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Factor Affecting the Production Decisions of Safety Vegetables by Farming Households: Empirical Research in the Midland and Northern Mountainous Regions of Vietnam

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Abstract

The sustainability of the fruit and vegetable industry has been threatened by the indiscriminate use of agricultural chemicals to enhance commercial production. Implementing Good Agricultural Practices (GAP) can help minimize chemical use in commercial vegetable farming. This study uses a quantitative approach to examine how various factors influence both the initial adoption and continued compliance with GAP among Vietnamese farmers. Using a structural equation modeling (SEM) approach, the research analyzes data from 214 vegetable-growing households across 14 provinces in Vietnam's northern midland and mountainous regions. The findings indicate that subjective norms, perceived behavioral control, and communication positively impact farmers' decisions to adopt GAP. However, environmental awareness among farming households does not significantly affect their decision to adopt GAP in safe vegetable production. This study contributes to the theoretical framework and practical applications in the agricultural sector, offering farmers valuable insights into GAP adoption. It also highlights that the beliefs of farming households play a crucial role in the successful implementation of GAP in safe vegetable production.

Keywords: Safety Vegetables, Farming Household, Decision, GAP.

Introduction

Research on the adoption of technological innovations in agriculture has garnered significant attention from scholars across various disciplines. The foundation for this research dates back to Bernoulli's (1738) expected utility theory, which examines how farmers weigh benefits and risks when adopting new innovations [1]. Over time, psychological and behavioral theories, such as Roger's diffusion of innovations theory (1962) and Ajzen's theory of planned behavior (1991), have provided alternative perspectives on this issue [2,3]. Numerous empirical studies have validated these theories in practice, demonstrating that factors like attitudes, social norms, and perceived behavioral control significantly influence farmers' adoption decisions [4,5]. Meanwhile, studies based on expected utility theory suggest that farmers' perceptions of benefits and risks—particularly economic risks—play a crucial role in their decision-making [6]. However, the adoption of technological innovations in agriculture is shaped not only by psychological factors but also by economic, social, and cultural influences. Bergevoet et al.

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(2004) argue that economic models alone cannot fully explain the complexity of farmers' decisions, as both financial and non-financial motivations drive their choices [7]. Consequently, most theoretical and empirical models have approached this issue from a single-disciplinary perspective [8]. Given this, verifying these theories in the context of a developing agricultural country like Vietnam remains an urgent research priority.

Vegetables are a staple in family diets, and the demand for safe vegetables is increasingly critical. To enhance consumer safety, ASEAN introduced Good Agricultural Practices (GAP) guidelines in 2006 for its member states. Vietnam has implemented food safety policies since 1994 (initially using the term "clean vegetables") and introduced safe vegetable production guidelines in 2007. The Ministry of Agriculture and Rural Development, along with the Ministry of Science and Technology, has also established GAP guidelines for fresh fruits and vegetables to minimize food safety risks. In 2017, the Ministry of Science and Technology issued the national standard TCVN 11892-1:2017 on GAP (VietGAP) for crop production. However, by 2023, the area dedicated to safe vegetable (RAT) production remained just 0.26% of the country's total vegetable-growing area (Pham Hai Vu et al., 2016). This low adoption rate may be partially attributed to consumer-related factors such as purchasing behavior, trust, and willingness to pay for safe vegetables. Studies on consumer behavior in Vietnam, including those by Minh (2018), VECO (2016), and Thang (2018), indicate that over 97% of Hanoi residents are concerned about food safety, with more than 70% willing to pay for safe or organic vegetables [9,10]. Despite this, fewer than one-third of surveyed consumers purchase safe vegetables from stores, primarily due to low trust in certifications and limited product information [11]. Other research highlights challenges faced by farmers in producing safe vegetables, but there has been little in-depth exploration of the factors affecting their decision to adopt safe production practices.

Existing studies have helped raise awareness among policymakers, businesses, and farmers about the importance of GAP adoption in vegetable production. However, no research has thoroughly examined the psychological motivations, perceptions, and decision-making processes of farmers regarding GAP adoption. Furthermore, most previous studies have relied on qualitative methods, often limited to expert interviews, without employing robust empirical analysis. To fill this gap, this study aims to identify the factors influencing farmers' decisions to adopt GAP in vegetable production by utilizing survey data and applying advanced estimation methods. Specifically, the study seeks to address the following questions:

1. What factors influence the decision to adopt Good Agricultural Practices (GAP) among vegetable farming households in Vietnam?
2. To what extent do these factors impact this decision?

