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Factors Affecting High-Tech Application Behavior in Livestock Industry in the South Central and Central Highlands Regions, Vietnam

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ABSTRACT

The application of high technology in agricultural activities contributes to increased productivity, improved production efficiency, enhanced product quality, cost savings, reduced production costs, and, potentially, environmental protection. However, the development and adoption of high technology in agricultural production–particularly in the livestock sector–remain significant challenges in Vietnam. This study was conducted to identify and analyze the factors influencing the behavior of high-tech adoption in livestock farming in the South Central Coast and Central Highlands regions of Vietnam. The data used in this study were collected through a survey of 297 livestock farmers in the South Central and Central Highlands regions of Vietnam. It utilized SPSS 22 and AMOS software to evaluate the factors influencing the adoption of high technology in the livestock industry. The analysis revealed a direct positive relationship between several factors–expected efficiency, expected effort, favorable conditions, social influence, trade–off value, limitations of traditional production, and environmental awareness–and the intention to use high technology. Additionally, favorable conditions were positively linked to both the intention to use high technology and the actual behavior of adopting it in livestock farming. Based on these findings, the study offers several recommendations for localities, farms, and livestock companies to promote the application of high technology in production, particularly in the South Central and Central Highlands provinces of Vietnam.

Keywords: High–Tech Agriculture; High–Tech Applications; Livestock; Behavior

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1. Introduction

The global population is projected to reach 9.6 billion by 2050, necessitating a 70% increase in food production to satisfy escalating demand [1]. This pressing challenge is further compounded by the adverse impacts of climate change, the depletion of natural resources, and growing concerns regarding food safety. In this context, the application of high technology in agriculture—particularly in livestock farming—has become an inevitable trend. Technological innovations play a vital role in enhancing production efficiency, controlling disease outbreaks, ensuring food quality and safety, and minimizing environmental degradation [2].

To meet these growing demands, it is crucial to accelerate scientific and technological progress across the agricultural sector. The modernization of conventional farming practices through the adoption of advanced technologies has become an essential objective for many countries, including Vietnam [3]. In recent years, the Vietnamese government has introduced a range of strategic policies to support the application of high technology in livestock farming. Notable examples include Decision No. 575/QD–TT, which outlines the master plan for developing high–tech agricultural zones by 2020 with a vision to 2030, and the national project titled *"Promoting Scientific and Technological Activities in the Livestock Industry until 2030,"* which aims to strengthen technological capacity and promote sustainable livestock development. More recently, Decree No. 106/2024/ND–CP has set out support policies to improve livestock farming efficiency.

Vietnam's efforts have not been limited to policy–making but also involve practical activities such as upgrading infrastructure, enhancing scientific research, applying advanced breeding techniques, promoting organic livestock production, and encouraging private sector participation. Among the regions prioritized for such initiatives are the Central Coast and Central Highlands, where livestock farming plays a significant role in the local economy. These regions possess a diverse livestock structure and have experienced substantial growth in recent years. According to the 2023 Statistical Yearbook of Vietnam, the Central Coast and Central Highlands accounted for 11.56% of the national buffalo population (246.8 thousand heads), 35.72% of the national cattle population (2262 thousand heads), and 19.12% of the national pig population (4885.3 thousand heads). Additionally, these regions lead the country in the farming of sheep, ostriches, silkworms, and honeybees.

The adoption of high technology in livestock farming within these regions has delivered positive results. It has helped reduce labor intensity, increase productivity, and improve meat quality while also enhancing environmental hygiene. Technological advancements have contributed to more effective disease control, faster response to outbreaks, and greater economic stability for livestock producers. However, despite these benefits, the implementation of high technology still faces multiple challenges. High initial investment costs, technical complexity, limited access to expertise, and volatile market prices remain significant barriers. Furthermore, there is often no clear distinction in the market between products generated through traditional methods and those produced using advanced technologies. These constraints are particularly evident among small–scale livestock farmers, where technological adoption remains limited.

Given the strategic importance of livestock production in the South Central and Central Highlands provinces of Vietnam, and the potential benefits of high technology adoption, it is essential to understand the factors influencing farmers' behavior toward adopting such technologies. This study was conducted to identify the factors influencing the adoption of high technology in the livestock industry in the South Central and Central Highlands provinces of Vietnam. The aim is to provide insights for policymakers and stakeholders seeking to promote sustainable, high–tech livestock farming in Vietnam.

