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Technostress and Agricultural App Adoption Among Thai Farmers

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Abstract

This study investigates the relationship between technostress and agricultural application adoption among 420 Thai farmers, focusing on psychological factors influencing technology acceptance. Utilizing a mixed-methods approach, the research incorporates an extended Technology Acceptance Model with tools like the Thai General Health Questionnaire (Thai-GHQ-12) and Perceived Stress Scale (PSS-10). Findings show that 37.1% of farmers experience psychological distress, with those reporting mental health issues having a 42% lower likelihood of adoption (OR=0.58, $p<0.01$). Successful adopters experienced a 35% reduction in stress and greater decision-making confidence, whereas failed adoptions correlated with a 43% increase in anxiety. Structural equation modeling ($\chi^2/df=1.82$, CFI=0.96, RMSEA=0.044) indicates that technology anxiety, coping strategies, and social support significantly influence traditional TAM pathways. Five psychological barriers were identified: fear of catastrophic failure, identity threat, cognitive overload, social comparison stress, and learned helplessness. The study recommends incorporating mental health support within digital agriculture initiatives to promote sustainable agricultural digitalization.

Introduction

Thailand's agricultural sector, employing approximately 8 million farming households with 11.63 million workers in the agricultural labor force, constitutes a fundamental pillar of the national economy and food security [1]. However, this vital sector faces unprecedented challenges that significantly impact farmers' mental health and their capacity to adopt technological innovations. The convergence of climate change impacts, including unpredictable weather patterns and increasing frequency of extreme events, combined with market price volatility and rapid technological transformation, creates a complex matrix of psychosocial pressures that profoundly affect farming communities. Research evidence demonstrates that farmers globally experience stress rates 3.5 times higher than general populations, with suicide rates among agricultural workers representing one of the highest occupational categories worldwide [2]. This mental health crisis in agricultural communities represents not merely a health concern but a critical barrier to sustainable agricultural development and modernization efforts.

The intersection of mental health challenges with digital transformation initiatives creates a particularly complex landscape for policy implementation. The Royal Thai Government, through the Ministry of Agriculture and Cooperatives' 20-year strategic plan, emphasizes enhancing agricultural sector competitiveness through technology and innovation adoption, aligning with the national Digital Economy Development Integration Program [3]. This strategic direction recognizes that digital technologies, particularly mobile applications, offer transformative potential for addressing longstanding agricultural challenges including information asymmetry, market access limitations, inefficient resource allocation, and climate adaptation needs, as shown in Figure 1.

The National Agricultural Data Center has documented 86 agricultural applications currently available for Thai farmers, comprising 40 government-provided applications and 46 private sector solutions, covering diverse functionalities from weather forecasting and pest management to financial services and market price information [4].

