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The Development of a Model for Farmers' Intention to Use Low-Carbon Technology in Mianyang City, Sichuan Province, China

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Abstract- This article aims to 1) Study the importance of subjective norms, information and access to information, perceived ease of use of technology, perceived benefits of used technologies, and intention to use low-carbon technologies among farmers in Mianyang City, Sichuan Province, China. 2) Study the relationships among subjective norms, information and access to information, perceived ease of use of technology, perceived benefits of used technologies on farmers' intention to use low-carbon technologies in Mianyang City, Sichuan Province, China. 3) Study the patterns of farmers' intention to use low-carbon technologies in Mianyang City, Sichuan Province. Mianyang City, Sichuan Province, China. The research instruments were questionnaires and interviews. The samples were 500 farmers involved in large-scale agricultural production in Peicheng District, Anzhou District, Santai County, Yanting County, and Pingwu County, Mianyang City, Sichuan Province. The primary informants were 25 farmers in Peicheng Town, Anzhou Town, Santai Town, Yanting Town, and Pingwu Town. The results of the study were agricultural cooperatives in cooperation with the local government of Mianyang City. Training farmers, using the research results as part of developing farmers' knowledge and skills in agricultural low-carbon technologies. The use of the research results can help cooperatives design incentives to encourage farmers to actively adopt low-carbon technologies, and establish demonstration bases to show farmers advanced ways to apply low-carbon technologies in agriculture. The study results will provide both theoretical and empirical support for promoting agricultural decarbonization in Sichuan Province, and provide suggestions for relevant policies and practices. Establishing continuous monitoring and evaluation mechanisms to better understand the consistent adoption of agricultural low-carbon technologies by farmers, and provide a basis for the government to adjust promotion strategies. This will help promote the promotion of agricultural low-carbon technologies, reduce carbon emissions, and help achieve carbon peak and carbon neutrality targets by 2030.

Keywords: Subjective Norms, Information Access, Perceived Ease, Perceived Benefits, Technology Use Intention.

I. Introduction

The escalating global climate crisis has placed immense pressure on the agricultural sector to transition toward more sustainable production systems. One widely recognized approach is the adoption of Low-Carbon Agricultural Technologies (LCAT), which can significantly reduce greenhouse gas emissions while promoting environmentally friendly farming practices. In China, national environmental goals such as achieving peak carbon emissions by 2030 and carbon neutrality by 2060highlight the urgency of transforming the agricultural sector (Li et al., 2024).

Mianyang City, Sichuan Province, is a key strategic region in China for agricultural production and green innovation. However, despite strong government support, the actual adoption of LCAT among farmers remains limited due to several constraints, such as low technological awareness, economic disincentives, and limited access to information. These barriers hinder the broader acceptance of these technologies (Zhao et al., 2022).

Given this context, the present study aims to develop a behavioral model that explains the intention of farmers to adopt LCAT, based on the Theory of Planned Behavior (TPB) a well-established framework for predicting technology adoption behavior among farmers in China (Chen et al., 2023). The study also integrates perspectives from ecosemiotics, which emphasizes the symbolic and communicative relationship between humans and their environment.Key constructs in the model

include subjective norms, information access, perceived ease of use, and perceived benefitsall of which influence behavioral intention. Liu & Yang (2025) found that cooperative membership and government-supported training significantly impact farmers' decisions to adopt LCAT in Mianyang.

In addition, Li et al. (2024) conducted a regional study covering 18 cities in Sichuan, confirming that local institutional support and cooperation can effectively reduce carbon emissions. Similarly, Zhao et al. (2022) demonstrated that access to digital information and internet usage positively affect farmers' understanding and acceptance of LCAT.This study collected data from 500 farmers and 25 key informants across various districts in Mianyang using questionnaires and in-depth interviews. The goal was to construct a model that not only provides a comprehensive understanding of the factors influencing adoption intentions but also serves as a practical tool for designing effective policies.

