

ปัจจัยเชิงสาเหตุที่มีอิทธิพลต่อความเต็มใจยอมรับและนำเทคโนโลยีและนวัตกรรม
ทางการเกษตรมาใช้ของเกษตรกรรุ่นใหม่ในประเทศไทย

Causal Factors Influencing the Intention to Adopt Agricultural Technology and
Innovations among Young Farmers in Thailand

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาปัจจัยเชิงสาเหตุที่มีอิทธิพลต่อความเต็มใจในการยอมรับและนำเทคโนโลยีและนวัตกรรมทางการเกษตรมาใช้ในกลุ่มเกษตรกรรุ่นใหม่ โดยใช้กรอบแนวคิด Unified Theory of Acceptance and Use of Technology: UTAUT ที่ขยายด้วยตัวแปรความสามารถในการสร้างสรรค์นวัตกรรม (Innovativeness) และความเต็มใจนำไปใช้ (Willingness to Adopt) กลุ่มตัวอย่าง ได้แก่ เกษตรกรรุ่นใหม่จำนวน 370 คน ซึ่งได้มาจากการสุ่มแบบไม่ใช้ความน่าจะเป็นโดยอาศัยการตอบแบบสมัครใจ ผ่านช่องทางออนไลน์และออฟไลน์จากเครือข่าย Young Smart Farmer (YSF) ในภาคตะวันออกเฉียงเหนือของประเทศไทย โดยใช้แบบสอบถามที่ผ่านการตรวจสอบความเที่ยงตรงและความเชื่อมั่นแล้ว วิเคราะห์ข้อมูลด้วยสถิติเชิงพรรณนา (ความถี่และร้อยละ) การวิเคราะห์องค์ประกอบเชิงยืนยัน (CFA) และการวิเคราะห์สมการโครงสร้าง (SEM) ผลการวิจัยพบว่า ตัวแปรสำคัญทั้ง 5 ได้แก่ ความคาดหวังต่อผลสัมฤทธิ์ (Performance Expectancy: PE) ความง่ายดายในการใช้งาน (Effort Expectancy: EE) อิทธิพลทางสังคม (Social Influence: SI) เงื่อนไขสนับสนุน (Facilitating Conditions: FC) และแรงจูงใจเชิงสุขนิยม (Hedonic Motivation: HM) ทั้งหมดนี้มีอิทธิพลโดยตรงและมีนัยสำคัญทางสถิติต่อความสามารถในการสร้างสรรค์นวัตกรรม ซึ่งเป็นตัวแปรตัวกลางสำคัญที่ผลักดันให้เกิดความเต็มใจนำไปใช้เทคโนโลยีของเกษตรกรรุ่นใหม่ โดยเฉพาะแรงจูงใจเชิงสุขนิยม เป็นปัจจัยที่ส่งผลส่งเสริมแนวคิดริเริ่มและการเปิดรับนวัตกรรมมากที่สุด รองลงมาคือ ความง่ายดายในการใช้งาน อิทธิพลทางสังคม และเงื่อนไขสนับสนุน ตามลำดับ นอกจากนี้ ความสามารถในการสร้างสรรค์นวัตกรรม มีอิทธิพลสูงและโดยตรงต่อความเต็มใจนำเทคโนโลยีไปใช้ ผลการวิจัยที่ได้เป็นข้อเสนอแนะให้กับผู้กำหนดนโยบายในการส่งเสริมปัจจัยเชิงสาเหตุและความสามารถในการสร้างสรรค์นวัตกรรมให้เกิดขึ้นกับเกษตรกรรุ่นใหม่เพื่อนำไปสู่ความเต็มใจในการยอมรับและนำเทคโนโลยีทางการเกษตรมาใช้อย่างต่อเนื่องและยั่งยืนในระยะยาว

คำสำคัญ : ความสามารถในการสร้างสรรค์นวัตกรรม ความเต็มใจนำไปใช้ เกษตรกรรุ่นใหม่ เทคโนโลยีและนวัตกรรมทางการเกษตร

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Abstract

This study explores the factors influencing young farmers' willingness to adopt agricultural technologies and innovations, using an extended version of the Unified Theory of Acceptance and Use of Technology (UTAUT). The model incorporates two additional constructs: Innovativeness (IN) and Willingness to Adopt (WL). A total of 370 young farmers were recruited using non-probability voluntary response sampling (mixed-mode online/offline) from YSF networks across Northeastern Thailand and surveyed using a validated questionnaire. The data were analyzed using frequency and percentage distributions, confirmatory factor analysis (CFA), and structural equation modeling (SEM). The findings show that five key variables—Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), and Hedonic Motivation (HM)—had significant direct effects on Innovativeness, which in turn played a central mediating role in influencing young farmers' willingness to adopt new technologies. Among these variables, Hedonic Motivation emerged as the strongest predictor, followed by Effort Expectancy, Social Influence, and Facilitating Conditions. Innovativeness was also found to have a direct and strong impact on Willingness to Adopt. These results suggest that promoting innovativeness is essential for encouraging the adoption of agricultural technologies among young farmers. For policymakers, the study highlights the importance of designing interventions that support both external enabling factors and internal drivers of innovation readiness to ensure sustained technology adoption in the agricultural sector.

Keywords: Innovativeness, Willingness to Adopt, Young Farmers, Agricultural Technologies and Innovations

1. Introduction

Agriculture continues to be an essential part of Thailand's food security and overall economy. Although there are significant government efforts, including the 13th National Economic and Social Development Plan (2023–2027) and the Thailand 4.0 policy focused on moving toward a knowledge- and technology-based sector, a large portion of the nation's agriculture is still based on traditional methods. As a result, productivity levels remain low and competitiveness limited issues especially pronounced in Northeastern Thailand, where farmers encounter with degraded soil, scarce water resources, and an aging workforce (Office of Agricultural Economics, 2022).

To address these challenges, the Thai government has introduced initiatives such as the Smart Farmer and Young Smart Farmer programs. In parallel, it has actively promoted the use of advanced technologies in agriculture, including precision farming tools, Internet of Things (IoT) systems, drones, smart irrigation, and data-driven applications. These tools align with the principles of Good Agricultural Practices (GAP) and aim to assist farmers in enhancing crop planning, optimizing resource utilization, and improving yield forecasting (Sonthitham & Thongchaisuratkrul, 2023). However, adoption across the farming community remains uneven. However, adoption among farmers remains uneven due to barriers such as low digital literacy, limited access to capital, and varying levels of trust in technology implementation (FAO, 2023).

Recent research has shown that the successful adoption of innovations is influenced not only by economic and institutional factors but also by individual characteristics especially personal innovativeness (Wajasuwan &

Wongsansukcharoen, 2022). Personal innovativeness serves as a mediating factor, connecting farmers' perceptions of advantages and usability with their willingness to adopt new technologies (Chaodeethirathkul & Pankham, 2023). In Thailand, empirical studies indicate that adoption models which combine UTAUT2 with personal innovativeness offer enhanced predictive capability for understanding adoption behavior (Yawised et al., 2022).