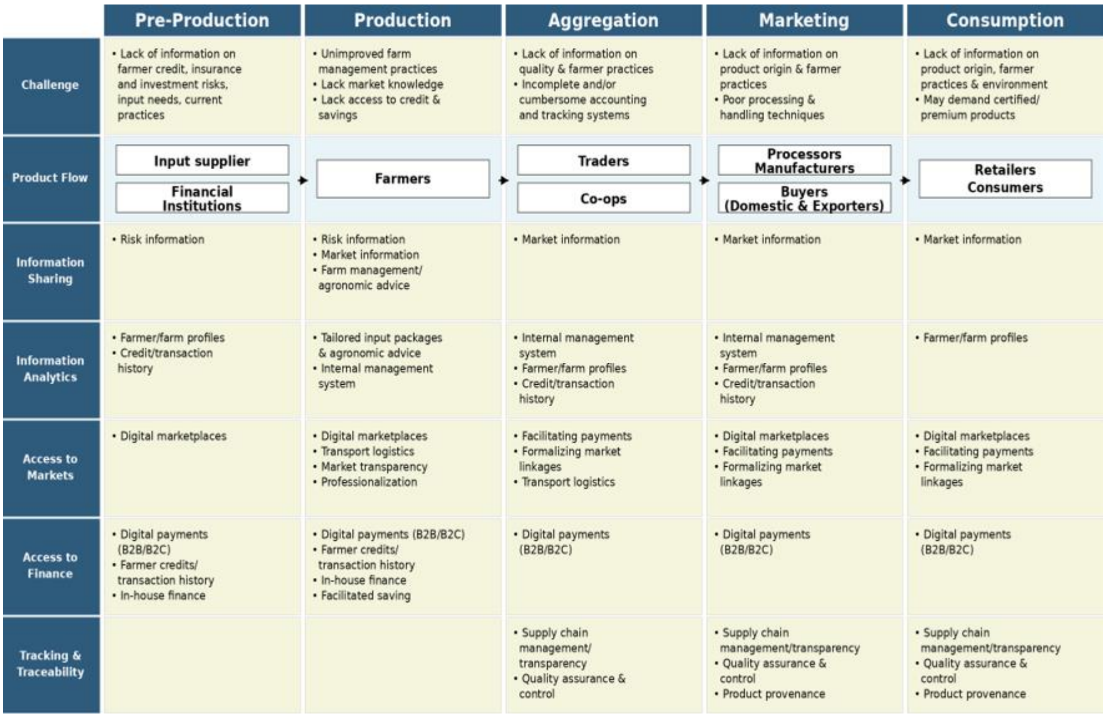

Figure 1. Digital Technology Applications Across the Agricultural Value Chain

Digital agricultural technologies theoretically offer promising solutions for enhancing farm management efficiency, reducing uncertainty, and improving decision-making quality. However, their introduction paradoxically creates what researchers term "technostress"—a constellation of negative psychological, physiological, and behavioral responses to information and communication technology use [5]. This phenomenon manifests particularly acutely in agricultural contexts where farmers, often working in isolation with limited technical support, must rapidly acquire digital competencies while managing time-critical farming operations. The technostress phenomenon encompasses five distinct dimensions: techno-overload (feeling overwhelmed by information volume), techno-invasion (technology disrupting work-life boundaries), techno-complexity (difficulty understanding and operating technology), techno-insecurity (fear of being replaced or marginalized), and techno-uncertainty (anxiety about constant technological changes) [6].

Statistical evidence reveals a troubling adoption paradox in Thai agriculture. While 96.8% of Thai farmers own mobile phones and 64.4% have internet access, actual agricultural application adoption remains limited at 69%, with only 11.63% of available applications achieving download rates exceeding 50,000 users [7]. This adoption gap cannot be explained by infrastructure limitations or device availability alone, suggesting that psychological and behavioral factors constitute primary barriers to technology uptake. The disparity between technology availability and actual usage indicates that traditional technology promotion approaches focusing on infrastructure development and technical training insufficiently address underlying psychological barriers preventing farmers from engaging with digital tools.

Existing Technology Acceptance Model (TAM) research, while providing valuable frameworks for understanding technology adoption in organizational contexts, inadequately addresses the unique psychological dimensions characterizing agricultural technology adoption [8]. Traditional TAM constructs—perceived usefulness and perceived ease of use—assume rational decision-making processes that may not fully capture the emotional and psychological complexities influencing farmers' technology engagement decisions. Agricultural populations face distinctive challenges including seasonal income variability, weather-dependent operations, intergenerational knowledge transfer tensions, and cultural attachments to traditional farming practices that fundamentally alter technology acceptance dynamics [9].

Recent empirical studies increasingly recognize that psychological distress, anxiety disorders, depression symptoms, and maladaptive coping mechanisms significantly influence technology adoption decisions in agricultural contexts. However, comprehensive integration of clinical mental health constructs within agricultural TAM frameworks remains remarkably limited [10]. This theoretical gap prevents accurate prediction of adoption behaviors and hinders development of effective interventions supporting farmers' technology engagement. The absence of mental health considerations in digital agriculture initiatives potentially exacerbates existing psychological vulnerabilities, creating unintended consequences that undermine both technology adoption goals and farmer well-being.

This study addresses these critical gaps through comprehensive investigation of the complex interplay between mental health and agricultural technology adoption among Thai farmers. The research objectives encompass four interconnected dimensions: First, examining bidirectional relationships between technology adoption and psychological well-being, recognizing that mental health status influences adoption capacity while adoption outcomes reciprocally affect psychological states. Second, identifying specific mental health variables that moderate traditional TAM constructs, including anxiety symptoms, stress levels, coping strategies, and social support networks. Third, evaluating differential impacts of various agricultural application types on farmers' stress levels, anxiety symptoms, and overall psychological well-being. Fourth, developing evidence-based recommendations for integrating mental health support within digital agriculture initiatives to optimize both technology adoption success and farmer well-being outcomes. Understanding these psychological dimensions represents not merely an academic exercise but an essential prerequisite for developing humane, effective, and sustainable digital transformation strategies that enhance agricultural productivity while protecting and promoting farmers' mental health.

Related Work

1. Mental Health Challenges in Agricultural Communities

Agricultural populations globally experience disproportionate mental health challenges compared to general populations, representing a critical but often overlooked public health crisis. Comprehensive meta-analyses examining mental health prevalence across farming communities reveal alarming statistics: farmers face elevated rates of depression ranging from 25% to 37%, anxiety disorders affecting 28% to 42% of agricultural workers, and psychological distress impacting 35% to 48% of farming populations [11]. These prevalence rates significantly exceed those observed in non-agricultural occupations, with particularly concerning suicide statistics showing farmers experiencing mortality rates 1.5 to 3.5 times higher than general population averages [12]. The mental health disparities stem from unique occupational stressors inherent to agricultural work, including extreme weather unpredictability affecting crop yields and income stability, commodity price volatility creating financial insecurity, physical isolation limiting social support access, demanding physical labor contributing to chronic health conditions, and severely limited mental health service availability in rural areas [13].