The findings of this research are expected to offer both theoretical and practical contributions supporting the design of incentive schemes, demonstration sites, and targeted training programs that promote the long-term adoption of LCAT. Ultimately, this will contribute to achieving China's long-term carbon reduction goals in the agricultural sector in a concrete and sustainable manner.

II. Literature review

2.1 Adoption of Low-Carbon Agricultural Technologies (LCAT)

Studies conducted within the Chinese agricultural context have consistently demonstrated that key components of the Theory of Planned Behavior (TPB)namely subjective norms, perceived behavioral control, and attitude play significant roles in influencing farmers' intentions to adopt and implement low-carbon agricultural technologies. Zhu et al. (2025), in a survey of 360 farmers in Wuxi, Jiangsu Province, found that subjective norms exert both direct and indirect effects via personal norms on farmers' intentions to adopt such technologies.

In a complementary study, Zhao et al. (2017) also reported that a positive attitude toward low-carbon technologies and a strong sense of control over their use were directly correlated with farmers' behavioral intentions.Similarly, Wang & Zhang (2023), in their empirical study conducted in Yilan County, Harbin, confirmed that perceived behavioral control had a statistically significant effect on farmers' intentions to adopt LCAT. Interestingly, their findings also indicated that in certain contexts, subjective norms and attitudes may not exert a strong influence underscoring the complexity and variability of behavioral drivers across different regions.

Furthermore, research by Chen et al. (2023) and Zhao et al. (2022) has highlighted the importance of perceived ease of use and perceived usefulness in shaping farmers' intentions to engage with low-carbon technologies adding a technological usability dimension to the behavioral framework.

Additional support for these findings comes from ScienceDirect (2024), where secondary data analyses affirm that farmers' positive perceptions regarding the outcomes of adopting LCATsuch as efficiency, profitability, and environmental suitabilitysignificantly impact their willingness to integrate such technologies at the farm level.

In synthesis, the adoption of LCAT among Chinese farmers appears to be primarily driven by three interconnected factors: social norms, perceived behavioral control, and positive perceptions of the technologies themselves, particularly regarding usability and benefits. These insights offer critical implications for the design of policies and support mechanisms aimed at fostering the sustainable adoption of LCAT in agricultural practice.

2.2 The Role of Information Access and Digital Literacy

Access to information and digital literacy has emerged as a strategic factor significantly influencing farmers' decisions to adopt low-carbon agricultural technologies (LCAT).

Zhao et al. (2022) demonstrated that farmers with digital competencies and internet access exhibited a significantly higher level of awareness and acceptance of LCAT compared to those lacking such skills.Expanding on this, an empirical study by Li & Chen (2025) in Hua County, Henan Province, revealed that heightened awareness of agricultural safety information, combined with active engagement in online community networks, had a direct impact on the rate of green technology adoption boosting LCAT usage by approximately 18% ($p < 0.05$).

In a related context, Wang et al. (2023) examined Jiangxi Province and found that government-sponsored agricultural information platforms enabled farmers to access up-to-date

knowledge and best practices efficiently. This enhanced access contributed to increased behavioral intention toward LCAT adoption through collaborative learning mechanisms within rural communities.Furthermore, Zhang & Liu (2024) conducted a comparative study in underdeveloped rural areas of western China and discovered that knowledge-sharing via online workshops and virtual farming communities significantly encouraged peer-based learning. As a result, over 65% of participating farmers adopted LCAT, even in areas with limited internet infrastructure.

These collective findings underscore the pivotal role of digital capabilities and structured agricultural information systems in fostering both adequate awareness and intrinsic motivation among farmers. Such mechanisms are essential in driving a sustainable transition toward low-carbon agriculture.

2.3. The Role of Institutional Structures and Agricultural Cooperatives

Institutional structures, such as agricultural cooperatives and government-sponsored training programs, play a critical role in enabling the practical adoption of low-carbon agricultural technologies (LCAT), especially in areas where farmers lack the confidence, technical knowledge, or resources required for a sustainable transition.