2. Literature Review

Numerous studies have examined the role and benefits of high–tech adoption in agriculture in general, and in the livestock sector in particular. Jain [4] emphasized that farmers who do not adopt agricultural technologies face significant difficulties in maintaining even marginal livelihoods. As a result, socio–economic development may stagnate, leading to persistent poverty and deprivation. The application of new technologies in agriculture contributes to increasing food production, playing a crucial role in ensuring food security and promoting sustainable economic development. Loevinsohn [5, 6] noted that the adoption of new techniques and technologies enables certain tasks to be performed more easily. Technology allows users to carry out their work more efficiently than they could without it, thereby saving time and labor. Technological advances help ease workloads, improve work effectiveness, and support more productive farming practices. In recent years, science and technology–based agricultural production has become an inevitable trend among countries, aiming to improve both productivity and product quality. This shift also facilitates compliance with increasingly strict export standards and the integration into global value chains. Challa [7] argued that technological adoption in agricultural production helps improve the relationship between inputs and outputs. Modern technologies tend to enhance productivity while reducing average production costs, thereby significantly increasing farmers' income. Simões [8] analyzed the influence of technology adoption in both the short and long term, as well as the estimated adoption rates and farm sizes. When other farmers adopt technology, non–adopters may incur reduced incomes and less productivity and income shares. The underlying causal structure of farm profitability and herd management decisions is sufficient to explain why non–adopting farms (particularly small–scale farms) may be excluded from the market when others adopt. Continuous usage of a new technology indicates that successful adopters reap a net advantage, while non–adopters will experience lower profitability and some will leave as a result.

Numerous studies, both globally and in Vietnam, have identified and analyzed the factors influencing the adoption of high technology in agriculture in general and in livestock farming in particular. These studies employed various research methods and adopted diverse analytical approaches [9].

Research by Katungi & Akankwasa [10], Atsriku [11] classified influencing factors into groups such as economic, social, and institutional factors. Meanwhile, other studies examined dimensions including human resources, production inputs, policy frameworks, and natural conditions [12]. Numerous domestic and international studies focus on identifying the factors that influence producers' decisions to adopt high technology in agricultural production. Most of these studies share the common finding that the decision to apply high technology is determined by both the characteristics of the technology and the specific conditions and circumstances of the producers implementing it.

Several studies have approached this issue from the perspective of technology acceptance, notably those by Venkatesh et al. [13, 14], Mamudu [15], and Challa [7]. These studies highlighted factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions, as well as external variables like gender, age, voluntariness, and prior experience.

Some representative studies are summarized as follows: A study by Atsriku [11] categorized the factors influencing the application of technology in agriculture into three groups: economic, social, and institutional factors. This study has shown many groups of factors influencing farmers' intention to apply technology in agriculture but has not distinguished between variables in each type of factor.

According to Loevinsohn et al. [6], farmers' decisions to adopt new technologies depend on the characteristics of the technology as well as the prevailing conditions and circumstances surrounding its diffusion.

The study by Kinyangi [16] found that access to credit facilities, training, education level, gender, and age of farmers positively influenced the adoption of modern technologies in agricultural production among farmers in Kakamega, Kenya. Melesse [17] identified three main categories of factors influencing the adoption of high technology in agriculture in Ethiopia. Demographic factors such as the gender of the household head and age affect adoption behavior; older farmers are often more attached to traditional practices, while younger farmers tend to be more receptive to new technologies. Socio–economic factors, including education level, land access, labor availability, and farm size, shape farmers' capacity to adopt technology. Institutional factors, such as access to credit, insurance, infrastructure, markets, and extension services, also play a critical role. Similarly, Li et al.[18] found that the adoption of high technology in lychee production in China is influenced by production scale, growers' knowledge and experience, education level, and positive attitudes toward technological innovation.

Additionally, Tran & Bui[19] analyzed the adoption of high technology in cattle farming in the Central Highlands provinces of Vietnam, identifying two key influencing factors: the gender of the household decision–maker and the education level of the households. The regression results confirmed that there are only 2 factors affecting the decision to apply high technology in cattle farming in the Central Highlands of Vietnam, which are the gender of the household's production decision maker and education level. The remaining factors were eliminated from the model because they had no correlation with the variables to be surveyed or had low reliability. This is also a limitation of the study, as too many variables were eliminated. However, the authors have added descriptive statistical analysis of the variables affecting the decision to apply high technology in cattle farming in the Central Highlands of Vietnam to evaluate and consider the application decision. Yan Shi et al.[20] conducted an analysis demonstrating that effort expectancy, performance expectancy, facilitating conditions, hedonic motivation, government support, price value, personal innovativeness, and trust significantly influence Bangladeshi farmers' willingness to adopt IoT technologies in agricultural production. Moreover, trust and willingness to adopt were identified as predictive factors affecting farmers' willingness to pay for IoT, whereas performance expectancy was found to have no significant effect. The study further revealed that adoption readiness moderates the relationship between performance expectancy, price value, and the willingness to pay for IoT, indicating a diminishing influence of these factors as readiness increases.

Nghia & Kien[21] investigated the factors influencing the intention to apply high technology in pangasius farming in Vietnam. The study found that several factors positively affect this intention, including the perceived usefulness of high technology in pangasius farming, awareness of financial capital, market variables, social capital, and human capital. Among these, the perceived usefulness of applying high technology was identified as the most significant factor in the model. Conversely, factors such as farming conditions, the influence of traditional production methods, and policy constraints negatively impact the intention to adopt high technology. Based on data collected from a survey of 90 households engaged in high–tech agricultural production in Vinh Phuc Province, Vietnam, Phuong and Huong[9] found that production organization and the planning of high–tech agricultural zones had a direct impact on the adoption of high–tech practices by local farmers. In addition, physical infrastructure was identified as a critical factor. Specifically, in areas where in–field transportation systems had been modernized and concreted, the adoption rate of high–tech agriculture reached up to 90%. Demographic variables, cultivated land area, and income from agricultural activities were also found to be statistically significant in explaining farmers' participation in high–tech farming.