Southeast Asian agricultural contexts present additional culturally-specific mental health challenges that compound universal farming stressors. In Thailand, preliminary epidemiological studies conducted by the Department of Mental Health suggest that 38% of farmers experience moderate to severe stress symptoms, 27% meet criteria for anxiety disorders, and 22% show clinically significant depression symptoms—rates substantially exceeding national population averages of 16%, 12%, and 9% respectively [14]. Cultural factors unique to Thai agricultural communities significantly influence mental health manifestations and help-seeking behaviors. The concept of "face" (saving face/losing face) creates powerful social pressures preventing farmers from acknowledging psychological difficulties or seeking professional help. Buddhist philosophical frameworks emphasizing karma and acceptance of suffering may inadvertently discourage active mental health treatment seeking, with farmers viewing psychological distress as inevitable life suffering rather than treatable medical conditions [15].

2. Technostress Theory and Agricultural Applications

Technostress, originally conceptualized by Brod as "a modern disease of adaptation caused by an inability to cope with new computer technologies in a healthy manner," has evolved into a comprehensive theoretical framework explaining technology-induced psychological distress [16]. Contemporary technostress research identifies five distinct creators that generate psychological, physiological, and behavioral stress responses. Techno-overload occurs when information volume exceeds processing capacity, creating cognitive fatigue and decision paralysis. Techno-invasion manifests as technology penetrating personal life boundaries, disrupting rest and family time. Techno-complexity emerges from difficulties understanding and operating sophisticated technological systems. Techno-insecurity develops from fears of becoming obsolete or replaced by technology-competent individuals. Techno-uncertainty arises from constant technological changes requiring continuous adaptation and learning [17].

Agricultural technology adoption contexts present unique technostress manifestations distinct from organizational settings extensively studied in existing literature. Unlike office workers who can physically separate from technology after work hours, farmers increasingly depend on agricultural applications for time-critical operational decisions that directly impact livelihood outcomes. Weather alert applications require constant monitoring during planting and harvesting periods, pest identification tools demand immediate response to prevent crop devastation, and market price applications necessitate rapid selling decisions to maximize profits. This continuous connectivity requirement creates what Chen et al. term "agricultural techno-anxiety," characterized by paralyzing fear of catastrophic crop loss resulting from technology failure, particularly during critical growth periods when delayed or incorrect decisions cause irreversible damage [18].

3. Evolution of Technology Acceptance Models in Agriculture

The Technology Acceptance Model, originally developed by Davis to predict information system usage in organizational contexts, posits that technology acceptance primarily depends on two fundamental beliefs: perceived usefulness (the degree to which individuals believe technology will enhance performance) and perceived ease of use (the extent to which technology use is expected to be effortless) [19]. These core constructs influence attitudes toward usage, which subsequently determine behavioral intention and actual system use. While TAM demonstrates robust predictive validity across diverse technological contexts, its application to agricultural settings reveals significant limitations in capturing the complex psychological and contextual factors influencing farmers' technology adoption decisions.

Extended TAM versions (TAM2 and TAM3) incorporate additional variables addressing some limitations of the original model. TAM2 introduced social influence processes including subjective norms, voluntariness, and image, alongside cognitive instrumental processes such as job relevance, output quality, and result demonstrability [20]. TAM3 further expanded the framework by identifying anchors (computer self-efficacy, perceptions of external control, computer anxiety, computer playfulness) and adjustments (perceived enjoyment, objective usability) as determinants of perceived ease of use [21]. However, even these extended models insufficiently address psychological health variables increasingly recognized as critical adoption determinants in agricultural contexts.

Recent agricultural technology acceptance research increasingly recognizes the necessity of incorporating psychological and emotional factors. Compeau and Higgins introduced computer anxiety as a critical factor influencing technology self-efficacy, demonstrating that anxiety symptoms significantly impair perceived capability regardless of actual competence [22]. Venkatesh expanded TAM to include emotional responses, showing that affect toward technology use substantially influences adoption intentions independent of rational usefulness assessments [23]. Saadé and Kira demonstrated that anxiety disorders fundamentally alter information processing, reducing perceived ease of use evaluations regardless of actual interface simplicity or user-friendliness [24]. Despite these advances, comprehensive integration of clinical mental health constructs—including depression, stress disorders, and coping mechanisms—within agricultural TAM frameworks remains remarkably limited.

4. Coping Strategies and Social Support in Technology Adoption

Lazarus and Folkman's transactional model of stress and coping provides a theoretical framework for understanding how individuals manage technology-related stressors. The model distinguishes between problem-focused coping strategies (direct actions to address stressor sources) and emotion-focused coping strategies (regulating emotional responses to stressors)

[25]. In technology adoption contexts, problem-focused strategies include seeking technical training, practicing with applications, consulting knowledgeable peers, and systematically troubleshooting problems. Emotion-focused strategies encompass avoidance behaviors, denial of technology importance, self-blame for difficulties, and wishful thinking about returning to traditional methods. Research consistently demonstrates that problem-focused coping predicts successful technology adoption and positive psychological outcomes, while emotion-focused coping correlates with adoption failure and increased psychological distress [26].