The findings of this study will provide empirical evidence on the quantitative impact of various factors on farmers' production choices in Vietnam, contributing to a deeper understanding of technological innovation adoption in agriculture.

Literature Review

Theory of Planned Behavior – TPB

The Theory of Planned Behavior (TPB) builds upon the Theory of Reasoned Action (TRA) by emphasizing that attitude alone is not sufficient to predict behavior. Other key factors, such as social pressure and the perceived difficulty of performing an action, also play a crucial role [12].

While “intention” remains central to TPB, the theory introduces "perceived behavioral control," which reflects an individual's belief in their ability to influence the outcome of their actions [13]. This addition acknowledges that behavior is not always entirely rational or within an individual's control, but rather exists on a spectrum ranging from full control to complete lack of control [3].

TPB suggests that attitude affects the decision to adopt technological innovations. However, in practice, adopting new technologies—such as the GAP process in vegetable farming—requires a clear understanding of the process. Farmers who recognize how a technology can improve productivity and bring benefits are more inclined to adopt it. Yet, awareness alone does not guarantee adoption; social consensus also plays a critical role. For instance, genetically modified technology has faced limited acceptance due to societal concerns about unintended consequences. When both farmers and society approve of a technology, its adoption in agriculture becomes more likely.

Decision-making is often influenced by the opinions of others, as individuals seek to align with shared family values or consult experts. Farmers may seek guidance from their spouse, children, agricultural extension officers, cooperative leaders, or village heads. Consequently, the decision to adopt GAP standards in vegetable farming is shaped by these external influences. Even when the benefits are well understood and there is broad social support, the absence of sufficient behavioral control can still hinder the adoption of new technologies.

Overall, TPB has proven effective in explaining farmers' behavior and identifying the factors that influence their decision-making process. Studies by Läpple and Kelley (2013), Lynne et al. (1995), Bergevoet et al. (2004), Wauters et al. (2017), and Borges et al. (2014) further demonstrate its applicability in agricultural contexts [4,14,7,5,15]. This leads to the following hypotheses:

> **H1.** There is a positive relationship between subjective norms and the decision to adopt GAP standards in vegetable production by farmers.
>
> **H2.** There is a positive relationship between perceived behavioral control and the decision to adopt GAP standards in vegetable production by farmers.

Expected Ultility theory – EUT

Building on the Expected Utility Theory (EUT) introduced by Bernoulli (1738), Batz et al. (1999) proposed that farmers evaluate innovative technology by comparing its expected utility with that of traditional methods, adopting it if the anticipated benefits outweigh those of existing practices. In the study of consumer demand, economists have highlighted that subjective preferences for product characteristics influence purchasing behavior [1,16]. However, research on how farmers' preferences shape their decisions to adopt new technologies has received less attention from economists [17]. Moreover, EUT suggests that farmers' perceptions of the benefits and risks associated with innovations—particularly economic risks—play a significant role in their adoption decisions [18].

When farmers recognize the economic advantages of adopting new agricultural practices, along with concerns about food safety and environmental sustainability, they are more likely to implement Good Agricultural Practices (GAP). However, agriculture—especially vegetable production—remains highly vulnerable to risks such as unpredictable weather, pests, fluctuating market prices, and brand-related uncertainties.

The expected utility theory, with its focus on value-based and motivation-driven decision-making, provides a useful framework for analyzing farmers' adoption of technological innovations. However, this theory primarily considers the maximization of expected utility and does not account for psychosocial influences or social pressures that may affect farmers' choices. Bergevoet et al. (2004) argue that economic models alone cannot fully explain the complexity of farmers' decision-making, as both financial and non-financial factors drive their choices [7].

H3. There is a positive relationship between environmental benefits and farmers' decisions to adopt GAP standards in vegetable production.

Innovation Diffusion Theory (IDT)

Research on the adoption of new innovations has been ongoing for many years, with the Innovation Diffusion Theory (IDT) being one of the most widely recognized models. According to this theory, individuals go through five stages when adopting a new practice or behavior: (i) acquiring initial knowledge and understanding of the innovation, (ii) forming either a positive or negative attitude toward the innovation during the persuasion stage, (iii) engaging in activities that lead to a decision to adopt or reject the innovation, (iv) implementing the innovation, and (v) evaluating the decision's outcomes and considering external opinions for reinforcement.