These findings demonstrate that different studies–depending on the context, research subjects, and methodological approaches–have identified a variety of influencing factors. Despite this diversity, the existing literature consistently highlights and quantifies the impact of these factors on farmers' behavior and intention to adopt advanced technology in agricultural production, particularly in the livestock sector.

3. Methods

3.1. Data Collection Methods

In the Central and Central Highlands provinces of Vietnam, there are many livestock farming households. Research data were collected from livestock farmers in this region, specifically targeting farm owners. According to Thang[22], a minimum sample size of 100 is required to conduct statistical analyses. To ensure an adequate number of observations, this study surveyed 320 livestock farmers. The total number of survey forms distributed was 320; the total number of forms collected was 317 (reaching a response rate of 99.1%). A response rate of over 50% is expected, which would satisfy the minimum requirement for a valid statistical analysis. The research team used a convenience sampling method combined with a snowball sampling method, which involved sending the survey to acquaintances and asking them to share it with other potential participants. Additionally, the team implemented reminder procedures to boost the response rate by calling and texting individuals who did not respond after 10 days of receiving the survey form. From the 317 collected surveys, 17 responses from farm owners who did not use technology in their production processes were excluded. Furthermore, 3 responses were eliminated because the respondents selected the same level for all observed variables. This left 297 valid responses, all of which contained complete information, and therefore, all were included in the data analysis.

With a total of 297 valid observations, the sample size is adequate for conducting statistical analysis. Data were initially entered into Microsoft Excel and subsequently processed using statistical analysis software. The survey was conducted from June 2024 to December 2024. The descriptive statistics of the sample are as follows (**Table 1**):

Table 1. Descriptive Statistics of the Research Sample.

Criteria		Number of Respondents (People)	Percentage (%)
Gender	Male	261	87.9
	Female	36	12.1
Age	>50 years old	13	4.4
	18–35 years old	68	22.9
	36–50 years old	216	72.7
Educational level	High school	165	55.6
	College, vocational	96	32.3
	University	36	12.1

Source: The author group synthesized from research results.

3.2. Data Analysis Methods

The study uses reliability analysis of the scale, exploratory factor analysis (EFA), structural equation modeling (SEM) to assess the influence of factors on the behavior of applying technology in livestock farming.

Based on the research overview and theoretical basis, the research team proposes the following research model (**Figure 1**):

The variables and scales of the research model are defined as follows (**Table 2**):

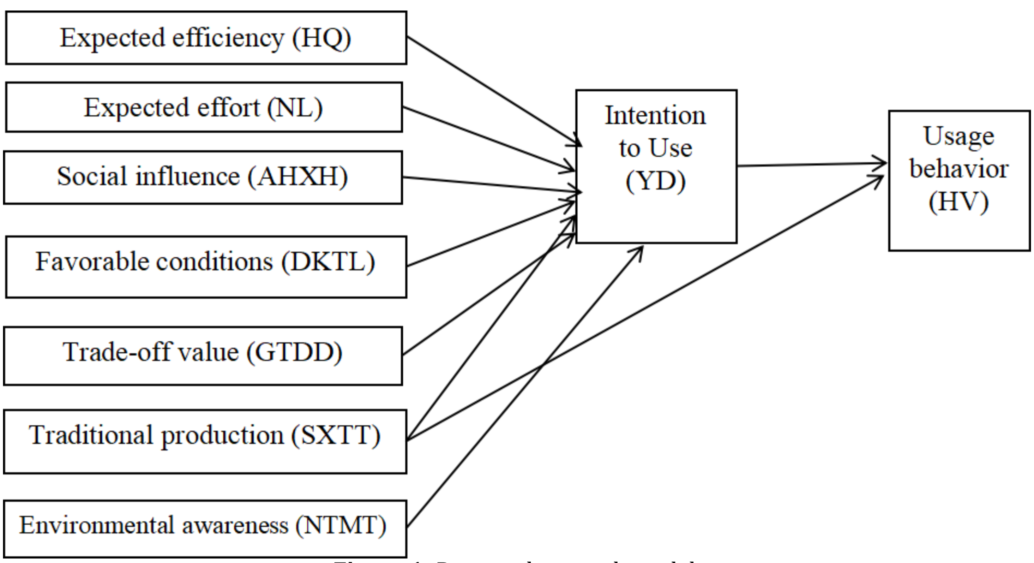

Figure 1. Proposed research model.

Table 2. Variables and scales utilized.