Social support emerges as a critical buffer against technostress and facilitator of successful technology adoption in agricultural communities. House's multidimensional social support framework identifies four distinct support types relevant to agricultural technology contexts: instrumental support (hands-on technical assistance and troubleshooting help), informational support (advice, guidance, and knowledge sharing), emotional support (empathy, encouragement, and reassurance), and appraisal support (feedback, validation, and social comparison) [27]. In agricultural communities characterized by strong social networks and collective decision-making, peer support demonstrates particularly powerful influence on technology adoption outcomes. Farmer-to-farmer learning networks consistently show greater effectiveness than formal training programs, attributed to shared experiential knowledge, culturally appropriate communication styles, and trust-based relationships [28].

Method

1. Research Design and Framework

This research employed a sequential explanatory mixed-methods design integrating quantitative survey methodology with qualitative phenomenological inquiry to comprehensively investigate the complex interplay between mental health and agricultural technology adoption. The mixed-methods approach enabled triangulation of findings, providing both statistical generalization and contextual depth essential for understanding psychological phenomena in agricultural settings. The theoretical framework integrated the extended Technology Acceptance Model (TAM3) with established mental health assessment paradigms, creating a novel analytical lens for examining how psychological well-being moderates technology adoption processes, as shown in Figure 2. This integration recognized that technology acceptance cannot be fully understood without considering the mental health context within which adoption decisions occur.

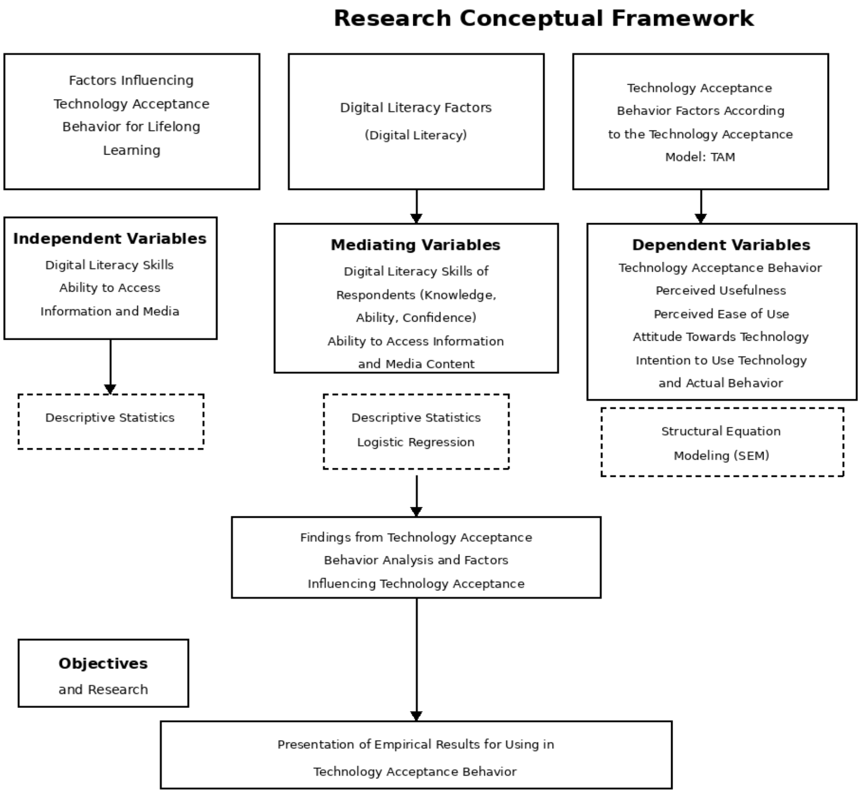

Figure 2. Research Conceptual Framework

2. Study Population and Sampling Strategy
The target population comprised farmers registered in Thailand's Large Field Crop System project, a government initiative encompassing organized farmer groups across all provinces. This sampling frame provided access to diverse agricultural practitioners while ensuring participants had exposure to government technology promotion efforts. A multi-stage stratified random sampling approach ensured comprehensive representation across critical stratification variables. First-stage stratification by crop type included four major categories: rice (n=120), representing Thailand's staple crop with traditional cultivation practices; vegetables and herbs (n=100), characterized by intensive management and higher technology requirements; durian (n=100), a high-value export crop demanding precise cultivation techniques; and longan (n=100), representing perennial fruit cultivation with specific seasonal management needs. Second-stage stratification ensured geographical representation across Thailand's four regions (Northern, Central, Northeastern, and Southern), capturing regional variations in agricultural practices, infrastructure development, and technology adoption patterns. Within each region, provinces were purposively selected based on farmer population density (minimum 200 farmers for specialty crops, 2,000 for rice) and operational feasibility. Third-stage random selection of individual farmers from provincial lists ensured unbiased participant selection. Sample size determination using G*Power 3.1 software indicated a minimum requirement of 385 participants for detecting medium effect sizes (f^2=0.15) with 95% confidence level and 80% statistical power. The final sample of 420 farmers exceeded this requirement, providing adequate power for subgroup analyses including mental health status comparisons and multi-group structural equation modeling as shown in Table 1.