Integrating personal innovativeness as a mediating factor significantly enriches the understanding of technology adoption among farmers. However, the transition to modern agriculture is a gradual process, constrained by farmers' limited technical skills, digital infrastructure, and mindset challenges. Behavioral factors such as attitudes, personal values, and perceived behavioral control strongly shape this transformation. Notably, young farmers in Northeastern Thailand—the country's most productive agricultural region—play a crucial role in embracing and adapting innovative agricultural practices. Insights from this demographic and geographic context provide valuable guidance for policymakers to develop targeted, locally relevant strategies that address specific challenges and facilitate sustainable agricultural development (Adokou et al., 2024; Mohammed et al., 2024)

By supporting this transition, the study contributes to a broader shift from conventional farming toward a more innovative-led model of agricultural entrepreneurship. Such a transformation holds potential to boost national competitiveness while fostering long-term sustainability within Thailand's agricultural economy.

2. Literature Review

2.1 UTAUT and Innovativeness

The Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh et al. (2003), is a key framework for explaining technology adoption. It highlights four key constructs such as Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions that shape behavioral intention and actual usage. These are further moderated by variables such as gender, age, experience, and voluntariness (Venkatesh et al., 2012).

An extension of this model, UTAUT2, was introduced to reflect consumer contexts by incorporating additional elements like Hedonic Motivation, Price Value, and Habit, thereby enhancing its relevance for real-world technology adoption scenarios (Venkatesh et al., 2012).

Innovativeness, defined as a person's tendency to adopt new technologies ahead of others (Rogers, 2003), is now widely viewed as a key driver of technology adoption. This trait is especially evident among individuals and groups with a strong inclination to explore and experiment, such as farmers and IT entrepreneurs (Amid, 2021). In agriculture, innovativeness positively influences technology adoption intentions and behaviors by reinforcing core UTAUT constructs such as performance expectancy and hedonic motivation, supporting rapid and sustainable uptake of new technologies (Yan et al., 2022).

Integrating innovativeness into the UTAUT framework improves its ability to predict user behavior, particularly in dynamic and complex contexts such as agriculture. This addition enables more nuanced and context-specific policy design for promoting technology adoption. Importantly, it shifts the analytical emphasis beyond perceived ease of use to include internal drivers such as positive attitudes and intrinsic motivation which are essential for encouraging widespread and enduring adoption of agricultural technologies.

H1: Social Influence (SI) has a positive effect on Innovativeness (IN) among young farmers in Northeastern Thailand.

Social Influence in this context refers to the pressure or motivation stemming from social groups, families, or networks in which young farmers are engaged. Such support generates psychological motivation that strengthens their level of innovativeness. A prominent example is the Young Smart Farmer (YSF) Program initiated by the Department of Agricultural Extension (DOAE), which aims to enhance the potential of young farmers through social networking and collaborative learning. This approach facilitates knowledge exchange and the adoption of new techniques, thereby fostering creativity and readiness to embrace technologies and modern agricultural practices more effectively (DOAE, 2019).

In addition, research examining technology adoption behavior among farmers in southern Thailand has revealed that Social Influence positively affects Innovativeness through support from family, peers, and local communities. Such influence encourages openness toward new practices by shaping beliefs about the ease of use and perceived effectiveness of technology (Effort Expectancy and Performance Expectancy), consistent with the Technology Acceptance Model (TAM). These factors serve as mediators, linking social influence to innovativeness, and significantly drive farmers' willingness to adopt new technologies (Jariyapaktikorn, 2024; Wichean & Sungsanit, 2022).

Government and community support, in the form of creating an innovation-oriented environment and networks, also constitutes a critical accelerator of innovativeness among young farmers. Such support has contributed to actual acceptance and implementation of modern agricultural technologies in alignment with the Thailand 4.0 policy, which emphasizes sustainable development of agriculture and industry through innovation and technology (Markow et al., 2023; Phuensane et al., 2022).

Overall, Social Influence emerges as a causal factor with substantial positive effects on Innovativeness among young farmers in Thailand. By mobilizing encouragement and motivation from social groups and networks, young farmers are more willing to adopt agricultural technologies and innovations that improve their livelihoods and strengthen their business competitiveness. This supportive mechanism is therefore vital and should be integrated into the design of policies and programs aimed at effectively advancing agricultural innovation in the country.

H2: Performance Expectancy (PE) has a positive effect on Innovativeness (IN) among young farmers.

In the UTAUT framework, Performance Expectancy (PE) refers to the belief that using a particular technology will improve one's job performance (Venkatesh et al., 2003). This perception has consistently been identified as a key driver of technological adoption across different settings and cultural contexts.

Empirical evidence examining the adoption of modern agricultural technologies among young farmers demonstrates that PE serves as a crucial motivational factor that strengthens innovativeness. Farmers with high expectations regarding the effectiveness of technology tend to recognize the value of its application and are more likely to experiment with new technologies compared to those with lower expectations (Jariyapaktikorn, 2024; Wichean & Sungsanit, 2022). Particularly, farmers with a higher level of innovativeness are more strongly influenced by PE in their decision-making, enabling faster and more sustainable adoption of agricultural technologies.

Furthermore, research addressing the development of digital agriculture in Thailand highlights that PE functions as both a motivational and accelerating factor, fostering creativity among young farmers and enhancing their adaptability to new technologies that support sustainable development and increase agricultural productivity (Markow et al., 2023; Phuensane et al., 2022).

In conclusion, Performance Expectancy emerges as a causal factor with strong positive effects on innovativeness and the willingness to adopt technological innovations among young farmers in Thailand. The role of PE is reflected in farmers' perceived benefits and efficiency gains derived from technology, which act as key mechanisms driving continuous acceptance and adoption in the agricultural sector.

H3: Facilitating Conditions (FC) have a positive effect on Innovativeness (IN) among young farmers.

Facilitating Conditions refer to the extent to which individuals believe that sufficient organizational and technical support is available to enable the use of a given technology (Venkatesh et al., 2012). It originally conceptualized by Triandis (1979), emphasizes the significance of external resources in enabling task performance and behavioral execution.

In the agricultural sector, the successful adoption of emerging technologies is contingent upon access to critical resources, including adequate infrastructure, technical expertise, and institutional support. While the UTAUT framework posits that such facilitating conditions influence user behavior directly, empirical evidence suggests their impact also extends to individual innovativeness. By lowering perceived obstacles and fostering a supportive environment, these conditions promote experimentation and the early uptake of new technologies (Faqih & Jaradat, 2021).

In the context of Thailand, research has repeatedly stressed the importance of strong facilitating conditions, including comprehensive infrastructure, access to technical services and knowledge, continuous training, and advisory support. These factors collectively enhance the innovativeness and readiness of young farmers to integrate agricultural technologies and innovations into their practices (Phuensane et al., 2022).

