory of technology acceptance and use technology to explain users' intention to accept to use new technology. The model focuses on four key determinants that influence the intention to adopt technology: expectation of performance, expectation of effort, social influence and physical condition.

Based on the fundamental theory, many researchers have done research on the determinants affecting behavior and the intention to accept the application of new technology in agricultural production by farmers. The studies confirm that farmers' intention to apply any new technology is influenced by many determinants, including internal and external determinants. A study by Rogers (2004) focused on the dissemination of agricultural

innovations in rural areas, concluding that there are four determinants influencing the intention to use new agricultural technologies, namely innovation, communication channels, time and social system. A study by Loevinsohn et al. (2013) has shown that the intention of farming households to adopt new technologies is influenced by the dynamic interaction between the characteristics of the technology itself and its conditions and circumstances. Akudugu et al. (2012) grouped the determinants that influence the application of high technology in agriculture into three categories: economic, social and institutional determinants. Kebede et al. (1990) cited by Lavison (2013) also classify determinants that influence the application of new technologies in agriculture according to such determinants. McNamara et al. (1991) classified the impact determinants according to: farmer characteristics, farm structure, institutional characteristics and management structure. Nowak (1987) stated that the impact determinants are classified into information, economics and ecology; while Wu and Babcock (1998) categorize them by human resources, production, policies and natural resource characteristics. Although there are views on the classification of determinants that influence the decision of high technology to agricultural production by farmers, the research team has selected a number of key drivers affecting the farmers' intention toward the use of new technologies, which are incorporated into the research model.

External determinants affecting farmers' intention to apply new technologies, including finance, the State incentive policies, reference group, communication and market demand.

In terms of *financing*, there is small-scale farming, limited financial capacity and capital, low accumulation ability, while investment costs for new technologies are often high. Therefore, favorable financial access such as capital support or the ability to access low-interest loans will have a positive influence on farmers' intention to apply new technology. In contrast, the impact of difficult and limited access to finance will be considered a barrier to farmers' use of technology in farming production. Therefore, the assumption here is:

H1. Financial conditions have a positive impact on the farmers' intention to apply new agricultural technologies.

State incentive policies: All countries issue and implement incentive and support policies to create favorable conditions in order to stimulate the application of new technologies in farm production. Land policies, market intelligence support, training assistance,... can all influence farmers' intention toward adoption of novel agricultural technologies. Nevertheless, if these policies are not suitable, it will hinder farmers' intention to apply new agricultural technologies. The research team thus propose a hypothesis as follows:

H2. The government's policies of encouraging technology application has a positive impact on Vietnamese farmers' intention to adopt new agricultural technologies.

Communication: Information on new technologies, benefits of applying new technologies in agriculture from mass media and state-sponsored propaganda activities affect perceptions, motivations and intentions of farmers toward technological application in farming. In case of insufficient and inconclusive information on agricultural technologies, it can cause negative thinking and limit the intention to apply new agricultural technologies. Hence, a following hypothesis is provided.

H3. Communication activities have a positive impact on the farmers' intention to apply new agricultural technologies

Reference group: Reference group is the external organizations and individuals whose opinions and attitudes have an influence on the intentions of farmers. The opinions of scientists, agricultural managers, extension workers, other members of the family, neighbors, opinions of other farmers who have applied new technologies, etc. have the strongest impact. In the context of Vietnam, the opinions of these reference groups might raise uncertainties and concerns about risks for farmers, and may therefore be a barrier to the intention of applying the new agricultural technology.

H4. Reference groups have a positive impact on the farmers' intention toward the application of new agricultural technologies.

Market demand: increased output and higher product quality can only raise higher income for farmers when there is a stable consumer market. The facilitation of market accessibility is a strong determinant of farmers' intention to apply advanced technology. Without a consumer market for increased supply, farmers' investment in new agricultural technologies would be futile. A hypothesis is proposed as follows:

H5. The market demand certainly has a positive impact on the farmers' intention to apply new agricultural technologies.

Determinants of farmers' perceptions and application conditions include: beliefs in successful application of technology (on the contrary, the level of risk awareness); technology applicability; culture; awareness of technology's benefits.