Table 1: Demographic characteristics and technology usage patterns (N=420)

Characteristic	n	%
Crop Type		
Rice	120	28.6
Vegetables and Herbs	100	23.8
Durian	100	23.8
Longan	100	23.8
Age Group		
Below 40 years	89	21.2
40-50 years	156	37.1
Above 50 years	175	41.7
Education Level		
Primary school or below	189	45.0
Secondary school	147	35.0
Vocational or higher	84	20.0
App Adoption Status		
Non-users	43	10.2
Limited users	87	20.7
Regular users	290	69.0

3. Quantitative Data Collection Instruments
The comprehensive survey instrument integrated multiple validated scales adapted for the Thai agricultural context. The extended TAM questionnaire incorporated ten constructs measured using 5-point Likert scales (1=strongly disagree to 5=strongly agree). Subjective Norms assessed social influence through three items examining publicity exposure, training participation, and peer influence (Cronbach's α=0.82). Output Quality evaluated application content through four items addressing information currency, practical applicability, presentation format, and agricultural benefit (α=0.85). Computer Self-efficacy measured digital confidence via four items examining skill levels, experience, confidence, and learning capability (α=0.88). Perceived Risk captured security concerns through three items addressing usage apprehension, data security worries, and error fears (α=0.79). Perceived Usefulness assessed functional value through five items covering information access, communication enhancement, networking benefits, workflow improvement, and error reduction (α=0.91). Perceived Ease of Use

evaluated usability perceptions via three items examining learning difficulty, operational simplicity, and agricultural applicability (α=0.86). Behavioral Intention measured adoption likelihood through three items assessing continued usage plans, recommendation willingness, and learning interest (α=0.89). Actual Adoption captured usage behavior via three items measuring willingness, proficiency, and frequency (α=0.84). Mental health assessment employed multiple clinically validated instruments culturally adapted for Thai populations. The Thai General Health Questionnaire (Thai-GHQ-12) served as the primary psychological distress screening tool, with established Thai population norms and validated cutoff scores (≥3 indicating probable mental health concerns) [29]. The instrument demonstrates excellent psychometric properties in Thai agricultural populations with sensitivity of 84% and specificity of 79% for detecting psychological distress. The Perceived Stress Scale (PSS-10) measured subjective stress experiences over the preceding month, with Thai validation studies confirming strong internal consistency (α=0.85) and test-retest reliability (r=0.82) [30]. The Technology Anxiety Scale, adapted from the Computer Anxiety Rating Scale, incorporated agriculture-specific modifications addressing fears of equipment damage, costly errors, and competence judgments (α=0.87) [26].

4. Qualitative Data Collection Procedures

Qualitative data collection employed two complementary approaches providing rich contextual understanding of psychological experiences. Focus group discussions (eight groups total, 6-8 participants each) were stratified by adoption status (current users versus non-users) and age cohort (<50 years versus ≥50 years) to capture diverse perspectives across critical demographic segments. Focus groups lasted approximately 90-120 minutes, conducted in local dialects by trained facilitators with agricultural extension experience. Discussion guides systematically explored emotional responses to technology introduction, stress experiences during learning processes, coping strategies employed when facing difficulties, support needs and preferences, and perceived mental health impacts of technology use or non-use.

In-depth individual interviews (n=24) targeted farmers experiencing significant technostress, identified through screening questionnaire scores exceeding the 75th percentile on technology anxiety measures. These semi-structured interviews, lasting 60-90 minutes, provided detailed narratives of psychological challenges, adaptation processes, and mental health trajectories associated with technology adoption attempts. Interview protocols employed phenomenological questioning techniques exploring lived experiences, emotional responses, meaning-making processes, and identity negotiations related to technological change.

5. Data Analysis Procedures

Quantitative analysis employed hierarchical analytical approaches progressing from descriptive to inferential to structural modeling techniques. Descriptive statistics characterized sample demographics, technology usage patterns, mental health prevalence, and scale distributions. Bivariate analyses using chi-square tests examined categorical associations between mental health status and adoption categories, while independent samples t-tests and one-way ANOVA compared continuous variables across groups. Effect sizes (Cohen's d, eta-squared) quantified practical significance beyond statistical significance. Logistic regression models examined socioeconomic and psychological predictors of binary adoption outcomes, controlling for potential confounders including age, education, farm size, and regional variations.