Name	Symbol	Observed Variables	Encryption	Source
Dependent Variable				
Usage behavior	HV	*I definitely use high technology in animal husbandry.*	HV1	(Venkatesh et al., 2003) [13]; (Venkatesh et al., 2012) [14]; (Kebebe, 2015) [23]; (Steg & Vlek, 1997) [24]; (GSO, 2024) [25]; (Nhuong & Truong, 2024) [26]; (Issaka et al., 2021) [27]; and surveyed experts
		I intend to continue investing in new technologies to enhance the production process.	HV2	
		I actively encourage those around me to adopt high technology in animal husbandry.	HV3	
Intermediate Variable				
Intention to Use	YD	*I intend to use high technology in my production process.*	*YD1*	(Venkatesh et al., 2003) [13]; (Venkatesh et al., 2012) [14]; (Nhuong & Truong, 2024) [26]; (Issaka et al., 2021) [27] and surveyed experts
		I believe that I will be interested in new high technologies for use in livestock farming in the future.	*YD2*	
		I will encourage surrounding farms to apply technologies in their production process.	*YD3*	
Independent Variable				
Expected efficiency	HQ	*Using high technology in livestock farming helps livestock not to depend entirely on nature.*	*HQ1*	(Challa & Tilahun, 2014) [7]; (Venkatesh et al., 2003) [13]; (Venkatesh et al., 2012) [14]; (Mamudu et al, 2012) [15]; (Nhuong & Truong, 2024) [26]; (Issaka et al., 2021) [27]; and reviewed experts
		Using high technology in livestock farming will limit diseases in the production process	*HQ2*	
		Using high technology in livestock farming will save production costs	*HQ3*	
		Using high technology in livestock farming will save production time	*HQ4*	
		Using high technology in livestock farming will bring higher productivity	*HQ5*	
Expected effort	NL	*The instructions for using high technology on the farm are straightforward and comprehensible*	*NL1*	(Venkatesh et al., 2003) [13]; (Venkatesh et al., 2012) [14]; and reviewed experts
		The technologies are easy to learn and accessible to users.	*NL2*	
		Using high technology on the farm is relatively easy for producers.	*NL3*	
		Users can efficiently and quickly learn to operate high technology when receiving direct technical guidance	*NL4*	
Social influences	AHXH	*The livestock processing companies encourage me to adopt high technology in production.*	*AHXH1*	(Venkatesh et al., 2003) [13]; (Venkatesh et al., 2012) [14]; (Mamudu et al, 2012) [15]; (Nhuong & Truong, 2024) [26]; (Issaka et al., 2021) [27]; and reviewed experts
		There are positive impacts from livestock companies and farms that have implemented advanced technology in the region.	*AHXH2*	

Table 2. *Cont.*

Name	Symbol	Observed Variables	Encryption	Source
Social influences	AHXH	*The local government has established various policies to promote the use of high technology in livestock farming activities.*	*AHXH3*	
Favorable conditions	DKTL	*Able to independently decide on the application of high technology in production*	*DKTL1*	(Challa & Tilahun, 2014) [7]; (Venkatesh et al., 2003) [13]; (Venkatesh et al., 2012) [14]; (Mamudu et al, 2012) [15]; (Kebebe, 2015) [23]; and reviewed experts
		Provided with favorable access to preferential credit sources.	*DKTL2*	
		Supported in securing a convenient production site (sufficient area, proximity to electricity and water sources, etc.).	*DKTL3*	
Trade–off value	GTDD	*The expenses associated with high technology in livestock farming are reasonable.*	*GTDD1*	(Challa & Tilahun, 2014) [7]; (Venkatesh et al., 2003) [13]; (Venkatesh et al., 2012) [14]; (Mamudu et al, 2012) [15] and reviewed experts
		Implementing high technology in livestock farming provides greater value than its cost.	*GTDD 2*	
		I value the effectiveness of using high technology in livestock farming.	*GTDD 3*	
Limitations of traditional production	SXTT	*It is essential to change the habit of traditional farming (manual production) and adopt modern farming practices to enhance production efficiency.*	*SXTT1*	(Nhuong & Truong, 2024) [26]; (Issaka et al., 2021) [27] and Surveyed experts
		Traditional methods are simple and convenient, but their productivity is low	*SXTT2*	
		The initial costs of traditional farming are lower, but they also result in reduced efficiency.	*SXTT3*	
Environmental awareness	NTMT	*The application of advanced technology in livestock farming will significantly decrease the amount of solid and liquid waste–such as feces, urine, leftover food, and cleaning water–released into the environment.*	*NTMT1*	(Steg & Vlek, 1997) [24] and reviewed experts
		Using high technology in livestock farming will reduce air pollution	*NTMT2*	
		Using high technology in livestock farming will improve the health of producers.	*NTMT3*	

Source: Synthesized by the author group.

4. Results

4.1. Results of Reliability Testing of Scales and Exploratory Factor Analysis

The results of the reliability test for the scale indicate that the Cronbach's Alpha coefficient for all factors is greater than 0.79, which exceeds the acceptable threshold of 0.6. This suggests that the quality of the scale is good. Additionally, the total correlation coefficients for the scales range from 0.60 to 0.75, all of which are greater than the minimum acceptable value of 0.3. Therefore, the factor groups included in the analysis demonstrate adequate reliability.

Exploratory factor analysis of the factors and variables in the model yields the following results (**Table 3**):

Table 3. Factors and Scales in the model after performing Cronbach's Alpha and Exploratory Factor Analysis (EFA) test.