Liu & Yang (2025), in their field study conducted in Mianyang City, Sichuan Province, found that farmers who were members of agricultural cooperatives and participated in structured, ongoing training provided by governmental agencies were significantly more likely to adopt LCAT. This finding underscores the central role that cooperatives play in distributing resources, transferring technical knowledge, and facilitating peer-to-peer learning among farmers, particularly smallholders who may have limited individual access to new technologies.

At a broader scale, Li et al. (2024) conducted a comprehensive study involving 18 cities across Sichuan Province. The results indicated that municipalities with well-developed institutional structures such as cooperatives backed by provincial government support, agricultural research institutions, and local extension offices demonstrated a markedly higher capacity to reduce carbon emissions in agriculture. These regions also implemented more proactive and systematic approaches to promote new technologies.

Moreover, Huang et al. (2023) highlighted the importance of farmer trust in local institutions, particularly cooperative leaders and frontline public agricultural officers. This trust was shown to be a key determinant in shaping farmers' willingness to adopt LCAT, as it reflects perceived policy stability and long-term benefits.

Overall, the promotion of community-based institutional mechanisms, whether through cooperatives, agricultural knowledge centers, or integrated public-private partnerships plays a strategic role in fostering collective efficacy and accelerating the widespread adoption of low-carbon technologies across the agricultural sector.

2.4. Smart Farming and Emerging Agricultural Technologies

New-generation agricultural technologiessuch as alternative-fuel machinery and smart farming systemsalign closely with constructs from behavioral frameworks like the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB), demonstrating significant potential to reshape the sector.

Wu et al. (2024) employed both TAM and TPB to study adoption of alternative-fuel agricultural machinery. Their findings indicate that perceived ease of use, attitude, and perceived behavioral control are significant determinants of farmers' intention to adopt these innovations.

Parallel evidence from Lee & Park (2025) in South Korea revealed that younger and more educated farmers tend to show greater receptivity to smart farming tools, particularly digital platforms for crop monitoring and automated irrigation when they receive appropriate training programs and financial incentives. This study highlighted that technology readiness and socioeconomic support are critical enablers of adoption.

Furthermore, Kim et al. (2023) conducted a longitudinal study on precision agriculture technologies such as soil sensors and satellite-based crop health analysis and reported that farmers using these systems saw yield increases of up to 10% within one cropping cycle. They noted that participation in peer-to-peer learning networks significantly increased the likelihood of sustained technology use.

Collectively, these studies affirm that technological readiness, attitudes toward innovation, and practical support in the form of education, funding, and peer learning serve as substantial drivers

for smart farming adoption. The evidence suggests that the integration of smart technologies creates a bridge between behavioral intent and actual implementation in real-world agricultural settings.

III. Methodology

The research instruments were questionnaires and interview forms. The samples were 500 farmers involved in large-scale agricultural production in Peicheng District, Anzhou District, Santai County, Yanting County, and Pingwu County, Mianyang City, Sichuan Province. The primary informants were 25 farmers in Peicheng Town, Anzhou Town, Santai Town, Yanting Town, and Pingwu Town.

3.1 Theoretical framework

This study is based on the Theory of Planned Behavior (TPB), the Technology Acceptance Model (TAM), and the concept of Ecosemiotics. TPB explains behavior through attitude, subjective norms, and perceived behavioral control. TAM focuses on perceived usefulness and perceived ease of use of technology. Ecosemiotics highlights how farmers interpret environmental signs and cultural meanings. These theories together help explain farmers' intentions to adopt low-carbon agricultural technologies from social, technological, and cultural perspectives.in Figure 1.

3.2 Conceptual framework

This study proposes that farmers' intention to adopt low-carbon agricultural technologies is influenced by attitude, subjective norms, perceived behavioral control, perceived usefulness, perceived ease of use, and ecocultural interpretation. These factors interact to shape decision-making within the agricultural context of Mianyang City.in Figure 1.