Structural Equation Modeling using AMOS 26.0 software tested the integrated TAM-mental health model through two-step procedures. Confirmatory Factor Analysis first validated measurement models for all latent constructs, evaluating factor loadings (threshold >0.50), construct reliability (composite reliability >0.70), convergent validity (average variance extracted >0.50), and discriminant validity (square root of AVE exceeding inter-construct correlations). The structural model subsequently tested hypothesized relationships using maximum likelihood estimation with bootstrapping (5,000 samples) for robust standard errors. Model fit assessment employed multiple indices including chi-square/degrees of freedom ratio (<3.0), Comparative Fit Index (>0.90), Tucker-Lewis Index (>0.90), Root Mean Square Error of Approximation (<0.08), and Standardized Root Mean Square Residual (<0.08).

Qualitative data analysis followed Braun and Clarke's six-phase thematic analysis framework: data familiarization through repeated reading and initial noting, systematic generation of initial codes across the dataset, searching for themes by collating codes into potential themes, reviewing themes against coded extracts and entire dataset, defining and naming themes through ongoing analysis refinement, and producing the report with vivid extract examples [29]. Two independent researchers coded all transcripts using NVivo 12 software, achieving substantial inter-rater reliability (Cohen's κ=0.82). Discrepancies were resolved through discussion and consensus, with a third researcher arbitrating unresolved disagreements. Themes were organized within a socio-ecological framework examining individual, interpersonal, community, and system-level factors influencing the technology-mental health relationship.

Results and Discussion

1. Mental Health Prevalence and Adoption Patterns

Mental health screening revealed concerning prevalence rates. The Thai-GHQ-12 identified 156 farmers (37.1%) with psychological distress requiring intervention. Technology anxiety affected 67.4% of participants, with 14.3% experiencing severe anxiety preventing technology use. Mental health prevalence differed substantially across adoption groups, as shown in Table 2.

Table 2: Mental health indicators by technology adoption status

Indicator	Non-Users (n=43)	Limited Users (n=87)	Regular Users (n=290)	p-value
GHQ-12 ≥3 (%)	58.1	43.7	31.4	<0.001
High Stress (%)	37.2	24.1	13.8	<0.001
Technology Anxiety (%)	93.0	78.2	59.7	<0.001

Farmers with psychological distress showed 42% lower adoption likelihood (OR=0.58, 95% CI: 0.39-0.86, p<0.01) despite recognizing benefits. High stress correlated negatively with application usage (r=-0.412, p<0.001). Technology anxiety emerged as the strongest barrier, with anxious farmers reporting significantly lower perceived ease of use (2.31 vs. 3.92, p<0.001).

2. **Psychological Factors in Technology Acceptance**

Structural Equation Modeling (SEM) demonstrated excellent fit (χ^2/df=1.82, CFI=0.96, RMSEA=0.044), as shown in Figure 3. Including psychological variables increased R^2 for adoption from 0.875 to 0.924.

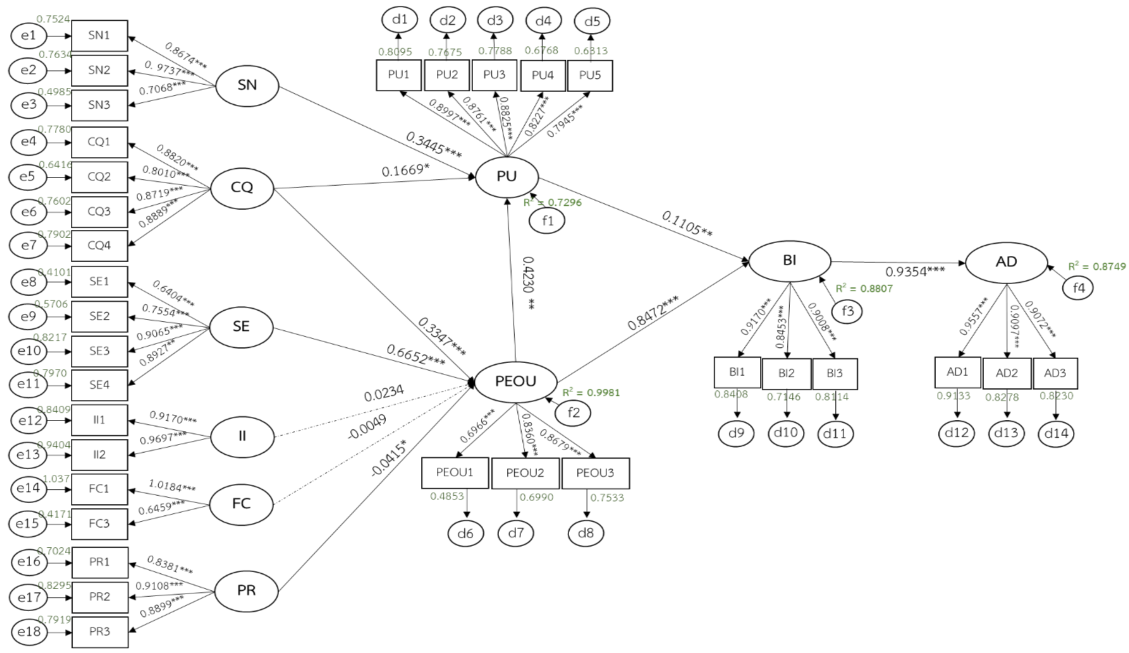

Figure 3. Structural Equation Modeling (SEM)