No.	*Factor*	*Symbol*	*Characteristic Variable*
1	Expected efficiency	HQ	HQ1; HQ2; HQ3; HQ4; HQ5
2	Expected effort	NL	NL1; NL2; NL3; NL4
3	Trade–off Value	GTDD	GTDD1; GTDD2; GTDD3
4	Favorable conditions	DKTL	DKTL1; DKTL2; DKTL3
5	Environmental Awareness	NTMT	NTMT1; NTMT2; NTMT3
6	Social Influences	AHXH	AHXH1; AHXH2; AHXH3
7	Limitations of traditional production	SXTT	SXTT1; SXTT2; SXTT3
8	Intention to Use	YD	YD1; YD2; YD3
9	Usage Behavior	HV	HV1; HV2; HV3

Source: The author group synthesized from research results.

4.2. Results of Confirmatory Factor Analysis (CFA)

The results of the confirmatory factor analysis are as follows (**Figure 2**):

Regarding the assessment of the model's suitability (**Table 4**), the p–value is less than 0.05 due to the small sample size, and other measures are appropriate. In conclusion, the CFA analysis indicates that the measurement model fits well with the actual data.

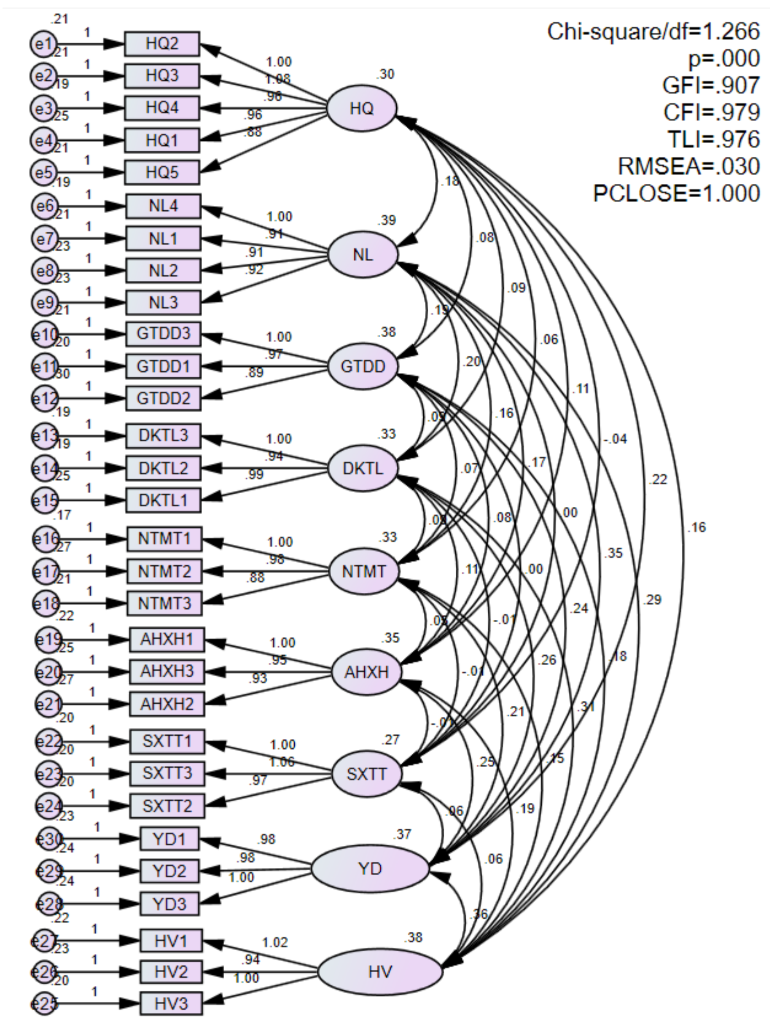

Figure 2. CFA analysis results.

Source: The author group synthesized from research results.

Table 4. Model fit assessment.

	Name	Symbol	Reference Value	Model Value	Conclusion
1	*Chi–square significance level (χ2)*	*p–value*	*p–value > 0.05*	*0.000*	
2	*Chi square adjusted for degrees of freedom (Cmin/df)*	*χ2/d.f*	*χ2/d.f <= 5*	*1.266*	
3	*TLI index (Tucker – Lewis Index)*	*TLI*	*TLI > 0.9*	*0.976*	*The measurement model fits the actual data*
4	*Comparative Fit Index CFI (Comparative Fit Index)*	*CFI*	*CFI > 0.9; 0 < CFI < 1, Values closer to 1, the better the model fit*	*0.979*	
5	*RMSEA Index (Root Mean Square Error Approximation*	*RMSEA*	*RMSEA < 0,05: good model fit; RMSEA < 0.08 Accept; The smaller the better*	*0.030*	

Source: The author group synthesized from research results.