A practical example of facilitating conditions in action is the Young Smart Farmer (YSF) program, which supports young farmers through collaborative networks, training initiatives, and technical assistance. The program has proven successful in fostering motivation, promoting innovative behavior, and strengthening farmers' willingness to experiment with and adopt new technologies (Manalili et al., 2023).

In conclusion, facilitating conditions play a pivotal role in strengthening innovativeness and the willingness of young farmers in Thailand to adopt agricultural technologies. Investment in infrastructure development, technical support, and continuous knowledge services should therefore be prioritized and integrated into national policies and institutional mechanisms as part of the broader strategy for promoting digital agriculture and achieving sustainable agricultural development.

H4: Hedonic Motivation (HM) has a positive effect on Innovativeness (IN) among young farmers.

Hedonic Motivation (HM) is defined as the perceived enjoyment and pleasure derived from using technology (Brown & Venkatesh, 2005). In the agricultural context, modern technologies such as the Internet of Things (IoT), drones, and digital platforms often provide engaging experiences that stimulate farmers' motivation to experiment with and adopt innovative tools (Fitrah, 2022)

Empirical findings suggest that HM has a positive relationship with innovativeness, as farmers who report higher levels of HM are typically early adopters of new technologies. Their eagerness is driven not solely by efficiency but by the enjoyment and positive experiences they gain from interacting with technology (Shi, Li, & Yang, 2022).

More recently, a 2024 study on technology adoption among Thai farmers revealed that HM exerts a stronger influence on trial and actual use of agricultural technologies than core constructs such as Performance Expectancy or Social Influence (Zhang et al., 2024). When farmers perceive that new technologies deliver enjoyment and satisfying user experiences, this perception helps foster positive attitudes that enhance creativity and innovativeness, ultimately accelerating behavioral acceptance and adoption of novel agricultural practices.

In light of these findings, it can be concluded that enjoyment-driven motivation constitutes a causal factor with substantial influence on innovativeness among young farmers. By shaping attitudes through pleasurable and engaging experiences, HM plays a prominent role in facilitating the effective adoption and sustained use of advanced agricultural technologies in Thailand.

H5: Effort Expectancy (EE) positively influences Innovativeness (IN) among young farmers.

Effort Expectancy (EE) refers to the perceived ease of use or the degree of effort expected to be required when adopting a technology (Venkatesh et al., 2003). Research in the agricultural sector has demonstrated that EE is a key determinant influencing farmers' innovativeness, particularly among young farmers who often value convenience in learning and applying new technologies (Jariyapaktikorn, 2024). When technologies are easy to use and not overly complex, farmers are more likely to develop positive perceptions, which in turn encourage experimentation and effective adoption of innovations.

Empirical studies conducted in southern Thailand confirm that EE exerts a significant positive effect on technology acceptance, as farmers who perceive technologies as easy to use are more inclined to adopt agricultural innovations (Jariyapaktikorn, 2024). Furthermore, the provision of knowledge support and training has been identified as a critical mechanism for reducing complexity and enhancing farmers' confidence in technology adoption (Wichean & Sungsanit, 2022).

Within the framework of the Young Farmer initiative in Thailand, the design and provision of tools and technologies that are user-friendly, combined with supportive systems to minimize complexity, play a crucial role in fostering innovativeness and enhancing technology adoption (Manalili et al., 2023; Zhang et al., 2024). These supports build an enabling environment that encourages creativity and accelerates the integration of modern agricultural practices.

In conclusion, Effort Expectancy represents a causal factor with substantial positive influence on innovativeness and the willingness of young Thai farmers to adopt agricultural technologies. By lowering barriers to adoption and simplifying the learning process, EE functions as a critical driver in promoting sustainable development and strengthening the modernization of agriculture in Thailand.

H6 : Innovativeness (IN) has a positive effect on Willingness to Adopt (WL) agricultural technologies and innovations.

The relationship between innovativeness and the willingness to adopt agricultural technologies and innovations has been extensively examined in numerous research studies and literature reviews. Findings consistently

indicate that personal innovativeness plays a crucial role in motivating farmers to experiment with and effectively implement new technologies.

Innovativeness is a personality trait that drives individuals to experiment with and adopt new technologies at a faster pace. Research on Thai farmers, particularly within the Young Smart Farmer initiative, has shown that individuals with higher levels of innovativeness exhibit more open attitudes toward the adoption of agricultural technologies and innovations, which in turn facilitates effective and sustained use (Manalili et al., 2023).

Several studies conducted among farmers in southern Thailand have similarly identified attitudinal factors such as innovativeness as strong predictors of intention and willingness to adopt agricultural technologies. The significant influence of innovativeness on farmers' willingness to adopt has also been confirmed in international contexts. Findings from Zhang et al. (2024) demonstrate that individuals with high innovativeness are more likely to become early adopters in the agricultural sector, thereby accelerating acceptance and diffusion of innovations within farming communities (Fitrah, 2022; Yan et al., 2022).

Moreover, external enablers such as social networks, institutional support, and infrastructure development serve as important complementary factors that enhance the effect of innovativeness on willingness to adopt new technologies (Adnan et al., 2025). Within rural communities, early adopters with high innovativeness often serve as hubs for disseminating knowledge, sharing experiences, and fostering broader acceptance of agricultural innovations.

H7a: Innovativeness (IN) mediates the relationship between Performance Expectancy (PE) and Willingness to Adopt (WL).

Performance Expectancy (PE) positively influences Innovativeness (IN), which mediates its effect on Willingness to Adopt (WL) agricultural technologies. In precision agriculture contexts, PE fosters farmers' innovativeness toward IoT adoption, as perceived performance gains enhance experimental tendencies leading to stronger adoption intentions. Empirical evidence from smart farming demonstrates that IN transmits PE's impact on technology uptake among smallholders, consistent with UTAUT extensions rural IoT applications (Larasati et al., 2024).

H7b: Innovativeness (IN) mediates the relationship between Effort Expectancy (EE) and Willingness to Adopt (WL).

Effort Expectancy (EE) enhances Innovativeness (IN), serving as a mediator to WL. Farmers perceiving technologies as user-friendly exhibit heightened innovativeness, facilitating adoption of smart farming systems such as sensor networks. Studies in developing agricultural settings confirm EE's indirect effect on adoption intentions through personal innovativeness, aligning with established UTAUT-IoT frameworks (Larasati et al., 2024; Mishra, et al., 2024).

H7c: Innovativeness (IN) mediates the relationship between Social Influence (SI) and Willingness to Adopt (WL).

Social Influence (SI) strengthens Innovativeness (IN), mediating its relationship with WL. Peer networks within farming communities promote IN via social learning mechanisms, channeling SI toward IoT and smart farming adoption. Mediation precedents in UTAUT models applied to Asian smallholder agriculture validate this pathway (Ravindran et al., 2024; Zhang et al., 2024).

H7d: Innovativeness (IN) mediates the relationship between Facilitating Conditions (FC) and Willingness to Adopt (WL).

