Using the KAP model to support legal policy development for circular economy practices in agriculture: A case study from Northern Vietnam

Hang Nguyen Thi Thuy[*]

Abstract

This study examines farmers' Knowledge, Attitudes, and Practices regarding legal frameworks for circular economy practices in agriculture in northern Vietnam. Based on a cross-sectional survey of 365 farmers, the research applies the Knowledge-Attitude-Practice approach to assess how legal awareness and perceived regulatory barriers influence the adoption of circular agricultural practices. Exploratory Factor Analysis and Generalized Linear Models are used to analyze relationships among demographic characteristics, awareness, attitudes, and behavioral intentions. The findings reveal a clear gap between farmers' general understanding of circular economy principles and their knowledge of specific legal provisions, with legal and policy-related constraints exerting a negative impact on adoption behaviors. Younger farmers and those with moderate levels of farming experience show greater willingness to continue circular practices, while positive attitudes significantly enhanced participation in training and peer promotion. At the policy level, the results indicate that existing legal arrangements for circular economy practices in agriculture remain fragmented, characterized by dispersed regulations, limited enforcement mechanisms, and insufficient policy communication. This fragmentation limits farmers' ability to translate positive attitudes into sustained practice. The study highlights the need for an integrated and agriculture-specific policy framework, supported by binding technical standards, strengthened monitoring and enforcement, and complementary market-based instruments to facilitate the transition toward more sustainable agricultural systems in Vietnam.

Keywords: circular agriculture, legal awareness, farmer behavior, sustainability transition, Vietnam.

JEL classification: K32, Q18

First submission: 29th July 2025, accepted 30th January 2026

1. Introduction

The rapid advancement of industrial revolutions has introduced substantial challenges and obstacles to achieving a sustainable economy(Nguyen et al., 2024). Additionally, studies suggest that global agricultural production needs to rise by 70%

[*] School of Economics and Management, Hanoi University of Science and Technology, Vietnam. PhD Candidate - Hanoi Law University, Vietnam. E-mail: hang.nguyenthithuy @hust.edu.vn.

Economics and policy of energy and the environment (ISSNe 2280-7667), 2026, 1
DOI: 10.3280/epe2026oa22893

to satisfy the food demand projected for 2050 (Aznar-Sánchez et al., 2019). These developments pose risks such as the depletion of natural resources, population growth pressures, climate change, and environmental pollution. Addressing these challenges requires fundamental changes in production and consumption systems rather than incremental improvements to existing agricultural practices.

The prevailing linear food production system incurs substantial environmental and social costs, including biodiversity loss through land-use change and environmental degradation (Batlles-delaFuente et al., 2022; Lal et al., 1988; Singh & Mahanta, 2021), which ultimately translate into significant economic costs. If there are no changes to the existing unsustainable food systems and consumption habits, food-related CO_2 emissions could potentially double by 2050 (Helgason et al., 2021).

In this context, the circular economy (CE) offers a promising strategy for conserving vital resources, mitigating the negative environmental impacts of agricultural activities, and enhancing economic performance (Kuisma & Kahiluoto, 2017; Stegmann et al., 2020). Rather than focusing solely on waste management or end-of-pipe solutions, the CE emphasizes systemic change through resource efficiency, material circulation, and value retention across production and consumption systems. A comprehensive synthesis of CE definitions by Kirchherr (2023) shows that, despite conceptual diversity, most definitions converge on principles such as reducing resource inputs, extending material use, and minimizing waste generation.

It represents an innovative economic model aimed at eliminating waste and promoting the continual use of resources, diverging from the traditional linear 'take-make-dispose' approach (Dagevos & Lauwere, 2021; Homrich et al., 2018; Morseletto, 2020). By prioritizing the design of products and processes that minimize waste and pollution, maintaining the use of products and materials through practices such as reuse, repair, remanufacturing, and recycling, and regenerating natural systems, CE fosters resource efficiency, economic growth, and environmental sustainability (Batlles-delaFuente et al., 2022).

Within the agricultural context, the principles of the CE are increasingly reflected in sector-specific policy and practice. Circular agriculture (CA), as delineated by the United Nations (UN), prioritizes the utilization of minimal external inputs to facilitate soil regeneration and mitigate environmental repercussions (Lima et al., 2021; Wysokińska, 2020). Its primary objectives encompass the reduction of land utilization, curtailment of chemical fertilizer application, and mitigation of waste generation to alleviate global emissions and address the exigencies of climate change. Recent literature further emphasizes that circular approaches in agriculture extend beyond specific production techniques to encompass the reconfiguration of production systems and resource flows (Chiaraluce et al., 2021).

Accordingly, the transition toward CA should be understood as a systemic shift from a linear to a circular production logic, rather than as the adoption of a single farming model. CA, thus, refers to the application of CE principles within agricultural production systems, with particular attention to resource efficiency, the utilization of agricultural by-products, and the reduction of environmental impacts (Rukundo et al., 2021). It is noteworthy that the term "agricultural by-products" is used as an overarching concept, encompassing crop residues and livestock by-products.