Beliefs: Some models of adopting new technologies are often influenced by farmers' expectation for the success of the technology and their perceived risks. The main belief is the perception and understanding of farmers about the certainty of success (less potential risks) when applying new technologies in production. The higher the belief of success is, the greater the intention to apply new technologies will be. On the contrary, the higher level of risk awareness hinders farmers' intention to accept new technology applications. From there, the team put forward the following hypothesis:

H6. The belief that successful application of technology has a positive impact on Vietnamese farmers' intention to apply new agricultural technologies.

Technology applicability: human resources, capacity, knowledge, and other production conditions required to adopt new agricultural technologies. These determinants have an impact on the intention to apply new technologies in their agricultural production. If farmers' ability to apply new technologies is high, they will surely be able to think of applying new technologies. On the contrary, the limited capacity, qualifications, land conditions, and ability of farmers will negatively affect the ability to apply technologies, becoming a barrier to the intention to apply new agricultural technologies. From there, the team hypothesized:

H7. Technology applicability has a positive impact on the farmers' intention to apply new agricultural technology.

Traditional culture: Farmers' cultural values such as traditions, customs, cultivation habits, etc. affect their awareness, thinking and production and business behaviors. The question is whether or not culture influences (positively or negatively) on the farmers' intention to apply new agricultural technology. The team thus propose a hypothesis as follows:

H8. The traditional culture of production has a positive impact on the farmers' intention to apply new agricultural technologies.

Awareness of the benefits of technology: Many studies have shown a positive correlation between the awareness of the benefits offered by new technologies to farmers and the ability to apply the technology in their production. How they perceive the benefits of new technology stems from the process of receiving information about the results of using new technology with real evidence that farmers observe from other farmers. From there, the team hypothesized:

H9. Perception of the benefits of technology has a positive impact on the farmers' intention to apply new agricultural technologies.

Based on the synthesis of relationships and hypotheses, a model is established to study a number of determinants affecting the farmers' intention to apply new technologies in agricultural production (Figure 1).

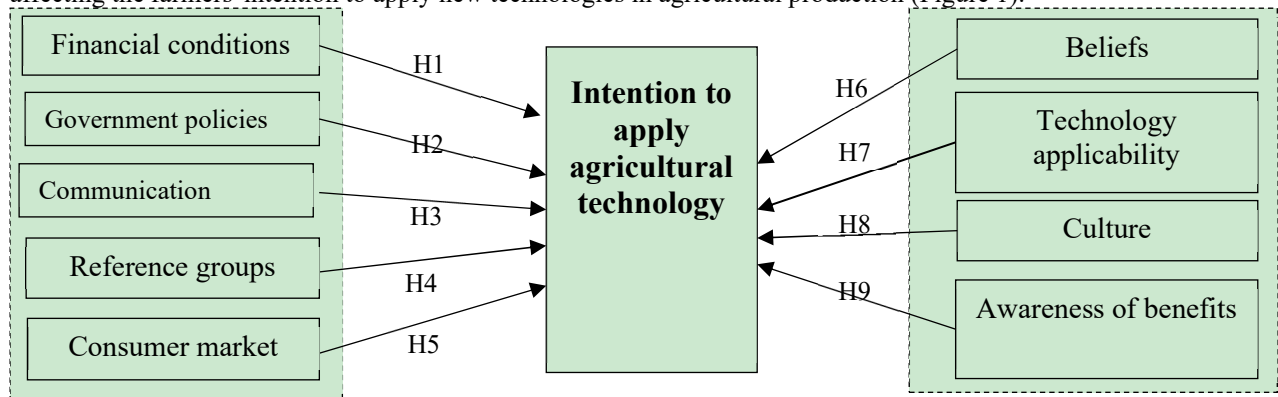


Figure 1: The research model

3. Research methodology

To assess the impact of these determinants on farmers' intention to apply new agricultural technologies based on a defined research model, the research team combined qualitative and quantitative research in research stages.