Facilitating Conditions (FC) bolster Innovativeness (IN), which mediates effects on WL. Access to infrastructure and training enables technological experimentation, transmitting FC's influence through IN to precision agriculture adoption. Empirical support from IoT and cold chain studies in agriculture substantiates this indirect mechanism (Mkunda, 2025; Zhang et al., 2024).

H7e: Innovativeness (IN) mediates the relationship between Hedonic Motivation (HM) and Willingness to Adopt (WL).

Hedonic Motivation (HM) stimulates Innovativeness (IN), mediating its path to WL. Enjoyment derived from technology interactions drives early adoption behaviors via enhanced IN in smart farming contexts. UTAUT 2 extensions in Chinese precision agriculture confirm HM's significant indirect effect through innovativeness (Larasati et al., 2024; Mishra, et al., 2024).

Taken together, the evidence suggests that innovativeness and willingness to adopt are positively linked and mutually supporting. A deeper understanding of this relationship can guide the development of targeted policy interventions that not only foster innovative capacity among farmers but also ensure the availability of enabling infrastructure and institutional support necessary for sustained and widespread adoption.

2.2 Conceptual Model and Research Hypotheses

Figure 1 provides a visual representation of the proposed conceptual framework, elucidating the hypothesized relations among the various constructs. The selected constructs in this study, in combination with the established connections derived from the previous literature on technology adoption, establish the foundation for the hypotheses outlined in the subsequent section.

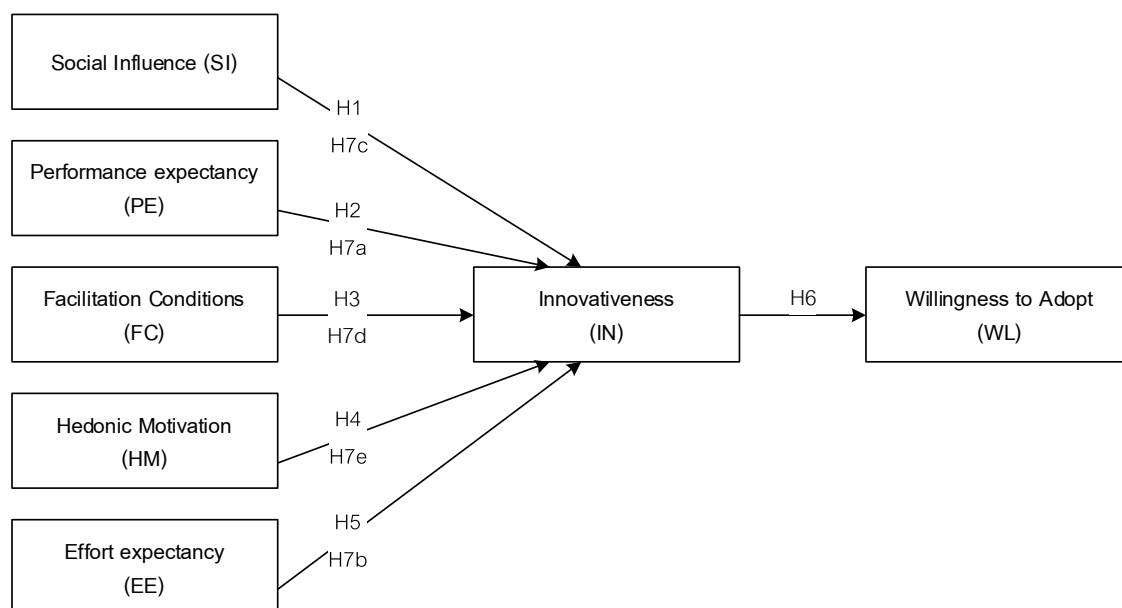


Figure 1. Proposed conceptual model (source: by author).

Given that the proposed framework specifies both (i) direct effects of UTAUT-related antecedents on Innovativeness and (ii) indirect effects on Willingness to Adopt operating through Innovativeness, this study formulates hypotheses to test both the direct structural paths and the mediation mechanisms. Accordingly, the hypotheses are organized into direct-effect hypotheses (H1–H6) and mediating hypotheses (H7a–H7e) to provide a clear overview of the proposed causal relationships embedded in the conceptual model.

Based on the proposed conceptual framework and prior literature, eleven hypotheses were formulated to examine both the direct and mediating effects among the constructs, as summarized in Table 1.

Table 1. Summary of research hypotheses

Hypothesis	Structural path	Hypothesized relationship
H1	SI → IN	Social Influence (SI) has a positive effect on Innovativeness (IN) among young farmers.
H2	PE → IN	Performance Expectancy (PE) has a positive effect on Innovativeness (IN) among young farmers.
H3	FC → IN	Facilitating Conditions (FC) have a positive effect on Innovativeness (IN) among young farmers.
H4	HM → IN	Hedonic Motivation (HM) has a positive effect on Innovativeness (IN) among young farmers.
H5	EE → IN	Effort Expectancy (EE) has a positive effect on Innovativeness (IN) among young farmers.
H6	IN → WL	Innovativeness (IN) has a positive effect on Willingness to Adopt (WL) agricultural technologies and innovations (IN).
H7a	PE → IN → WL	Innovativeness (IN) mediates the relationship between Performance Expectancy (PE) and Willingness to Adopt (WL).
H7b	EE → IN → WL	Innovativeness (IN) mediates the relationship between Effort Expectancy (EE) and Willingness to Adopt (WL).
H7c	SI → IN → WL	Innovativeness (IN) mediates the relationship between Social Influence (SI) and Willingness to Adopt (WL).
H7d	FC → IN → WL	Innovativeness (IN) mediates the relationship between Facilitating Conditions (FC) and Willingness to Adopt (WL).
H7e	HM → IN → WL	Innovativeness (IN) mediates the relationship between Hedonic Motivation (HM) and Willingness to Adopt (WL).

3. Research Methodology

The research objectives have been formulated to achieve the anticipated outcomes, specifically focusing on the development of a comprehensive conceptual framework that elucidates the factors influencing the intention to adopt agricultural technology and innovations among young farmers. Objectives align directly with hypotheses H1–H7e and measurement model validated via CFA.

3.1 Questionnaire Design and Measurements

This study employed a questionnaire consisting of two parts: one for demographic characteristics and the other, which formed the core of the data collection. The core included five explanatory variables, namely Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Hedonic Motivation (HM), and Facilitating Conditions (FC). The mediating variable was Innovativeness (IN), and the dependent variable was the Willingness to Adopt (WL) agricultural technologies and innovations among young farmers, which itself comprised five main factors identified from relevant literature. The final form of the questionnaire was designed based on previous research and was reviewed by experts to assess its suitability and clarity before actual deployment. Appropriate adjustments were made in light of pre-survey feedback. Four to five items represented each variable in the core part of the questionnaire, and the items were rated on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree).