Additionally, IDT identifies five key attributes that influence innovation adoption: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability [19]. Rogers (1995) defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system" [20]. Donna et al. (2000) further differentiate diffusion from adoption, explaining that diffusion refers to the spread of technological advancements among consumers, whereas adoption is the individual's internal decision-making process [21].

In the agricultural sector, Feder and Umali (1993) supported Fliegel's (1993) argument that the linear approach to innovation adoption is often restrictive. Instead of viewing the diffusion process as solely driven by rational planning through organizations such as government agencies, Fliegel emphasized the active role of farmers, recognizing that social interactions and communication play a crucial role in the adoption process [22,23]. Communication is a key factor influencing farmers' decisions to adopt innovations, as highlighted in Rogers' (1995) work [20]. Effective communication involves the exchange of information to foster understanding, making it an essential element in technology diffusion. In this study, the adoption of Good Agricultural Practices (GAP) is influenced by the frequency of farmers' interactions with agricultural extension officers, as well as exposure to information through television, radio, and other audiovisual media.

According to Rogers' (1995) Diffusion of Innovations theory, communication significantly impacts farmers' decisions by enabling the sharing of knowledge and insights [20]. Makokha et al. (1999) applied this theory to show that farmers' characteristics—such as participation in group discussions, training attendance, workshop engagement, and leadership roles—have only a minor influence on their adoption of innovations [24]. However, Gebremariam (2001) found that frequent interactions between farmers and agricultural extension services positively influenced their adoption of new maize and wheat varieties in Ethiopia's Tigray region [25]. Given this context, this study proposes the following hypothesis regarding the adoption of GAP standards in vegetable production.

H4: There is a positive relationship between communication and the decision to adopt GAP standards in vegetable production among farmers.

Data and Methodology

Data

The target population for this study consists of farming households from 14 provinces in Vietnam's midland and northern mountainous regions. These provinces are part of the northern mountainous area of the country.

The list of vegetable-growing households in each province was obtained from the provincial Department of Agriculture and Rural Development, which maintains records of most farming households. From this list, a random sample of 259 farming households was selected, accounting for 25% of the vegetable-growing households in each province.

Prior to conducting the survey, a pre-test was carried out with 11 farmers and two experts to ensure the clarity and comprehensibility of the questionnaire. The final survey comprised four sections: socio-economic characteristics, questions based on the Theory of Planned Behavior (TPB), Expected Utility Theory (EUT), and Innovation Diffusion Theory (IDT), as well as farmers' goals and personality traits (though the last two are not discussed in this paper).

To gather responses, 259 farming households were contacted and invited to participate, either via phone or through direct farm visits. If a farmer was unavailable or declined to participate, another was randomly selected from the list. Those who agreed took part in face-to-face interviews to complete the survey. Of the 259 questionnaires distributed, 214 were completed and deemed valid for data analysis, resulting in a response rate of 82.6%.

Methodology

The study used a mixed-methods approach, combining both quantitative and qualitative techniques. The quantitative aspect was guided by the key research questions, while the qualitative data served to provide additional validation and triangulation. The quantitative data was collected through a survey of 214 farms across 14 provinces in the Northern midland and mountainous regions of Vietnam. These farms were purposely selected based on criteria such as feasibility, the level of vegetable commercialization, and their adoption of Good Agricultural Practices (GAP) for safe and sustainable vegetable production. The Testing and Certification Center (TQC CGLOBAL) provided regular technical support and supervision for these farms. A semi-structured questionnaire with both closed and open-ended questions was used to gather information on GAP adoption, farmers' perceptions, challenges, and their willingness to adopt such practices. The questionnaire was pre-tested and modified as needed before the survey was launched.

Before the analysis, the reliability of the scales used to measure the constructs was assessed using Cronbach's α coefficient. A Cronbach's α coefficient above 0.6 indicated that the beliefs measured could be aggregated to calculate subjective norm and perceived behavioral control (Ajzen, 1991). Similarly, a Cronbach's α coefficient over 0.6 meant that the results of different statements for intention, direct attitude, direct subjective norm, and direct perceived behavioral control could be combined and represented as the mean for these constructs. The Spearman rank correlation coefficient (rs) was used to test the hypotheses; a non-parametric test was chosen due to the ordinal nature of the data [26]. Confirmatory Factor Analysis (CFA), a statistical technique

within Structural Equation Modeling (SEM) introduced by Steenkamp and Van Trijp (1991), was performed to assess how well the observed variables represented the factors [27].