4.3. Results of Structural Equation Modeling (SEM) Testing

The results of Structural Equation Modeling (SEM) testing as follows (**Figure 3**):

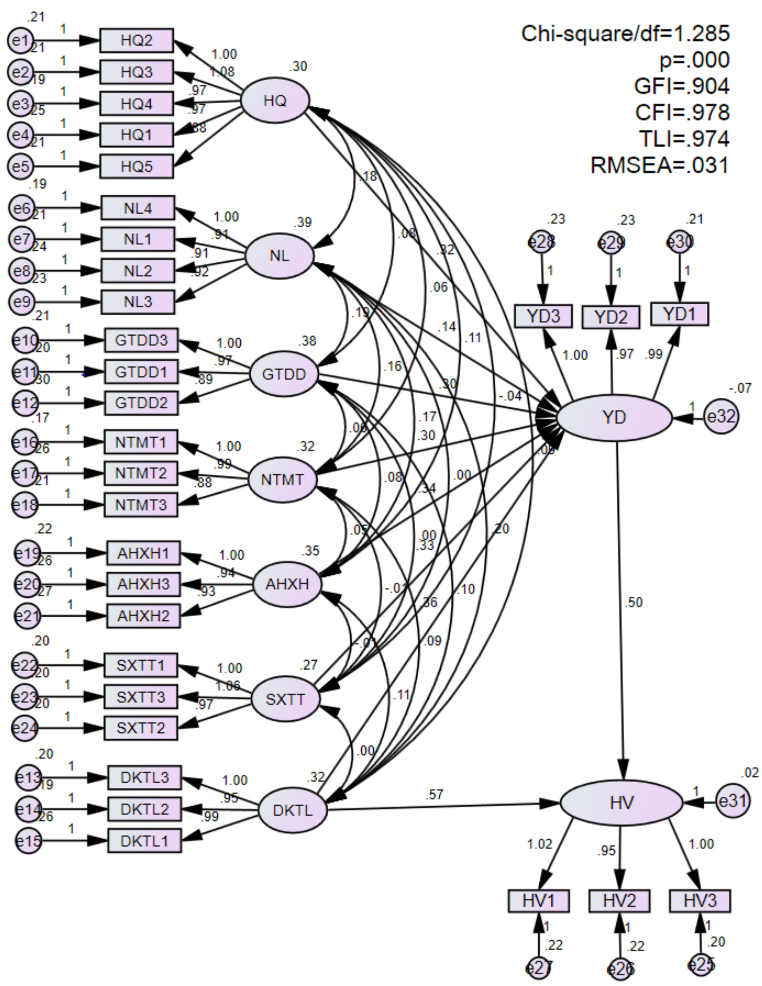

Figure 3. SEM analysis results.

Source: The author group synthesized from research results.

4.3.1. Research Model Evaluation

Evaluation of the Integrated Model Fit

Based on **Table 5**, although the p–value = 0.000 is less than 0.05 due to the small sample size, other measures are appropriate. Therefore, the integrated model is suitable for the actual data when testing the interaction relationship of factors.

Testing the interaction relationship of factors

In **Table 6**, the variables Expected efficiency (HQ), Expected Effort (NL), Social Influence (AHXH), Favorable Conditions (DKTL), Trade–Off Value (GTDD), Limitations of Traditional Production (SXTT), and Environmental Awareness (NTMT) all positively affect the Intention to Use (YD) with statistical significance (p–value ≤ 0.05).

Favorable Conditions (DKTL) and Intention to Use (YD) also positively influence Usage Behavior (HV) with statistical significance (p–value ≤ 0.05).

Order of influence from high to low: DKTL, AHXH, SXTT, HQ, GTDD, NTMT, NL (**Table 7**).

Order of influence from high to low: DKTL, YD (**Table 8**).

Table 5. Evaluation of the degree of fit for the Integrated Model.

	Name	*Symbol*	*Reference Value*	*Model Value*
1	*Chi–square significance level (χ2)*	*p–value*	*p–value > 0.05*	*0.000*
2	*Chi square adjusted for degrees of freedom (Cmin/ df)*	*χ2/ d.f*	*χ2/ d.f <= 5*	*1.285*
3	*TLI index (Tucker – Lewis Index)*	*TLI*	*TLI > 0.9*	*0.974*
4	*CFI Index (Comparative Fit Index)*	*CFI*	*CFI > 0.9; 0 < CFI < 1, Values closer to 1, the better the model fit*	*0.978*
5	*RMSEA Index (Root Mean Square Error Approximation)*	*RMSEA*	*RMSEA < 0.05: good model fit; RMSEA < 0.08 Accept; The smaller the better*	*0.031*

Source: The author group synthesized from research results.

Table 6. Regression estimation results.

Relation			*Estimate*	*S.E.*	*C.R.*	*p*
YD	< − − −	*HQ*	*0.322*	*0.038*	*8.513*	*0.000*
YD	< − − −	*NL*	*0.139*	*0.046*	*3.005*	*0.003*
YD	< − − −	*GTDD*	*0.303*	*0.033*	*9.073*	*0.000*
YD	< − − −	*NTMT*	*0.302*	*0.035*	*8.630*	*0.000*
YD	< − − −	*AHXH*	*0.337*	*0.036*	*9.401*	*0.000*
YD	< − − −	*SXTT*	*0.325*	*0.035*	*9.209*	*0.000*
YD	< − − −	*DKTL*	*0.356*	*0.040*	*8.997*	*0.000*
HV	< − − −	*DKTL*	*0.567*	*0.065*	*8.665*	*0.000*
HV	< − − −	*YD*	*0.504*	*0.051*	*9.825*	*0.000*

Source: The author group synthesized from research results.

Table 7. Level of direct impact of factors on Intention to use.