3.2 Data Collection and Sample

The data for this study were collected over a three-month period from April to June 2025 (B.E. 2568) across 20 provinces in Northeastern Thailand, a key agricultural region where young farmers—particularly those connected to the Young Smart Farmer (YSF) initiative—are actively engaged in farming activities (Tikum & Ahmad, 2024). The target population comprised YSF members in Northeastern Thailand, totaling 5,309 individuals as of 2021 (31.44% of the national YSF total of 16,885), based on official Department of Agricultural Extension (DOAE) data summarized in national research reports (NRCT, 2021) .

The Young Smart Farmer (YSF) program is administered by DOAE under the Ministry of Agriculture and Cooperatives and aims to develop young farmers, typically aged 17–45 years and registered with DOAE, as innovation leaders and community role models through training and networking in modern agriculture, IoT/digital farming, agribusiness practices, financial management, value addition, and market linkages, thereby strengthening knowledge exchange and innovation diffusion in rural communities (DOAE, 2019; Tikum & Ahmad, 2024). In practical terms, respondent access was achieved through two main channels: YSF social-network communities (LINE and Facebook groups) spanning the 20 Northeastern provinces, and an in-person provincial networking event in Surin province (“Power Network for Samakkhi ‘Khok Nong Na’ Model and Arya Agriculture” at the Surin Provincial Hall).

To ensure adequate statistical power for model estimation, 420 questionnaires were distributed to allow for potential non-response and incomplete responses, resulting in 370 valid questionnaires for analysis, corresponding to an 88.09% usable response rate (370/420); this final sample size exceeds commonly cited SEM guidelines suggesting that samples of around 300 or more are generally acceptable for complex models with multiple constructs and mediation (Hair et al., 2017; Hair et al., 2019).

Data collection employed a mixed-mode approach (offline and online) using a structured questionnaire: offline data were collected from event participants who voluntarily completed the survey on -site, while online data were collected by distributing the survey link through YSF LINE and Facebook communities. Because participation depended on respondents’ willingness to complete the questionnaire through these channels, the sampling approach is best characterized as non-probability, voluntary response sampling rather than strict simple random sampling; nevertheless, to minimize bias and enhance representativeness, the survey was disseminated broadly across

provinces and data-collection channels, and all returned questionnaires were screened for completeness and consistency before being included in the final dataset for subsequent PLS-SEM analysis (Hair et al., 2017; Hair et al., 2019).

3.3 Data Analysis

The SmartPLS 3.0 software was employed to estimate the proposed model and analyze the survey data using Partial Least Squares Structural Equation Modeling (PLS-SEM). The analysis began with an assessment of the measurement model to establish reliability and validity, including indicator loadings, internal consistency reliability, and convergent validity. Discriminant validity was then evaluated to ensure adequate construct distinctiveness. Subsequently, the structural model was examined to test the hypothesized relationships among constructs.

In addition to estimating the direct effects, the study assessed indirect (mediated) effects to examine whether Innovativeness (IN) transmits the influence of the UTAUT antecedents—Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), and Hedonic Motivation (HM)—onto Willingness to Adopt (WL). The significance of the indirect paths was evaluated using a bootstrapping procedure, which is commonly recommended for mediation testing in PLS-SEM because it does not rely on distributional assumptions for indirect-effect estimates (Hair et al., 2017; Hair et al., 2019).

In this study, a structural equation model (SEM) was formulated to examine the relationships among the key variables. The independent variables included Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), and Hedonic Motivation (HM). Innovativeness (IN) served as the mediating variable, influencing the dependent variable, Willingness to Adopt (WL), agricultural technologies. The model is mathematically represented as follows

$$\begin{aligned} IN &= \beta_1 \times PE + \beta_2 \times EE + \beta_3 \times SI + \beta_4 \times FC + \beta_5 \times HM + \varepsilon_1 \\ WL &= \beta_6 \times IN + \varepsilon_2 \end{aligned}$$

where $\beta_1, \beta_2, \dots, \beta_6$ represent the standardized path coefficients reflecting the strength and direction of the relationships between variables, and ε_1 and ε_2 denote the error terms capturing unexplained variance within the model. This structural framework enables the explanation of variance in Innovativeness by five predictor variables, while Willingness to Adopt is directly influenced by Innovativeness (Hair et al., 2017; Hair et al., 2019).

4. Results

4.1 Descriptive statistics

In this study, the sample consisted of 370 young farmers. Their demographic information, such as gender, age, education level, work experience, farming type, land size, annual income, technology adoption, preferred sources of agricultural news, and types of startup businesses, is detailed in Table 2.

Of all participants, 50.54% identified as male, 46.49% as female, and 2.97% as LGBT. Most were aged between 31 and 45, accounting for 76.49%, while 55.14% had not completed a bachelor's degree. Regarding professional experience, 129 individuals (34.86%) had spent less than five years working in agriculture.

When looking at farming practices, the largest group (40.27%) focused on field crops, followed by mixed agriculture (26.49%), horticulture (22.43%), and livestock (10.81%). No respondents reported working in fisheries or

other agricultural sectors. Nearly half of the farmers (47.30%) managed less than 10 rai, while 40.54% cultivated between 10 and 20 rai; a minority (12.16%) had farms exceeding 20 rai.

For annual earnings, 46.49% reported incomes between 100,001 and 200,000 baht. Another 38.92% earned less than 100,000 baht, 11.89% fell in the range of 200,001 to 300,000 baht, and just 2.7% earned over 300,000 baht per year.

Technology use was notable, with 76.22% of these young farmers utilizing some form of technology in their operations, while 23.78% had not yet adopted such tools. Among technology users, agricultural drones were the most common (36.09%), typically used for tasks like monitoring crops, precision pesticide spraying, and field mapping. An automatic irrigation and IoT system, which includes temperature and humidity sensors, was utilized by 33.83% of respondents, supporting water management and farm monitoring. Additionally, 30.08% reported using agricultural database systems or production tracking apps to improve planning and decision-making.

Social media proved to be the primary source of agricultural news for 72.70% of the participants, followed by public relations channels (13.78%) and television programs (13.51%). No one selected other options. In terms of entrepreneurship, a majority (60.00%) were engaged in family businesses, while the remaining 40% had started their own ventures.