For data analysis, this study applied Structural Equation Modeling (SEM), which is a robust and effective method for verifying relationships between latent constructs and observed variables. SEM allows for more accurate measurement of latent variable variance and is commonly used in management and sociology research. There are two main SEM estimation methods: covariance-based SEM and variance-based SEM. Researchers have found that variance-based SEM, such as Partial Least Squares Structural Equation Modeling (PLS-SEM), is particularly effective in analyzing and explaining the variance of dependent variables, verifying relationships between multiple variables within the same model, and encountering fewer statistical identification problems than covariance-based SEM. Furthermore, PLS-SEM is well-suited for models with smaller sample sizes and can handle exploratory analyses and formative constructs. As such, PLS-SEM was used in this study to analyze the data and test the model.

Findings

Respondent's Profile

Table 1 presents the socioeconomic characteristics of the farmer sample. In addition to the variables listed in the table, the study also measured education level. The findings revealed that 69.6% of the farmers had not completed high school, 21.5% had completed high school, 8.9% had completed college or earned a bachelor's degree, and none had pursued postgraduate studies. All of the respondents rent land for vegetable production, as most are migrants without land ownership. The average number of years of practical experience with Good Agricultural Practices (GAP) among the respondents is approximately two years. Vegetable farming serves as the primary source of income for the farming households in the study area, as shown in Table 1.

No	Categorize	N	Percentage (%)
I	**Gender**	**214**	**100**
1	Male	82	38.3
2	Female	132	61.7
II	**The number of years of GAP practice experience**		
1	< 1 year	100	46.7
2	1 – 3 years	73	34.1
3	> 3 years	41	19.2
III	**Education level**		
1	Incomplete high school	149	69.6
2	High school	46	21.5
3	College and Bachelor	19	8.9

Table 1. Respondents' information
Source: Authors' computation

Emprical Results

Reliability of the scale

The article utilized reliability analysis, factor analysis, and regression techniques to assess how organizational culture influences employee commitment. The results of Cronbach's Alpha coefficient are presented in Table 2.

	Variables	**Cronbach's Alpha**	**CR**	**AVE**
1	Communication	0.850	0.832	0.557
2	Environmental awarness	0.597	0.961	0.869
3	Subjective norms	0.900	0.931	0.582
4	Perceived behavioral control	0.860	0.898	0.562
5	Decision – Making	0.915	0.956	0.828

Table 2. Results of assessing the reliability of the scale
Source: Authors' computation

As shown in Table 2, the Cronbach's Alpha values for the variables CO, SN, and PC are all above 0.8, indicating that the data's overall reliability is satisfactory. According to Nunnally (1978), a reliable scale should have a Cronbach's Alpha of 0.7 or higher [28]. Hair et al. (2009) also emphasized that a scale demonstrating unidimensionality and reliability should have a Cronbach's Alpha of 0.7 or above. However, the variable EA exhibited an unexpected result, with a low Cronbach's Alpha of 0.697, despite its high composite reliability (CR) and average variance extracted (AVE). This suggests that the variable may have internal consistency issues, leading to its exclusion from the model. The variable DM, on the other hand, showed a Cronbach's Alpha of 0.915. According to Hair et al. (1995), for a scale to be deemed reliable, the CR should exceed 0.7, and the AVE should be above 0.5. Therefore, the variables CO, SN, PC, and DM met these criteria and were included in the subsequent stage of analysis.

Exploratory Factor Analysis (EFA)

The results of the exploratory factor analysis of this study are as follows:

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.935	0.5 < 0.935 <1
Bartlett's Test of Sphericity Approx. Chi-Square	0.000	0.000 < 0.05
Total variance explained	73.685	73.685%>50%
Eigenvalue	1.513	1.513> 1

Table 3. Results of KMO and Bartlett's Test
Source: Authors' computation

Therefore, the total variance extracted is 73.685% (greater than 50%), the KMO coefficient is 0.935 (within the acceptable range of 0.5 to 1), and the Bartlett test is statistically significant ($p < 0.05$), indicating that EFA analysis is appropriate. With an Eigenvalue of 1.513 and an extracted variance of 73.685%, this suggests that at the cutoff point of 1.513, these five factors account for 73.685% of the variability in the data.