Note: *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10

Source: Appendix 3.13 (Summary of Regression Weight, Standardized Regression Weight, Variances and Square Multiple Correlations, pages 147-150)

Technology anxiety directly reduced perceived ease of use while moderating self-efficacy effects, as shown in Table 3.

Table 3: Psychological variables' effects on TAM pathways

Path	Direct Effect	Moderation by Anxiety	Moderation by Stress
Technology Anxiety → PEOU	-0.267***	--	--
Coping Strategies → BI	0.298***	-0.142**	-0.089*
Social Support → PU	0.345***	-0.203***	-0.156**

*Note: ***p<0.001, **p<0.01, *p<0.05; PEOU=Perceived Ease of Use, BI=Behavioral Intention, PU=Perceived Usefulness*

Technology anxiety directly reduced perceived ease of use while moderating self-efficacy effects. Problem-focused coping enhanced behavioral intention, but effects diminished under high stress. Social support's influence weakened with psychological distress, indicating mental health fundamentally alters technology acceptance processes.

3. Mental Health Outcomes

Three-month follow-up assessment revealed differential trajectories. Successful adopters showed 35% stress reduction (pre: M=22.4, SD=5.8; post: M=14.6, SD=4.2; t=8.92, $p<0.001$), 28% decrease in psychological distress, and 58% increase in farming self-efficacy. Conversely, failed adoption attempts increased stress by 18% and technology anxiety by 43%, with 61% developing learned helplessness patterns.

4. Qualitative Themes

Thematic analysis identified five psychological barriers: (1) Fear of catastrophic failure during critical periods, (2) Identity threat to traditional expertise, (3) Cognitive overload from information abundance, (4) Social comparison stress within farmer groups, and (5) Empowerment through successful mastery. Farmers expressed: "What if the app fails and I lose my crop? I'd rather trust my judgment" (Rice farmer, 58).

5. Discussion

The findings of this study reveal profound psychological dimensions underlying agricultural technology adoption that fundamentally challenge conventional understanding of digital transformation in farming communities. The remarkably high prevalence of psychological distress (37.1%) among Thai farmers aligns with global agricultural mental health statistics but demonstrates particularly concerning implications for technology-driven modernization initiatives. This mental health burden does not merely represent a co-occurring challenge but constitutes a fundamental barrier that shapes, constrains, and often determines technology adoption trajectories. The observation that farmers experiencing mental health challenges demonstrated 42% lower adoption likelihood despite recognizing application benefits suggests that psychological barriers override rational cost-benefit assessments traditionally assumed in technology acceptance models.

The bidirectional relationship between technology adoption and mental health represents a critical finding with substantial theoretical and practical implications. While successful technology adoption yielded significant mental health benefits—including 35% stress reduction and enhanced psychological well-being—failed adoption attempts exacerbated existing psychological vulnerabilities, creating a vicious cycle of technostress, reduced self-efficacy, and adoption avoidance. This bidirectionality suggests that technology introduction in agricultural communities carries psychological risks comparable to its promised productivity benefits, necessitating careful consideration of mental health safeguards in digital agriculture programs.

Agricultural technostress manifests distinctively from organizational contexts extensively studied in existing literature, characterized by unique features that amplify psychological impact. The isolation from immediate technical support creates prolonged anxiety periods when farmers encounter difficulties, unlike office workers who can readily access IT departments. The high stakes of technology failure—potentially affecting entire seasonal income—generate catastrophic thinking patterns resembling those observed in anxiety disorders. Time-critical decision pressures during weather events or pest outbreaks create acute stress responses that may overwhelm cognitive processing capacity, impairing technology learning and use. Identity threats to traditional farming expertise challenge core self-concepts, potentially triggering depression and reduced self-worth. Intergenerational tensions around technology use fracture family support systems traditionally buffering against agricultural stressors.

The moderating effects of mental health variables on TAM relationships reveal previously unrecognized complexity in agricultural technology acceptance processes. The substantial attenuation of social support effects under high stress conditions (coefficient reduction from 0.345 to 0.142) indicates that psychological distress creates cognitive and emotional barriers that external support cannot easily overcome. This finding challenges assumptions about social influence in collectivist societies, suggesting that mental health status fundamentally alters how farmers process and respond to social pressures and peer recommendations. Similarly, the diminished impact of computer self-efficacy under high anxiety conditions implies that confidence-building interventions may prove ineffective without concurrent anxiety management.