Table 2. Sample Characteristics (n = 370)

Variable	Definition	Frequency (n)	Proportion (%)
Gender	Male	187	50.540
	Female	172	46.486
	LGBT	11	2.972
Age	17-30 years old	87	23.513
	31-45 years old	283	76.486
Education	Lower bachelor's degree	204	55.135
	Bachelor's degree	141	38.108
	Bachelor's degree above	25	6.756
Experience working	≤ 5 years	129	34.864
	6 – 10 years	145	39.189
	> 10 years	96	25.945
Type of Agriculture	Field Crops	147	40.270
	Horticulture	83	22.432
	Livestock	40	10.810
	Mixed Farming	98	26.486
Area size	≤ 10 Rai	175	47.297
	10 – 20 Rai	150	40.540
	> 20 Rai	45	12.162

Variable	Definition	Frequency (n)	Proportion (%)
Income	≤ 100,000 baht	144	38.918
	100,001 – 200,000 baht	172	46.486
	200,001 – 300,000 baht	44	11.891
	> 300,000 baht	10	2.702
Technology Usage	Have ever	282	76.216
	Never	88	23.783
Sources of Agricultural News	Social media	269	72.702
	Public Relations	51	13.783
	Television Programs	50	13.513
Type of Business	Owner business	148	40.000
Start	Family business	222	60.000

4.2 Construct validity

For factor loadings, the recommended threshold is greater than 0.60. Upon inspection, it was found that all indicators had factor loadings exceeding the recommended threshold, ranging from 0.614 to 0.873. Furthermore, to assess reliability and validity, the Variance Inflation Factor (VIF) was analyzed to determine whether there were issues with collinearity among constructs. The recommended criterion is that VIF values should not exceed 5.00. The analysis results showed that all VIF values were below 5.00, indicating that there is no collinearity problem among the studied variables.

In addition, the composite reliability of all constructs was examined by calculating Dijkstra–Henseler's rho (rhoA). For all constructs included in the conceptual model, internal consistency and reliability were further confirmed by both Cronbach's Alpha and Dijkstra–Henseler's rho, with both values exceeding the minimum threshold of 0.7. The reliability of the indicators was also assessed according to the criteria proposed by Toader, Rădulescu, and Toader (2024), which showed values above 0.7, indicating that the items used to measure each construct consistently and reliably reflect the fundamental nature of that construct.

The convergent validity of the constructs was tested using the Average Variance Extracted (AVE), based on the criteria by Fornell and Larcker (1981), which recommend that AVE values should be greater than 0.5. It was found that all constructs had AVE values ranging from 0.588 to 0.700, indicating that the latent constructs can explain at least 58.8% of the variance in the indicators. This demonstrates a strong level of convergent validity, as shown in Table 3.

Table 3 Confirmatory Factor Analysis Results

	Factor Loadings	Cronbach Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE	VIF
Performance Expectancy (PE)						
PE1	0.823	0.857	0.859	0.903	0.700	1.945
PE2	0.823					1.972
PE3	0.842					2.166

	Factor Loadings	Cronbach Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE	VIF
PE4	0.858					2.235
Effort Expectancy (EE)						
EE1	0.873					2.333
EE2	0.841	0.828	0.832	0.886	0.662	2.060
EE3	0.790					1.665
EE4	0.744					1.505
Social Influence (SI)						
SI1	0.870	0.763	0.797	0.849	0.588	1.895
SI2	0.797					1.685
SI3	0.764					1.500
SI4	0.614					1.261
Facilitating Conditions (FC)						
FC1	0.740					1.473
FC2	0.833	0.778	0.790	0.857	0.602	1.763
FC3	0.814					1.647
FC4	0.709					1.353
Hedonic Motivation (HM)						
HM1	0.870					2.103
HM2	0.829	0.807	0.827	0.875	0.639	1.958
HM3	0.840					2.044
HM4	0.637					1.306
Innovativeness (IN)						
IN1	0.796					1.962
IN2	0.840					2.354
IN3	0.809	0.881	0.882	0.913	0.678	2.042
IN4	0.822					2.217
IN5	0.850					2.404
Willingness to Adopt (WL)						
WL1	0.745					1.736
WL2	0.791					1.919
WL3	0.856	0.860	0.863	0.899	0.642	2.337
WL4	0.811					2.106
WL5	0.798					1.928

The assessment of discriminant validity based on the Fornell and Larcker criterion refers to the extent to which each latent construct is truly distinct from other constructs in the structural model. Initially, the discriminant validity of the proposed constructs was evaluated using the Fornell and Larcker criterion, which posits that the amount of variance a construct shares with its own indicators should be greater than the variance it shares with other constructs (Toader, Rădulescu, & Toader, 2024). Table 4 presents the square roots of the Average Variance Extracted (AVE) for each variable and the correlation coefficients among the variables. These square root values must exceed the corresponding inter-construct correlations to confirm discriminant validity (Fornell et al., 1981; Semiz & Semiz, 2021). As shown in Table 4, the square roots of the AVE for each construct were greater than their correlations with other constructs. Therefore, it can be concluded that the measurement model demonstrates a satisfactory level of discriminant validity.

Table 4 Discriminant validity of the constructs

Construct	EE	FC	HM	IN	PE	SI	WL
EE	0.813						
FC	0.683	0.776					
HM	0.680	0.716	0.800				
IN	0.704	0.687	0.735	0.824			
PE	0.714	0.631	0.692	0.667	0.837		
SI	0.732	0.678	0.649	0.625	0.625	0.767	
WL	0.548	0.642	0.653	0.693	0.637	0.617	0.801

4.3 Testing the research model

The research model was examined through Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS software. The analysis outcomes are summarized in Table 5, with the conceptual model illustrated in Figure 2. The standardized path coefficients for the hypothesized relationships were as follows

$$\beta_{PE \rightarrow IN} = 0.137, \beta_{EE \rightarrow IN} = 0.235, \beta_{SI \rightarrow IN} = 0.027, \\ \beta_{FC \rightarrow IN} = 0.186, \beta_{HM \rightarrow IN} = 0.329, \beta_{IN \rightarrow WL} = 0.693$$

These coefficients indicate the strength and direction of the effects among variables. The model's explanatory power, denoted by the coefficient of determination, showed

$$R^2(IN) = 0.644, R^2(WL) = 0.480$$

Thus, the model accounts for 64.4% of the variability in Innovativeness ($R^2 = 0.644$) and 48.0% in Willingness to Adopt ($R^2 = 0.480$). Additionally, all path coefficients were statistically significant at the 0.001 level ($p < 0.001$), with t-values exceeding critical thresholds, confirming support for all hypothesized associations (Hair et al., 2019; Henseler, Ringle, & Sinkovics, 2009).

Table 5 Structural Equation Modelling Results

Hypothesis	Standardized Beta	t-values	p-value	Results
H1: SI→IN	0.027	0.574	p < 0.001	Supported
H2: PE→IN	0.137	2.277	p < 0.001	Supported
H3: FC→IN	0.186	4.123	p < 0.001	Supported
H4: HM→IN	0.329	6.000	p < 0.001	Supported
H5: EE→IN	0.235	3.845	p < 0.001	Supported
H6: IN→WL	0.693	23.131	p < 0.001	Supported

Note: ***p < 0.001, **p < 0.01, *p < 0.05

From Table 5 above, Bootstrapping analysis was conducted to measure the effects of the variables. It was found that Performance Expectancy ($\beta = 0.137$; $p < 0.001$), Effort Expectancy ($\beta = 0.235$; $p < 0.001$), Social Influence ($\beta = 0.027$; $p < 0.001$), Facilitating Conditions ($\beta = 0.186$; $p < 0.001$), and Hedonic Motivation ($\beta = 0.329$; $p < 0.000$) have significant effects on Willingness to Adopt through Innovativeness ($\beta = 0.693$; $p < 0.036$). Additionally, Innovativeness also significantly affects Willingness to Adopt ($\beta = 0.693$; $p < 0.000$). Therefore, it can be stated that all hypotheses were confirmed.