	Component			
	1	**2**	**3**	**4**
DM3	.883			
DM7	.878			
DM4	.872			
DM5	.867			
DM1	.866			
DM9	.858			
DM8	.837			
DM6	.835			
DM2	.791			
PC3		.813		
PC2		.786		
PC4		.777		
PC1		.756		
PC8		.712		
PC9		.694		
PC6		.685		
PC7		.677		
PC5		.662		
SN2			.839	
SN1			.754	
SN3			.726	
SN5			.657	
CO3				.858
CO2				.809
CO4				.793
CO5				.791

Table 4. Component matrix of variables
Source: Authors' computation

The exploratory factor analysis and reliability evaluation of the scale confirmed that the theoretical model and initial research hypotheses were upheld. As shown in Table 4, the authors excluded item SN6 to ensure that all observations had factor loadings exceeding 0.6, thus meeting the criteria for the next phase of analysis.

Scale Validation using Confirmatory Factor Analysis (CFA)

In the following step, the study re-assesses the scales using confirmatory factor analysis (CFA). CFA in Structural Equation Modeling (SEM) offers several advantages over traditional methods like correlation coefficients and Exploratory Factor Analysis (EFA). This is because CFA enables the testing of the theoretical structure of measurement scales, such as the relationship between research concepts, without being affected by measurement errors. Additionally, CFA allows for testing the convergent and discriminant validity of the scale without requiring multiple studies, as is necessary in the traditional MTMM method [27]. The results are presented in Table 5.

Comparative Fit Index	**CFA results**	**Evaluation**
CMIN ($p < 0.05$)	p-value=0.000	Fit
Chi-square/df ≤ 3	Chi-square/df=2.395	Fit
CFI ≥ 0.9	CFI=0.930	Fit
TLI ≥ 0.9	TLI=0.922	Fit
$0.8 \leq$ NFI ≤ 0.9	NFI=0.885	Fit
RMSEA ≤ 0.08	RMSEA=0.080	Good

Table 5: CFA analysis
Source: Authors' computation

Therefore, when compared to the requirements, the model is deemed to align well with the market data. According to Steenkamp and Van Trijp (1991), the results indicate that the model is in agreement with the market data. There is no correlation between the measured errors, confirming that the model is unidimensional.

Distinguishing Value Assessment

The discriminant value of a scale is the degree to which factors are distinct from each other and uncorrelated. The Fornell and Larcker (1981) criterion to evaluate the discriminant value between variables is to compare the square root of the AVE with the correlation coefficient of two latent variables [29]. The results of Table 6 showed that all variables in the model gained discriminant value.

Factor	**CO**	**SN**	**PC**	**DM**
CO	0.909			
SN	0.303	0.749		
PC	0.256	0.467	0.932	
DM	0.191	0.370	0.387	0.746

Table 6. Evaluation of the discriminant value of the scale

Source: Authors' computation

Testing the Research Model Using Structural Equation Modeling (SEM)

The aim of this study is to examine the factors that influence the adoption of GAP practices in vegetable production among farming households in the northern midland and mountainous regions of Vietnam.

Table 5 presents the beta values, collinearity values, and significance levels of the relationships between the independent variables and farmers' adoption decisions. The results show that communication, subjective norms, and perceived behavioral control all have a significantly positive effect on the decision to implement GAP in vegetable production.

Figure 1 indicates that the TLI = 0.922, CFI = 0.930, RMSEA = 0.08 (≤ 0.08), and the chi-squared value corrected for degrees of freedom (CMIN/df = 2.395) (≤ 3), all with P-values under 0.05. While the NFI index = 0.885 is slightly below 0.9, Baumgartner and Homburg (1996) note that for models with many observable variables, an NFI above 0.8 and up to 0.9 is acceptable.