Relation			*Regression Coefficient*	*Percentage%*	*Position*
YD	< − − −	*DKTL*	*0.356*	*17.1%*	*1*
YD	< − − −	*AHXH*	*0.337*	*16.2%*	*2*
YD	< − − −	*SXTT*	*0.325*	*15.6%*	*3*
YD	< − − −	*HQ*	*0.322*	*15.5%*	*4*
YD	< − − −	*GTDD*	*0.303*	*14.5%*	*5*
YD	< − − −	*NTMT*	*0.302*	*14.5%*	*6*
YD	< − − −	*NL*	*0.139*	*6.7%*	*7*

Source: The author group synthesized from research results.

Table 8. Level of impact of factors on Usage behavior.

Relation			*Regression Coefficient*	*%*	*Position*
HV	*< − − −*	*DKTL*	*0.567*	*52.9%*	*1*
HV	*< − − −*	*YD*	*0.504*	*47.1%*	*2*

Source: The author group synthesized from research results.

4.3.2. Examining the Role of Intermediary Factors

According to the proposed research model, it is necessary to consider whether the Intention to Use (YD) factor is a mediating factor for the influence of the factors Expected efficiency (HQ); Expected Effort (NL); Social Influence (AHXH); Favorable conditions (DKTL); Trade–Off Value (GTDD); Limitations of Traditional Production (SXTT); Environmental Awareness (NTMT) on Usage Behavior (HV) or not? **Table 9** presents the results.

In summary, testing and analysis indicate that the Intention to Use (YD) serves as a mediating factor in the relationship between several influences and Usage Behavior (HV). These influences include Expected efficiency (HQ), Expected Effort (NL), Social Influence (AHXH), Favorable Conditions (DKTL), Trade–Off Value (GTDD), Limitations of Traditional Production (SXTT), and Environmental Awareness (NTMT).

Regarding the impact level of factors on Usage Behavior (HV), the total impact level of factors is calculated in the **Table 10**.

Table 9. Direct and indirect impacts of factors.

Relationship			*p*	*Direct Impact*	*Indirect Impact*	*Explanation of Indirect Impact*	*Total*
YD	*< − − −*	*HQ*	***	*0.322*			*0.322*
YD	*< − − −*	*NL*	*0.003*	*0.139*			*0.139*
YD	*< − − −*	*GTDD*	***	*0.303*			*0.303*
YD	*< − − −*	*NTMT*	***	*0.302*			*0.302*
YD	*< − − −*	*AHXH*	***	*0.337*			*0.337*
YD	*< − − −*	*SXTT*	***	*0.325*			*0.325*
YD	*< − − −*	*DKTL*	***	*0.356*			*0.356*
HV	*< − − −*	*DKTL*	***	*0.567*	*0.179*	*DKTL − − > YD − − > HV (0.356 x 0.504)*	*0.746*
HV	*< − − −*	*YD*	***	*0.504*			*0.504*
HV	*< − − −*	*HQ*			*0.162*	*HQ − − > YD − − > HV (0.322 x 0.504)*	*0.162*
HV	*< − − −*	*NL*			*0.070*	*NL − − > YD − − > HV (0.139 x 0.504)*	*0.070*
HV	*< − − −*	*GTDD*			*0.153*	*GTDD − − > YD − − > HV (0.303 x 0.504)*	*0.153*
HV	*< − − −*	*NTMT*			*0.152*	*NTMT − − > YD − − > HV (0.302 x 0.504)*	*0.152*
HV	*< − − −*	*AHXH*			*0.170*	*AHXH − − > YD − − > HV (0.337 x 0.504)*	*0.170*
HV	*< − − −*	*SXTT*			*0.164*	*SXTT − − > YD − − > HV (0.325 x 0.504)*	*0.164*

Note: *** = 0.000.
Source: The author group synthesized from research results.

Table 10. The total effect of all factors on usage behavior.

Relationship			*Total*	*Percentage%*	*Position*
HV	*< − − −*	*DKTL*	*0.746*	*46.2%*	*1*
HV	*< − − −*	*AHXH*	*0.170*	*10.5%*	*2*
HV	*< − − −*	*SXTT*	*0.164*	*10.1%*	*3*
HV	*< − − −*	*HQ*	*0.162*	*10.0%*	*4*
HV	*< − − −*	*GTDD*	*0.153*	*9.4%*	*5*
HV	*< − − −*	*NTMT*	*0.152*	*9.4%*	*6*
HV	*< − − −*	*NL*	*0.070*	*4.3%*	*7*

Source: The author group synthesized from research results.

When evaluating the overall impact, the Favorable Conditions (FAC) factor has the strongest influence on *Usage Behavior* (HV), accounting for 46.2%. Following that is Social Influence (AHXH) at 10.5%. Next are the

Limitations of Traditional Production (SXTT) at 10.1%, along with Expected Efficiency (HQ), Trade-Off Value (GTDD), Environmental Awareness (NTMT), and lastly, Expected Effort (NL).