Problem-focused coping strategies' protective effects against technostress and their positive influence on adoption outcomes highlight the importance of adaptive coping mechanisms in technology acceptance. Farmers employing problem-focused strategies—actively seeking training, systematically practicing applications, and constructively troubleshooting difficulties—demonstrated not only higher adoption success but also improved mental health trajectories. Conversely, emotion-focused coping strategies—avoidance, denial, self-blame—predicted both adoption failure and psychological deterioration. These findings suggest that coping skill development should constitute a core component of digital literacy programs, teaching farmers not merely how to use technology but how to manage the psychological challenges inherent in technological change.

The qualitative themes emerging from focus groups and interviews provide crucial contextual understanding of statistical patterns. Fear of catastrophic failure during critical farming periods represents a rational response to genuine risks rather than irrational anxiety, acknowledging the reality that technology failures can indeed cause devastating crop losses. Identity threats experienced by older farmers reflect legitimate concerns about knowledge devaluation and social marginalization in increasingly digital agricultural systems. Cognitive overload from information abundance paradoxically increases rather than decreases decision-making uncertainty, challenging assumptions about information access benefits. Social comparison stress within farmer groups creates new hierarchies and exclusion patterns potentially fracturing traditional support networks.

These findings necessitate fundamental reconceptualization of digital agriculture promotion strategies. Current approaches emphasizing technical training and infrastructure development, while necessary, prove insufficient when psychological barriers remain unaddressed. The high prevalence of mental health challenges in farming communities represents a hidden obstacle to digital transformation that technology-focused interventions cannot overcome. Policy frameworks must therefore integrate mental health support as a core component of digital agriculture initiatives rather than treating psychological well-being as a peripheral concern. This integration requires coordinated efforts across agricultural, health, and technology sectors, challenging traditional sectoral boundaries and demanding innovative governance approaches.

Conclusion

This study demonstrates inseparable relationships between mental health and agricultural technology adoption among Thai farmers. The high prevalence of psychological distress (37.1%) and technology anxiety (67.4%) represents substantial barriers to digital transformation. The integrated TAM-mental health model reveals that psychological well-being fundamentally shapes technology engagement capacity while adoption outcomes reciprocally influence mental health trajectories. Successful adoption yielding 35% stress reduction demonstrates technology's potential as mental health intervention. Conversely, failed attempts exacerbating distress highlight risks of promoting technology without support. Recommendations include: (1) mental health screening before training, (2) stress-reduction design principles, (3) graduated exposure protocols, (4) peer support networks, and (5) culturally-appropriate interventions combining traditional practices with modern support.

Future research should explore longitudinal mental health trajectories, culturally-specific interventions, and predictive models for technology-related distress. As global agriculture undergoes digital transformation, prioritizing farmers' mental health alongside technological advancement represents both ethical imperative and pragmatic necessity for sustainable, inclusive development enhancing productivity and well-being.

Author Contributions

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Author Contributions Statement
This study followed the Contributor Roles Taxonomy (CRediT) to describe the specific contributions of each author. S.R. and N.C. contributed to the conceptualization of the study. S.R. and S.S. developed the research methodology. Data collection was carried out by C.P. and R.P. Formal data analysis was conducted by N.C. and S.S. The original draft of the manuscript was prepared by N.C., while S.R. and C.P. were responsible for reviewing and editing the manuscript. S.R. managed the overall project administration. All authors have read and agreed to the published version of the manuscript.

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C : **C**onceptualization
M : **M**ethodology
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O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
P : **P**roject administration

Conflict Of Interest Statement
The authors declare that there is no conflict of interest regarding the publication of this manuscript.

Informed Consent
Informed consent was obtained from all participants involved in the study. Participants were fully informed about the purpose of the research, the procedures involved, their voluntary participation, and their right to withdraw from the study at any time without penalty. All data were collected and analyzed anonymously to ensure participant confidentiality.

Ethical Approval
This study was conducted in accordance with national ethical guidelines and institutional research standards. Formal ethical approval was not required for this study as it involved anonymous data collection and posed minimal risk to participants.

Data Availability
Data Source
The data used in this study were obtained from primary data collection conducted among agricultural workers in Thailand. Data were collected through structured questionnaires administered to participants during the study period.

Data Access and Restrictions
Due to ethical considerations and the protection of participant privacy, the datasets generated and analyzed during the current study are not publicly available. The data contain sensitive personal information and were collected under conditions of confidentiality.

Data Sharing Policy
Anonymized and aggregated data may be made available upon reasonable request to the corresponding author, subject to approval by the relevant institutional authorities and compliance with ethical guidelines.

Data Storage
All research data are securely stored by the research team and maintained in accordance with institutional data management policies and national data protection regulations.

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