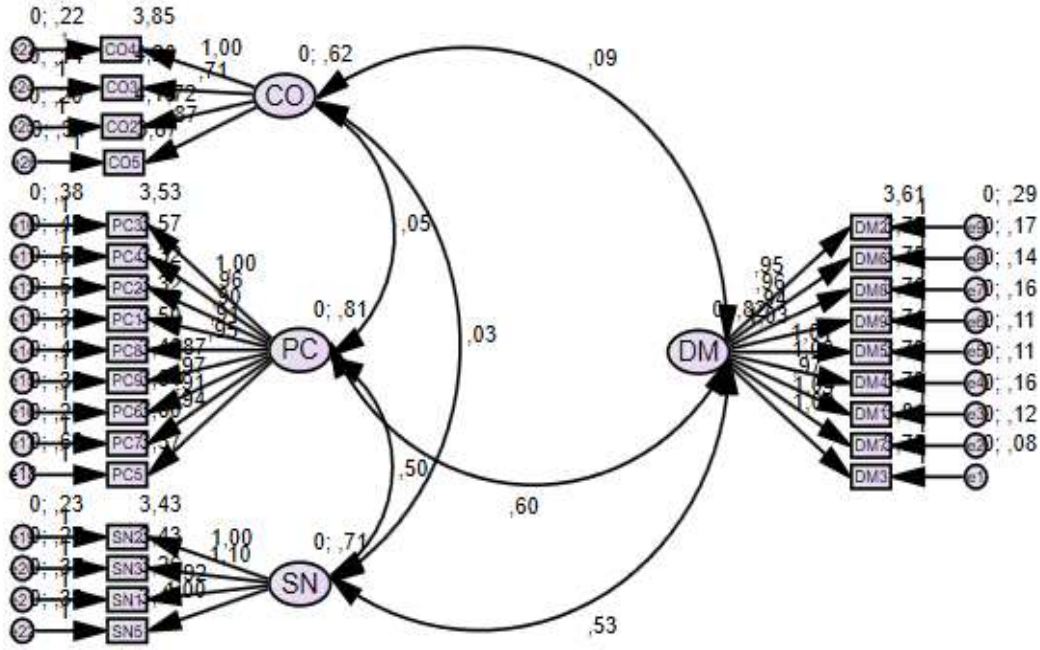

Figure 1. SEM results of theoretical model
Source: Authors' computation

The model's estimated regression coefficients are shown in the table below:

			Estimate	**S.E.**	**C.R.**	**P**
DM	<--	PC	0.600	0.077	7.767	***
DM	<--	SN	0.533	0.070	7.615	***
DM	<--	CO	0.087	0.053	1.658	0.007

Table 7. The unnormalized regression coefficient of the SEM

The studies showed that the DM (Decision-Making) factor has a P-value greater than 0.5, as indicated by the unstandardized regression coefficient. This suggested that this variable does not significantly impact the level of dedication.

On the other hand, all other covariates have P-values less than 0.5, implying that they do influence the commitment of bank employees to the institution. When examining the standardized regression coefficient, it is evident that all factors have positive values, indicating that they all contribute positively to commitment.

Discussion and Conclusion

Implications

In this paper, we examine the adoption of Good Agricultural Practices (GAP) standards in safe vegetable production in the Northern midland and mountainous region of Vietnam. We conducted a survey of 214 households to understand how they apply the standards and the factors influencing their decision-making to produce according to GAP standards.

The results indicate that factors such as Communication, Subjective Norms, and Perceived Behavioral Control have a positive impact on households' decisions to adopt safe vegetable production. In contrast, Environmental Awareness does not influence their decision-making in safe vegetable production. Specifically:

Hypothesis H1 states that subjective norms are positively related to the decision to adopt GAP standards in vegetable production among farming households. The analysis results, with $\beta = 0.533$ and $p < 0.05$, indicate that the voices of influential individuals have a significant impact, particularly the heads of cooperatives. These findings support Hypothesis H1, demonstrating that subjective norms have a positive and significant influence on the decision to adopt GAP standards in vegetable production among farming households. The analysis reveals that influential individuals, especially cooperative leaders, play a key role in shaping farmers' decisions. Cooperative leaders not only play an important role in product marketing but also promote the transfer of scientific and technological knowledge, while village leaders contribute by providing guidance and advice on production activities. This highlights the importance of social influence in promoting the adoption of improved agricultural practices.