The qualitative research is used to exploring the determinants that influence the farmers' intention to apply high technology in agricultural production and to adjust the scale of each factor in accordance with the context of Vietnam's agricultural production. Quantitative research is conducted through survey methods using a questionnaire based on the established research model. The collected data is the foundation for assessing the quality of the scale, testing models and research hypotheses. Data analysis techniques such as Cronbach's Alpha, discovery factor analysis (EFA) with the support of SPSS software version 22.0, to evaluate the quality of the scale. Meanwhile, to test the model and the research hypotheses, the research team used affirmative factor analysis (CFA) and structural model analysis (SEM). Research models with dependent variables are behavioral intents, and independent variables are the influencing determinants that will accurately indicate the degree of influence of these determinants on the intention of the surveyed farmers households to apply new technologies in planting fruit trees.

3.1. Scale

To build a measurement scale of respondents in quantitative research, the research team conducted a research review, inherited and adjusted the scale of a number of domestic and international studies.

Methods of consultation with experts and trial interviews with some participants in research and / or agricultural production in Vietnam are also used to adjust the scale to best suit the context of Vietnam's agriculture. There were 12 agriculture researchers and 12 households planting fruit trees consulted when designing and testing

the scale. Most of the respondents had suggestions on how to express the questions in a way that is familiar and realistic to the farmers. The scale used includes 51 observed variables (questions) divided into groups related to the determinants that are expected to influence the intention to apply technology in growing fruit trees including: (i) Finance ; (ii) Applicability; (iii) Policy; (iv) Communication; (v) Reference group; (vi) Consumer market; (vii) Belief; (viii) Culture and (ix) Awareness of the benefits of technology. These determinants were assessed by 48 observed variables/questions. Intention to apply new agricultural technology is measured by 3 observed variables. The questions are designed in a Likert scale with 5 levels used to measure the views of the research object by considering their degree of agreement with the given propositions. The level of consent increases from 1-Strongly Disagree to 5-Strongly Agree. Some of the clauses associated with environmental determinants (such as Finance, Applicability, Reference Group, Market demand, Media and Policy) are proposed in the research model. On the negative side with the hypothesis, these determinants hinder Vietnamese farmers' intention to apply new technologies to agriculture. The remaining determinants such as Awareness of benefits from technology application, Beliefs and Culture are hypothesized in line with positive impact on farmers' intention to apply new agricultural technology.

3.2. Sampling

The population is farmer households having orchards in Vietnam. The research team conducted the survey through a direct interview with a questionnaire of a sample of 273 farmer households in 23 provinces across the country. The surveyed areas are concentrated fruit-growing areas, with widely-known fruit trees and products sold in the national market and exported to many foreign markets. The survey areas include: Mekong River Delta (Dong Thap, Tien Giang); South Central Coast (Binh Thuan, Ba Ria - Vung Tau); Central Highlands (Dak Lak, Dak Nong) and Red River Delta (Hung Yen). The sample size of 273 questionnaires was guaranteed to meet the requirements of performing statistical analysis. Below is the sample structure of the study by criteria, region, gender, age, and level.

Table 1. Sample characteristics

	Criteria	No. of observers	Ratio (%)
Respondent	Household/farm owners	255	93.41
	Businesses	18	6.59
	Northern Vietnam	25	9.16
	Central Vietnam	53	19.41
	Southern Vietnam	191	69.96
	Missing	4	1.47
Region	Red River Delta	25	9.16
	South Central Coast	17	6.23
	Central Highlands	36	13.19
	Southeast	85	31.14
	Mekong River Delta	106	38.83
	Missing	4	1.47
Levels of education	Primary school	3	1.10
	Secondary school	18	6.59
	High school	77	28.21
	Elementary	6	2.20
	Intermediate	18	6.59
	College	11	4.03
	University	38	13.92
Missing	102	37.36	
Total		273	100.00

4. Results and discussion

4.1. Explore factor analysis (EFA)

Before conducting CFA to check the quality and reliability of the scales, the research team conducted EFA and Cronbach's Alpha factor analysis.