Moreover, the model based on the conceptual framework fits the empirical data well, as indicated by $\chi^2 = 2168.351$, NFI = 0.723, and SRMR = 0.074. Hence, the research framework model is appropriate and consistent with the empirical data.

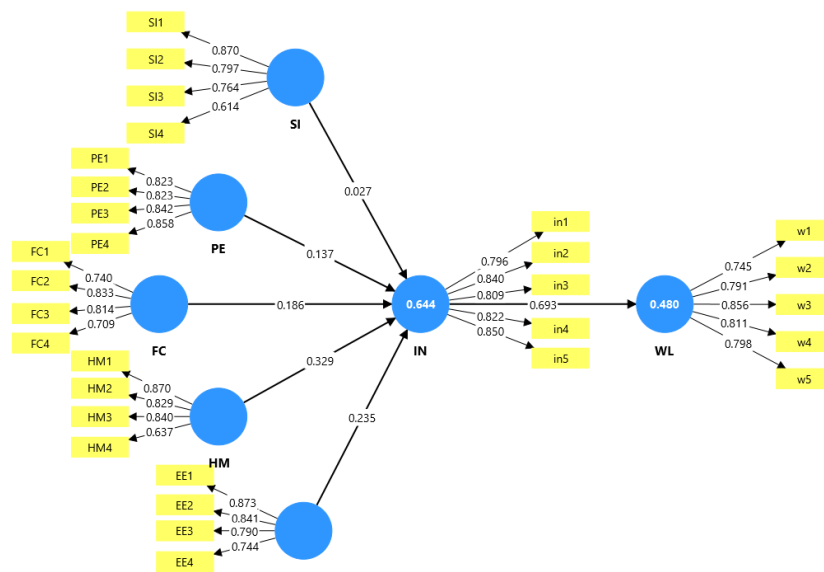


Figure 2 PLS-SEM Results

If the predictive relevance (Q^2) values of the endogenous variables are greater than zero, it indicates that the research model can predict the endogenous variables (Hair et al., 2014). Based on the Blindfolding analysis used to assess the predictive relevance of the endogenous variables, the Q^2 value for Innovativeness was 0.630, and the Q^2 value for Willingness to Adopt agricultural technology and innovation was 0.471. Since both values are greater

than zero, it can be concluded that the research model has significant predictive power for the factors influencing the willingness of young farmers in Thailand to adopt agricultural technology and innovation.

The predictive power of the proposed structural model was further examined using the coefficient of determination (R^2). The analysis results indicate that the combined influence of Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), and Hedonic Motivation (HM) explains 64.4% of the variance in Innovativeness (IN) ($R^2 = 0.644$), as shown in Figure 2 and Table 5. Additionally, Innovativeness explains 48.0% of the observed variance in Willingness to Adopt (WL) agricultural technology and innovation ($R^2 = 0.480$), confirming that the model provides strong explanatory and predictive power for young farmers' willingness to adopt agricultural technologies and innovations in Thailand.

Table 6 Results of the Analysis of Total Effects, Direct Effects, and Indirect Effects

Variable	Innovativeness			Willingness to Adopt		
	Direct effect	Indirect effect	Total effects	Direct effect	Indirect effect	Total effects
Performance Expectancy: PE	0.137***	-	0.137***	-	0.163***	0.095***
Effort Expectancy: EE	0.235***	-	0.235***	-	0.129***	0.163***
Social Influence: SI	0.027***	-	0.027***	-	0.228***	0.018***
Facilitating Conditions: FC	0.186***	-	0.186***	-	0.095***	0.129***
Hedonic Motivation: HM	0.329***	-	0.329***	-	0.018***	0.228***
Innovativeness: IN	-	-	-	0.693***	-	0.693***
R-square		0.644			0.480	
R-square adjusted		0.639			0.479	

Note: *** p -value < 0.001

From Table 6 above, the analysis of total effects, direct effects, and indirect effects within the model revealed that the five UTAUT factors —Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), and Hedonic Motivation (HM)—have statistically significant direct effects on Innovativeness (IN) at the 0.001 level (β ranging from 0.027 to 0.329). In addition, these factors exert statistically significant indirect effects on Willingness to Adopt (WL) agricultural technology and innovation through Innovativeness, as reflected in the total effect coefficients (e.g., PE = 0.163, EE = 0.163, FC = 0.129, HM = 0.228). Innovativeness itself has a statistically significant direct effect on Willingness to Adopt ($\beta = 0.693$, $p < 0.001$), confirming its central mediating role within the model.

5. Discussion

The present study extends the Unified Theory of Acceptance and Use of Technology (UTAUT) by positioning Innovativeness (IN) as a central psychological mechanism explaining young farmers' Willingness to Adopt (WL) agricultural technologies and innovations. The results indicate that the key UTAUT antecedents—Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), and Hedonic Motivation

(HM)—significantly enhance Innovativeness. In turn, Innovativeness exerts a strong positive effect on Willingness to Adopt, supporting the proposed direct-effect hypotheses (H1–H6). These findings are consistent with recent evidence showing that UTAUT/UTAUT2-related beliefs and motivations remain robust predictors of adoption-related outcomes in agricultural and technology-enabled contexts, particularly when intrinsic enjoyment and perceived performance benefits are salient (Shi et al., 2022; Yan et al., 2022). Taken together, these results extend the original UTAUT and UTAUT2 frameworks by explicitly positioning Innovativeness as a central mediating construct between core UTAUT antecedents (PE, EE, SI, FC, HM) and young farmers' willingness to adopt agricultural technologies, thereby enhancing the explanatory power of the model in this context. While some seminal UTAUT and innovation-diffusion studies are older than ten years, they are retained in this study as core theoretical anchors, whereas the empirical evidence used to substantiate the findings and contextualise the model is drawn primarily from research published within the last decade.

Importantly, the mediation analysis further demonstrates that Innovativeness transmits the effects of the UTAUT antecedents to Willingness to Adopt (H7a–H7e). This implies that external perceptions and enabling conditions (e.g., usefulness expectations, ease-of-use beliefs, social support, and access to resources) are more likely to translate into adoption readiness when they first strengthen young farmers' propensity to experiment with new technologies. Such a mediated pathway aligns with recent studies emphasizing the role of individual readiness and innovation-oriented traits in shaping adoption intentions and technology acceptance, including empirical work in Thailand and related settings (Phuensane et al., 2022; Wajasuwan & Wongsansukcharoen, 2022; Wichean & Sungsanit, 2022).