Hypothesis H2 states that perceived behavioral control is positively related to the decision to adopt GAP standards in vegetable production among farming households. The analysis results, with $\beta = 0.60$ and $p < 0.05$, indicate that perceived behavioral control has a positive impact on the decision to adopt GAP standards in vegetable production. When farmers feel confident in implementing GAP procedures and can rely on the methods of other farmers to follow their practices, their decision to adopt GAP standards in vegetable production increases. However, the study did not find any influence from control factors such as post-harvest storage, land area available for application, or transportation conditions on farmers' decisions. Observations and

interviews also revealed that farmers typically sell their vegetables immediately in the morning after harvest, either directly to traders at the farm or at local markets.

Unexpectedly, Hypothesis H3 was not statistically significant in this study (the factor of environmental awareness was hypothesized to have a positive relationship with the decision to adopt GAP standards in vegetable production among farming households). This result is not consistent with the reality in the northern midland and mountainous areas of Vietnam, because farmers often do not compare improved technologies with traditional ones or may choose not to apply them, even when the expected satisfaction level of the improved technology is higher than that of traditional technology [16]. Additionally, farmers in this region have lower education levels, which may prevent them from making decisions to adopt GAP standards, even if they are aware of the health benefits for themselves.

Hypothesis H4 suggested that communication is positively related to the decision to adopt GAP standards in vegetable production by farmers. As expected, the results show $\beta = 0.087$ and $p < 0.05$, indicating that the more communication relationships farmers have through channels such as exchanges with friends, neighbors, watching TV, or communicating with agricultural extension officers, the more likely they are to decide to apply GAP standards in vegetable production. Interview results also indicated that communication with agricultural extension officers is very limited, while farmers mainly exchange information through friends and watching media, which is probably not a specific characteristic of the northern midland and mountainous areas but a common issue throughout the country, as the extension workforce is very limited in number and cannot regularly reach farmers. Furthermore, access to information from the internet does not significantly impact farmers' decisions to adopt GAP standards, as most of the main labor force, the interviewees, have little practical experience with GAP in safe vegetable production (most have less than one year of experience). Moreover, internet access in rural areas is very limited, and if available, it is mostly used by children for studying. For example, when asked about their regular TV viewing habits, interviewees said they typically watch the news, and the rest is for relaxation before going to work early the next day. Therefore, internet use is even rarer. Thus, the study also recommends using this measure for regions with higher education levels.

Limitations and Futrure Research

This study has some limitations as follows:

- It was conducted exclusively in the northern midland and mountainous regions of Vietnam. As a result, the findings may not be applicable to other regions with different socio-economic conditions, agricultural practices, or levels of access to information. The results may be influenced by the unique challenges and characteristics of this area, such as limited internet access and lower education levels, which may not be representative of the broader farming population in Vietnam.

- It surveyed 214 farming households, which, while substantial, may not fully capture the diversity of experiences or practices among all vegetable farmers in the region. A larger and more varied sample might provide more comprehensive insights into the factors influencing GAP adoption.

- While the study focused on subjective norms, perceived behavioral control, communication, and environmental awareness, other potentially significant factors influencing GAP adoption,

such as economic incentives, access to markets, or government policies, were not explored in detail. Future research could expand on these variables for a more complete understanding of adoption dynamics.

- The study found that environmental awareness did not significantly influence the decision to adopt GAP standards, which was an unexpected result. This might be attributed to the limited focus of farmers on environmental benefits due to lower education levels and a lack of comparison between traditional and improved technologies. The findings suggest that other factors, such as economic and social influences, may have a stronger role in shaping decision-making in this region.

- The study highlighted that communication with agricultural extension officers is limited, and farmers primarily rely on informal communication channels such as exchanges with neighbors and friends. While communication is essential, the limited reach of extension services and the reliance on informal channels could hinder the effective transfer of knowledge about GAP practices. This is a common issue across rural Vietnam, suggesting that addressing the gap in extension services should be a priority for improving GAP adoption.

- The study found that internet access had little impact on farmers' decisions to adopt GAP standards due to the limited availability and usage of the internet, particularly among older generations or rural farmers. This factor may limit the ability to spread knowledge and information related to GAP practices through digital channels in rural areas.

- The study's results suggest that lower education levels among farmers may limit their ability to adopt GAP practices, even when they are aware of the potential benefits. This highlights the need for more accessible educational programs and training to improve farmers' understanding and application of GAP standards.

Thus, these limitations suggest that further research is needed to explore additional factors influencing GAP adoption and to include a broader range of regions and more diverse farmer populations for more generalizable conclusions.

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