The results of EFA and Cronbach's Alpha analysis in Table 2 show that the combined reliability coefficient of the scales is greater than 0.6 and the total variance extracted is greater than 50%, which is considered satisfactory. This result is aggregated from the performance of of Reliability Analysis that measures Cronbach Alpha and performs factor analysis to measure variance deduction.

Besides, the EFA analysis results indicate that 10 determinants corresponding to 3 groups of determinants all have observed variables and an independent factor corresponding to the factor loading value, ensuring the

requirement > 0.5. Thus, the determinants in the model all converged. In addition, from EFA analysis, the observed variables have factor loading on only one factor, so that the determinants in the model all achieve a discriminant value. The correlation coefficients of variables are also greater than 0.3, which meet the requirements of scale quality. Therefore, the measurement scales for variables in the research model are suitable to use for further analysis.

Table 2: Total reliability and Total Variance Explained of scales.

No	Scale	Number of observed variables	Reliability of Cronbach's Alpha	Total Variance explained	Conclusion
1.	Financial condition	5	0.874	67.633%	All scales achieved reliability
2.	Applicability	8	0.872	58.248%	
3.	Policies	6	0.930	74.166%	
4.	Reference groups	4	0.904	67.476%	
5.	Communication	4	0.868	72.339%	
6.	Market demand	3	0.757	68.182%	
7.	Beliefs	6	0.816	52.931%	
8.	Culture	3	0.818	69.509%	
9.	Awareness of Benefits	8	0.930	66.711%	
10.	Intention to apply	3	0.870	79.310%	

4.2 Confirmatory Factor Analysis (CFA)

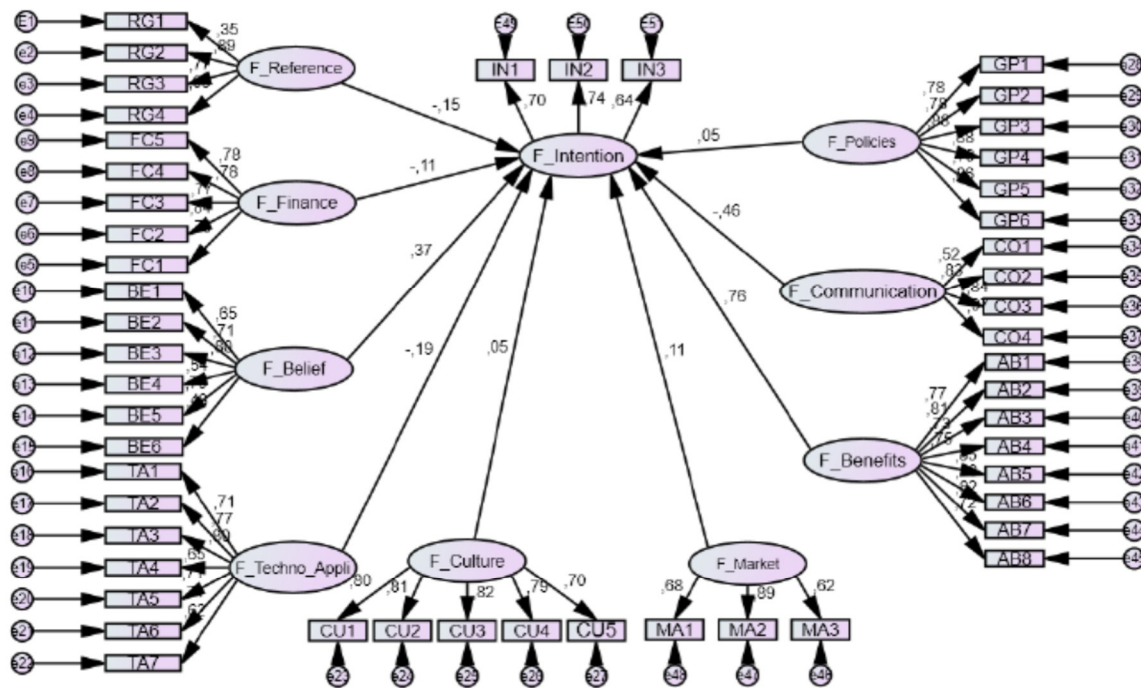
After preliminary evaluation of the scale, the authors continues to use AMOS software version 20.0 to conduct CFA (Confirmatory Factor Analysis) analysis of conceptual scales, testing the suitability of the model and hypotheses. Test criteria used includes degrees of freedom-order adjustment (CMIN / df); GFI index (Goodness of Fit Index); TLI index (Tucker & Lewis Index); CFI index (Comparative Fit Index); RMSEA (Root Mean Square Error Approximation). The model is considered suitable when the Chi-square test has a value of $P \leq 0.05$. However, Chi-Square has the drawback that it depends on the sample size. The larger the sample size, the larger the Chi-square thus reducing the suitability of the model. Therefore, besides P-value, the standard used is CMIN / df, in some practical studies people distinguish two cases: $\div 2 / df < 5$ (with the sample $N > 200$); or < 3 (when sample size $N < 200$), the model is considered to be a good fit (Kettinger and Lee, 1994). In this study, because the number of research samples of the author $N = 273$ ($N > 200$), the research team will use the criteria of Kettinger and Lee (1994) to accept CMIN / df < 5 ; GFI, TLI, CFI ≥ 0.9 (Bentler and Bonett, 1980); RMSEA ≤ 0.8 .