To interpret this mechanism, Innovativeness reflects an individual's tendency to try new ideas and technologies earlier than others and to tolerate moderate uncertainty during experimentation. In the context of young farmers, higher innovativeness can convert perceived usefulness-related beliefs, ease-of-use perceptions, social influence, and facilitating conditions into a stronger willingness to adopt, thereby clarifying how UTAUT-related drivers operate through an internal readiness-to-innovate pathway. This process-oriented explanation also complements recent empirical findings that highlight the importance of motivational and psychological factors (including enjoyment-related motives) in the adoption of smart/precision agriculture technologies (Shi et al., 2022; Yan et al., 2022).

6. Limitations and Future Research

This study is subject to several limitations. First, the use of non-probability, voluntary response sampling among Young Smart Farmer (YSF) members in Northeastern Thailand limits the generalizability of the findings to other regions, older farmers, and non-YSF groups. Second, the cross-sectional design precludes causal inferences about changes in technology adoption behaviour over time; longitudinal or panel data would allow future research to examine how willingness to adopt evolves as farmers gain experience with new technologies. Third, the proposed model focuses on UTAUT-related constructs and Innovativeness, while other structural constraints such as access to finance, land tenure security, climate risks, and market volatility were not explicitly incorporated and should be examined in subsequent studies. Future research could therefore expand the model to integrate these contextual and

structural variables, compare regions or farmer segments, and employ mixed-methods designs to capture more nuanced behavioural mechanisms.

7. Conclusions

This study investigated the factors influencing young farmers in Thailand to adopt agricultural technologies and innovations, using a structural equation modeling approach grounded in the Unified Theory of Acceptance and Use of Technology (UTAUT). The findings reveal that Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, and Hedonic Motivation significantly affect Innovativeness among young farmers, which in turn strongly influences their Willingness to Adopt new agricultural technologies. Innovativeness serves as a crucial mediator between these factors and adoption intentions, highlighting the importance of fostering a culture of experimentation and openness among young farmers.

The present findings should be interpreted as evidence of young farmers' willingness to adopt agricultural technologies rather than their actual adoption rates. Related research in Thailand has shown that farmers' intentions to adopt IoT-enabled smart farming technologies are influenced by perceived gains from adoption and perceived losses associated with climate change (Piancharoenwong & Badir, 2024). Evidence from other developing-country contexts similarly suggests that technology adoption intentions may be influenced by perceived usefulness, perceived ease of use, social factors, and institutional support. However, these findings should be interpreted cautiously because adoption contexts, technologies, and farmer characteristics may differ across countries.

Policy implications support national Farming 4.0 and BCG economy initiatives prioritizing digital infrastructure, skills enhancement, and financial incentives. Concrete examples include depa-Krungsri collaborations offering low-interest loans for IoT sensors and smart farms, alongside banks' modern agriculture fairs integrating credit with smartphone platforms (Sowcharoensuk, 2025). Commercial banks and specialized financiers increasingly host expos, provide tech advisory, and link loans to smart farm apps, enabling unified access to capital and IoT knowledge via tripartite farmer-bank-tech provider partnerships (Limpamont et al., 2024).

Taken together with recent empirical evidence, the results indicate that promoting IoT and smart technologies among young farmers cannot rely solely on-farm readiness and individual attitudes. Instead, it requires a broader "support ecosystem" that interconnects multiple stakeholders, including national and provincial government agencies, financial institutions (commercial banks, specialized banks, and SME banks), industrial promotion agencies, and digital technology providers (e.g., IoT and smart farming solution firms). Such an ecosystem should include budgetary measures (grants and concessional loans), technical training and capacity building, business advisory services, and market-linkage mechanisms. Together, these elements help transform "intention to adopt" into sustained, real-world use of IoT and smart farming technologies over the long term. (Limpamont et al., 2024; Sowcharoensuk, 2025)

Despite these limitations, the findings highlight important social and economic implications. By strengthening Innovativeness and hedonic engagement with digital tools, public agencies and financial institutions can accelerate the diffusion of agricultural technologies among young farmers, which in turn can enhance farm productivity, stabilize rural incomes, and reduce vulnerability to climate and market shocks. In the broader policy

context, such efforts directly support Thailand's national agendas on Farming 4.0 and the bio–circular–green (BCG) economy, contributing to more competitive, innovation-driven, and environmentally sustainable agricultural systems.

8. Policy Recommendations

Based on the analysis, four policy recommendations are proposed.

First, governments should coordinate with commercial banks, specialized banks, and SME Bank to provide low-interest loans and subsidies for IoT sensors, drones, and smart farm platforms, linking these to depa -Krungsri initiatives and modern agriculture fairs. This approach reduces initial cost barriers and enhances capital access for smallholder farmers (Sowcharoensuk, 2025).

Second, continuous technical training and support are essential, particularly since many young farmers have limited formal education and may struggle to interpret complex technical information. Active engagement from scientific and technical personnel at the local level, combined with accessible, regularly scheduled training programs, is vital to ensure proper technology implementation, encourage sustainable practices, and facilitate peer learning (Sabbagh & Gutierrez, 2022).

Third, supporting demonstration farms through targeted subsidies and preferential policies can strengthen community-based learning. These farms serve as platforms for hands-on training and peer-to-peer knowledge exchange, fostering local innovation and accelerating the adoption of technology. This approach also encourages the development of social networks among young farmers, which enhances collective capacity to integrate new agricultural practices (Zhang et al., 2024).

Fourth, consistent media engagement that delivers both technical guidance and environmental information can significantly raise awareness among young farmers. Such communication not only encourages the adoption of ecological practices but also helps cultivate favorable attitudes toward sustainable agricultural technologies (Zhang et al., 2024).

9. Practical Implications and Benefits

9.1 For policymakers and DOAE/YSF programs

The findings can be used to design training curricula that explicitly target the enhancement of Innovativeness and Hedonic Motivation among young farmers, for example through hands-on workshops on drones and IoT systems, field-based smart farming demonstrations, and innovation challenges or hackathons within YSF networks. Such interventions strengthen internal readiness to experiment with new tools and help translate perceived usefulness and ease of use into concrete adoption behaviour, in line with recent evidence on innovation-oriented training for smart agriculture.

9.2 For financial institutions (commercial banks, specialized banks, SME banks, and microfinance providers)

The extended UTAUT–Innovativeness model can inform the development of integrated “smart farm finance packages” that combine concessional credit with technology training and digital farm-management applications.

Bundling capital, knowledge, and monitoring tools in a single offering can increase young farmers' confidence, reduce perceived risk, and accelerate adoption of high-cost technologies such as IoT sensors and drones, complementing existing initiatives like low-interest IoT loans and modern agriculture fairs in Thailand.

9.3 For technology providers and agritech startups

The core constructs—Performance Expectancy (PE), Effort Expectancy (EE), and Hedonic Motivation (HM)—provide concrete design criteria for user-centred digital platforms and services. Developers can leverage these insights to create intuitive dashboards, simplified interfaces, and engaging usage experiences, supported by responsive online help and after-sales services, thereby reducing perceived complexity and increasing the likelihood that young farmers will adopt and continuously use smart and precision agriculture technologies.

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