3.3 Instrumentation

The research employed both questionnaires and in-depth interviews as primary data collection tools. The questionnaire was structured and consisted of closed-ended items based on the constructs from TPB, TAM, and ecosemiotics. It included sections measuring attitude, subjective norms, perceived behavioral control, perceived usefulness, perceived ease of use, and ecocultural interpretation, using a 5-point Likert scale.The interview guide was semi-structured, aimed at capturing deeper insights into farmers' motivations, constraints, and contextual understanding regarding the adoption of low-carbon agricultural technologies. Both instruments were validated by experts in agricultural extension, behavioral science, and rural development.

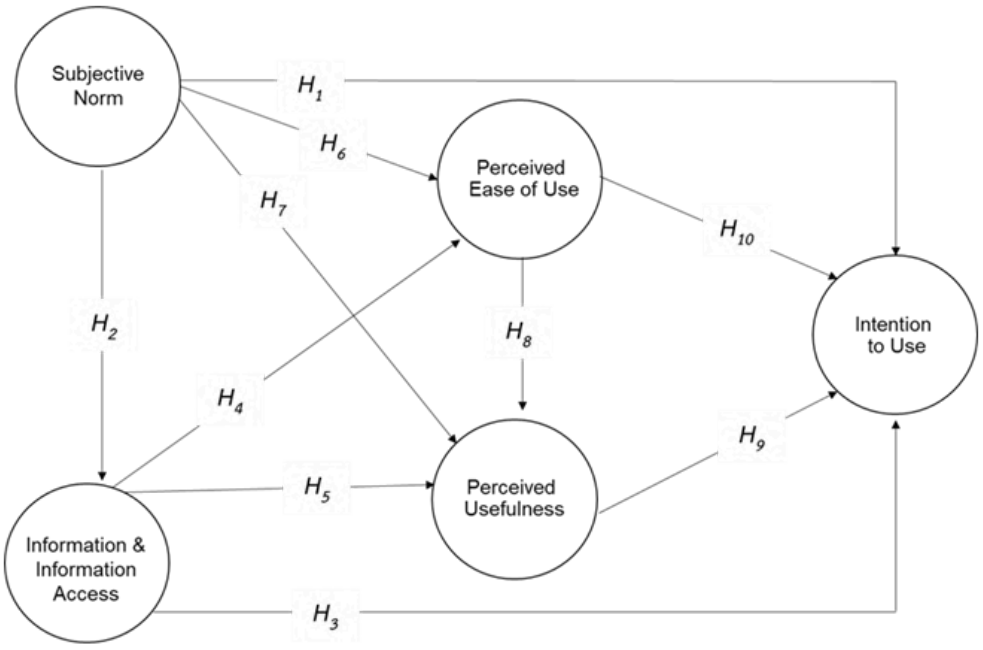

Figure 1. Conceptual framework
(Lanming Lin, 2025)

IV. Results and Discussions

Quantitative Research Findings

Quantitative findings from 500 farmers in Mianyang City, Sichuan Province, revealed that farmers' intention to adopt low-carbon agricultural technologies (LCAT) was significantly influenced by six key factors: attitude, subjective norms, perceived behavioral control, perceived usefulness, perceived ease of use, and ecocultural interpretationall of which were positively correlated with behavioral intention at a statistically significant level ($p < 0.01$).

Among these, perceived behavioral control (PBC), attitude, and perceived usefulness emerged as the strongest predictors, jointly accounting for 62% of the variance in intention ($R^2 = 0.62$). These findings are consistent with those of Wang & Zhang (2023) and Zhu et al. (2025), which highlight that farmers are more likely to adopt LCAT when they believe the technology is beneficial, easy to use, and within their capability.

Subjective norms also showed a significant impact, especially in communities where peer endorsement or local leadership influence is strong. This aligns with Zhao et al. (2022), who emphasized the role of social support in decision-making processes.