Table 3: Results of CFA evaluation of scales

No	Criteria	Internal characteristics	External Factors	Intention to apply agricultural technology
1.	Chi-square/df	2.108	3.142	2.392
2.	GFI	0.907	0.901	0.890
3.	TLI	0.934	0.909	0.902
4.	CFI	0.943	0.911	0.905
5.	RMSEA	0.064	0.074	0.072

4.3. Testing the theoretical models

After completing the evaluation of the scales, the authors have conducted tests of theoretical models: The testing results of the theoretical model (Figure 2) are shown in the figure: Chi-square/df = 3,088; GFI = 0,901; TLI = 0.923; CFI = 0.936; RMSEA = 0.068 proves that the model has a high relevance to market data. In addition, the estimation results show that the relationships are statistically significant ($P < 5\%$); there is only a relationship between Market factor; Culture and Policy with the intention. There is no statistically significant use of technology in growing fruit trees ($P > 5\%$), see Table 4.



Chi-square = 3754,617; df = 1216; P = .000
 Chi-square/df = 3.088;
 GFI = .901; TLI = .923; CFI = .936
 RMSEA = .073

Table 4: Results of testing relationships (standardized regression coefficients)

Hypotheses	Relationships	Estimate	S.E.	C.R.	P	Conclusion
H1	F_Intention <--- F_Finance	-0.096	.051	-1.884	.040	Significance
H2	F_Intention <--- F_Policies	.040	.060	.661	.508	Not significance
H3	F_Intention <--- F_Communication	-.550	.090	-6.094	***	Significance
H4	F_Intention <--- F_Reference	-.100	.037	-2.666	.008	Significance
H5	F_Intention <--- F_Market	.141	.102	1.383	.167	Not significance
H6	F_Intention <--- F_Belief	.550	.145	3.796	***	Significance
H7	F_Intention <--- F_Techno_Appli	-.195	.085	-2.294	.022	Significance
H8	F_Intention <--- F_Culture	.048	.085	.563	.573	Not significance
H9	F_Intention <--- F_Benefits	.755	.089	8.452	***	Significance