5. Discussion

The analysis results indicate that Expected Performance (HQ), Expected Effort (NL), Social Influence (AHXH), Favorable Conditions (DKTL), Trade–off Value (GTDD), Limitations of Traditional Production (SXTT), and Environmental Awareness (NTMT) all exert a statistically significant and positive influence on the Intention to Use (YD) high technology in livestock farming ($p \leq 0.05$). Among these factors, Favorable Conditions demonstrate the strongest effect, with a standardized coefficient of β = 0.356, suggesting that a one–unit increase in favorable conditions results in a 0.356–unit increase in the intention to adopt high technology. Following this, the most influential variables include Social Influence (β = 0.337), Limitations of Traditional Production (β = 0.322), Expected Performance (β = 0.303), Trade–off Value (β = 0.302), Environmental Awareness (β = 0.139), and Expected Effort (β = 0.070). Each of these factors contributes positively to the intention to use high technology in livestock production, although to varying degrees.

In addition to affecting intention, both Favorable Conditions (DKTL) and Intention to Use (YD) have a direct and statistically significant positive impact on Usage Behavior (HV) ($p \leq 0.05$). Specifically, Favorable Conditions have the strongest influence on actual usage behavior, with a standardized coefficient of β = 0.567, indicating that a one–unit improvement in favorable conditions increases the likelihood of actual technology use by 0.567 units. Similarly, Intention to Use is also a key determinant, with β = 0.504, showing that an increase in intention results in a corresponding increase in actual behavior.

When considering the overall effects of all variables on Usage Behavior (HV), Favorable Conditions remain the most influential factor, with a standardized coefficient of β = 0.746. This finding reinforces the critical role of contextual and infrastructural support in facilitating technology adoption among farming households. These favorable conditions may stem from both subjective factors–such as the decision–making authority of the household representative, scale of production, and internal farming conditions–and objective factors such as access to preferential credit policies, infrastructure, and institutional support.

Other contributing factors to usage behavior include Social Influence (β = 0.170), Limitations of Traditional Production (β = 0.164), Expected Performance (β = 0.162), Trade–off Value (β = 0.153), Environmental Awareness (β = 0.152), and Expected Effort (β = 0.070). Although the magnitude of influence varies, all factors positively contribute to the behavior of adopting high technology in livestock farming.

These findings highlight the importance of improving both external enabling conditions and internal motivational factors to strengthen the intention and actual adoption behavior of high technology among farming households in the South Central and Central Highlands regions of Vietnam.

Based on the research findings, several policy recommendations are proposed to promote the adoption of high technology in livestock farming in the South Central and Central Highlands regions of Vietnam. These recommendations are intended to reduce labor intensity, enhance productivity and product quality, minimize production costs, improve operational efficiency, and support environmentally sustainable agricultural practices.

First, to improve the enabling conditions for high–tech adoption, provincial authorities should expedite the formulation and implementation of detailed plans for concentrated livestock production zones aligned with high–tech agricultural models. These zones should be supported by adequate land allocation and the development of essential infrastructure, including reliable electricity, water supply, transportation networks, and road systems. Relevant departments and local agencies should allocate sufficient financial resources for infrastructure development to establish a favorable environment for the application of modern technologies. In addition, preferential credit policies should be introduced to incentivize farmers and livestock enterprises to invest in high–tech solutions. These financial incentives should be coupled with technical assistance to ensure the effective and efficient use of capital, leading to measurable outcomes.

Second, social and institutional support mechanisms must be strengthened. Existing policies related to land use, environmental protection, and infrastructure development should be revised to create a more attractive environment for private investment in high–tech livestock farming. Furthermore, livestock processing enterprises should be encouraged to establish collaborative partnerships with farms by introducing appropriate technologies, providing technical training on equipment usage, and sharing practical knowledge regarding the advantages and limitations of modern systems. Transparent and stable pricing mechanisms offered by processing companies can serve as a significant incentive for farms to adopt high technology, as they help mitigate financial risks and enhance returns on investment.

Third, increasing farmers' awareness of the perceived value of high technology is essential. Local authorities should implement targeted training programs and communication campaigns to improve understanding of the long–term economic and environmental benefits of high–tech adoption. Farmers should be guided to recognize the comparative advantages of adopting modern technologies, such as increased production efficiency, cost reductions, and higher product quality. Simultaneously, environmental awareness should be promoted by highlighting the role of high–tech applications in reducing environmental pollution and ensuring compliance with regulatory standards as part of a broader strategy for sustainable agricultural development.

Finally, the development of human capital is critical to supporting high–tech adoption. Specialized training programs should be designed and delivered to farm owners, technical personnel, and workers in livestock enterprises, with a focus on individuals of working age. These programs should emphasize the development of technological literacy, hands–on technical skills, and the capacity to operate and maintain advanced systems. Participation in technical training initiatives and agricultural associations should be actively encouraged to facilitate knowledge exchange and build collaborative networks that can accelerate the widespread and effective application of high technology in livestock production across the region.

Author Contributions

Conceptualization, H.H., N.T. and Y.L.; methodology, H.H. and Y.L.; software, H.H. and N.T.; validation, H.H. and Y.L.; formal analysis, Y.L.; investigation, H.H. and N.T.; resources, H.H.; data curation, H.H.; writing—original draft preparation, H.H. and Y.L.; writing—review and editing, H.H. and Y.L.; visualization, N.T.; supervision, H.H.; project administration, H.H.

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Conflicts of Interest

The authors have no competing interests to declare that are relevant to the content of this article.

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