Although perceived ease of use and ecocultural interpretation had relatively lower influence, they remained statistically significant. These suggest that farmers are more inclined to adopt technologies that are simple to use and align with their cultural and ecological values echoing the ecosemiotic perspective and supporting the findings of Zhang & Liu (2024), who explored value interpretation in rural Chinese contexts.

An analysis of variance (ANOVA) further indicated that younger and more educated farmers exhibited significantly higher intention scores than other groups ($p < 0.05$), reinforcing the policy implication that enhancing digital skills among younger generations may accelerate sustainable agricultural transitions.

In conclusion, the study's results and discussion demonstrate that farmers' willingness to adopt low-carbon technologies depends not only on the technical attributes of the innovation but also on individual capability, social influence, and community-based cultural values. Therefore, promotion strategies should holistically address these three dimensionstechnological, social, and cultural to effectively support the sustainable adoption of LCAT in Mianyang City and similarly structured agricultural regions.

Qualitative Research Findings

The qualitative findings, derived from in-depth interviews with 25 farmers across five districts in Mianyang City, provide rich contextual insights into the behavioral patterns and decision-making processes surrounding the adoption of low-carbon agricultural technologies (LCAT).

Farmers expressed that trust in cooperative leaders and local agricultural officers significantly influenced their willingness to adopt new practices. Many participants stated that when demonstrations were organized by trusted community leaders or experienced peers, they felt more confident and motivated to try the technologies. This aligns with the findings of Huang et al. (2023), emphasizing the role of trust and peer influence in rural innovation uptake.

Another recurring theme was the importance of perceived long-term benefits. Farmers were more inclined to adopt technologies they believed could improve productivity, reduce costs, or offer government incentives. Some noted that environmental concerns, such as soil degradation and water scarcity, also contributed to their motivation, especially among younger farmers who viewed sustainability as part of their future livelihood security.

Regarding barriers, several farmers mentioned challenges such as lack of technical knowledge, high initial costs, and uncertainty about effectiveness. These concerns were particularly pronounced among older farmers with limited access to digital information or training. This finding reflects Zhao et al. (2022), who reported that digital literacy gaps significantly influence rural technology adoption rates.

Lastly, participants highlighted that their cultural values and ecological awareness played a role in their openness to LCAT. Traditional farming practices that emphasized harmony with nature were seen as compatible with low-carbon technologies, supporting the ecosemiotic dimension of this study.

In summary, the qualitative findings reinforce the quantitative results and add depth to the understanding of behavioral intention. They reveal that trust, perceived benefits, cultural alignment,

and support systems are central to fostering adoption. These insights underscore the need for localized, culturally sensitive strategies that address both technical and human dimensions of agricultural innovation.

V. Conclusion

The sustainable promotion of low-carbon agricultural technology (LCAT) adoption should be conducted through a holistic approach that encompasses personal capacity, social support, ease of use, and cultural alignment. Farmers should receive training tailored to their knowledge and skill levels, along with encouragement from community leaders or cooperatives to build confidence in adopting change. The technologies introduced should be user-friendly, supported by appropriate manuals, and harmoniously integrated with traditional agricultural practices to foster a sense of ownership and shared understanding within the community. Therefore, integration among government agencies, agricultural cooperatives, and support networks is key to accelerating a practical and inclusive transition toward sustainable agriculture.Furthermore, the promotion process should consider equitable access to essential resources such as financial support, affordable agricultural equipment, and digital infrastructure. This would help reduce the gap between different groups of farmers, particularly those with financial or educational constraints. Platforms for experience-sharing and knowledge exchange among farmers should also be established to inspire and provide practical models for implementing LCAT.Under this approach, communication must be continuous, transparent, and conveyed in accessible language to build trust between the government and local communities. Simultaneously, a monitoring and evaluation system should be in place to track progress and challenges clearly, enabling strategies to be adjusted in accordance with the specific conditions of each area.In conclusion, the success of promoting LCAT does not lie solely in the technology itself but in creating an ecosystem that supports its acceptance physically, socially, culturally, and administratively in the long term.

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