4.4. Hypotheses testing

The estimation results in Table 4 indicate that the weights of the relationship between intrinsic determinants such as beliefs and perceptions of benefits are positive and statistically significant ($P \leq 0.05\%$). Meanwhile, cultural determinants were not considered statistically important ($P \geq 0.05\%$). It is worth noting that the beliefs and awareness of the benefits brought about by new technology in fruit tree planting have a positive relationship with the intention to apply technology (H6 = 0.550; H9 = 0.755). In addition, Table 4 shows that, among the determinants of Success Belief and Awareness of Benefits, Awareness of benefits has a greater positive impact (0.755) on the intention to apply technology in growing crops. By contrast, Trust has a smaller impact level (0.550). Meanwhile, the applicability factor has a negative relationship with people who intend to apply new technology in agricultural production (planting fruit trees) (H7 = -0,195). The survey results also illustrate that the determinants of the external environment, including Finance, Communications and Reference Group, have a negative correlation with the intention to apply new technology in agricultural production (growing fruit trees) of farmers (H1 = -0,096; H3 = -0,550; H4 = -0,100). The results in Table 4 show that among the three determinants Finance, Communications and reference group, Communication has the most negative impact (-0,550) on the intention to apply technology in growing fruit trees, while Finance again. have less impact than the four determinants above (-0,096). Meanwhile, the determinants of Policy and Consumer Market are not statistically significant ($P \geq 0.05\%$).

In conclusion, hypotheses H1, H2, H4, H5, H7 and H9 are accepted.

5. Conclusion and suggestions

The contribution of this study is to build theoretical models, test hypotheses, assess the level of impact of determinants (including motivating and obstructing determinants) on intention of Vietnamese farmers towards application of the new agricultural technologies. The research results have shown some new findings, including environmental determinants such as financial condition, reference group and communication, which do not have a positive influence the intention of applying new technology in agriculture, but it also hinders the application of new agricultural technology. In particular, communication determinants (-0.550) have a negative impact on farmers' intention to apply new technology. The communication factor also does not have a positive impact on the intention to apply new agricultural technology because the information in the media is currently incomplete and inaccurate, has not positively impacted the awareness of the benefits of technology in the success of new technologies, on the contrary, it causes concern for risks for farmers and negatively influence their intention to apply new technologies. The research results also indicate that applicability (-0.195) is also a factor that does not have a positive impact (a relatively strong hindrance factor) to farmers' intention to apply new agricultural technologies. This is explained by the ability and conditions of Vietnamese farmers to apply new agricultural technologies at a low level, thus negatively affecting the intention to apply new agricultural technologies.

Determinants belonging to farmers' internal capacities such as trust (0.550) and awareness of benefits (0.755) are determinants that positively influence the intention to apply new agricultural technology. When farmers believe in the ability of new technology to succeed, they will think about the application of new technology in production. Similarly, awareness of the benefits brought about by new technologies is an important impetus for farmers to think about applying this new technology. Research results with statistical significance sig. Greater than 0.05 indicates that the policy, consumer and cultural determinants have no relationship with farmers' intention to apply new technology in agriculture.

The results of the study have suggested a number of implications to motivate farmers to apply new agricultural technologies as below:

First, developing and implementing solutions to raise awareness about the benefits of technology and farmers' trust in the application of new technologies in agriculture, focusing on effective communication activities and organize training sessions from those who have successfully applied it.

Second, addressing the the limitations of communication activities by improving the content and communication channel to farmers about the benefits of new technology and application guidance. In particular, introducing real-life cases, thereby creating farmer's trust in applying new technologies. For example, organizing farmers' visits to successful technology application models is the best way to communicate with farmers.

Third, improve the determinants under the farmer's production conditions, their ability to absorb new technologies including: human capital, financial capital, and other determinants of production conditions. It is necessary to strengthen agricultural classes to popularize new agricultural technologies in order to improve farmers' knowledge and skills and thus promote the intention to apply new agricultural technologies. In order to create favorable conditions for farmers to invest in new technologies, it is necessary to have a preferential lending mechanism, loan amount and loan duration which are suitable to the farming requirements and convenient procedures for farmers. For example, farmers' new agricultural technology investment projects can be offered reduced interest rates.

Since the reference group has a strong and negative influence on the intention to apply new agricultural technology, it is imperative to promote innovation and increase the effectiveness of agricultural extension activities and agricultural production. In order to encourage farmers to apply any new agricultural technology, extension workers need strong knowledge and persuasive ability to transfer new technology to farmers.

In short, based on the results of surveys, this research provides some new, more specific findings on the determinants affecting farmers' intention to apply new agricultural technologies. These findings can help managers find solutions to promote the application of new agricultural technologies on millions of farmer households, increasing productivity and business efficiency for Vietnam's agriculture.

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