Despite the momentum in CE adoption, Vietnam currently operates without a standardized set of objectives, or a well-structured legal framework dedicated to CE. Regula-

tions are scattered across various documents, lacking specificity and practical applicability. Although the Environmental Protection Law is in effect and provides a legal basis for the development of CE in Vietnam, the sanctions are not strong enough to prevent actions that affect the environment. CA is also being conducted without specific evaluation criteria. Standards and regulations regarding scientific and technological aspects remain unclear, making implementation challenging. Policies regarding agricultural by-products are still directional. Legal framework for implementing CA and recycling agricultural by-products have not been established. There is a lack of standardized systems and policies prioritizing models using agricultural by-products within the current regulations.

Most previous studies on the circular economy in Vietnamese agriculture have focused on international experiences and lessons for Vietnam, or on evaluating current CE models and proposing solutions for improvement (Lan, 2021; Nhu, 2023; Pham, 2024). Empirical research analyzing barriers faced by farmers in adopting CE practices is still limited (Nguyen et al., 2024), and studies specifically addressing legal and policy aspects are almost absent.

This study employs the KAP model to assess farmers' awareness and attitudes towards legal policies related to the circular economy practices in agriculture in several provinces in northern Vietnam. By focusing on how farmers perceive and respond to regulatory frameworks promoting circular agricultural practices, the research evaluates the extent to which these perceptions and attitudes influence their actual behaviors and willingness to adopt circular economy approaches on their farms. Furthermore, this research seeks to identify influential factors and existing barriers associated with their adoption. Based on these analyses, the study proposes certain policies for legislative managers to assist and promote the transition from linear economy to CE in agriculture.

2. Theoretical framework and literature review

2.1. KAP model overview

The KAP (Knowledge-Attitude-Practice) model is rooted in learning theory (Bandura, 1977) and the diffusion of innovation theory (Roger, 1995). According to Rogers (1995), innovation adoption within a social system unfolds through four sequential stages: knowledge acquisition, persuasion, decision, and confirmation. Bandura (1977) also posits that individual behavior is shaped by social contexts. Additionally, the theory of planned behavior by Ajzen (1991) offers another perspective for examining behavioral change, as it explains how behavioral intentions are influenced by attitudes.

The KAP model represents a theoretical framework widely utilized in behavioral and social science research. Originally formulated to evaluate knowledge, attitudes, and practices within the field of public health (Li et al., 2020), the KAP model was designed to investigate the impact of health education interventions on health-related behaviors in populations. Over time, its application has extended beyond public health to encompass areas such as education, agriculture, and environmental protection. Notably, the interactions among knowledge, attitudes, and practices are understood to be cyclical rather than strictly linear. The KAP model is therefore valuable in uncovering the intricate dynamics between these components, thereby informing the development of more effective environmental policies and public education ini-

tiatives (Ahmad et al., 2020). Furthermore, it provides empirical evidence to support policymakers in formulating improved strategies for waste management and in promoting the broader adoption of circular economy principles (Owojori et al., 2022).

2.2. Circular economy practices in agriculture

CA refers to an agricultural system that applies CE principles to agricultural activities, emphasizing the recycling of agricultural waste and by-products, and the implementation of closed-loop systems to minimize waste. It also involves sustainable practices such as crop rotation and agroforestry to enhance biodiversity and improve soil fertility (Bianchi, 2020; Van Berkum et al., 2018). From the perspective of circular agriculture, the motto "reuse and recycle" is translated into the conversion of waste streams into valuable resources. The development of waste valorization chains may include several steps, such as the practical segregation of waste into upgradable and non-upgradable streams; establishing processing facilities capable of producing upgraded products, developing markets for these products, and organizing commercial logistics. What was previously considered waste or surplus thus becomes a revalued resource (Van Berkum et al., 2018). This process requires the participation of multiple stakeholders and may create business opportunities for each party involved.

A prominent feature in discussions of CE practices in agriculture is sustainability. The essence of the circular economy lies in pursuing economic and social development while safeguarding the environment by preventing pollution—forming the basis for sustainable development (Bencomo et al., 2019). Therefore, circular agriculture must ensure the following objectives: (i) to be a core contributor to the national economy, rather than a subsidized sector, thereby ensuring economic sustainability (Bos & Broeze, 2020); (ii) to maintain biodiversity and productivity over time within local agro-ecosystems, thus ensuring environmental sustainability (Jun & Xiang, 2011); and (iii) to contribute to food security, poverty reduction, and improvements in health and living conditions, thereby ensuring social sustainability (Bencomo et al., 2019; Kristensen et al., 2016). Ultimately, circular agriculture is regenerative in nature, meaning it is a system capable of sustaining and enhancing ecosystems (Morseletto, 2020). In developing CA models, the agricultural sector also requires development strategies aimed at creating regenerative systems that close nutrient cycles, minimize losses, and maximize long-term value within each cycle (Morseletto, 2020).

2.3. Legal and policy landscape of circular economy in agriculture in Vietnam

In recent years, Vietnam has actively transitioned from broad environmental strategies toward a more defined legal structure for the CE and green growth. The legal landscape is currently characterized by a multi-layered approach involving primary laws, guiding decrees, and sector-specific development projects that prioritize agriculture as a key sector for implementation. Table 1 provides a chronological overview of the primary legal instruments and policies that currently govern or promote circular practices within the agricultural sector.

Table 1 – Legal and policy framework for circular economy in Vietnamese agriculture

Year	Legal/Policy Document	Key Provisions for CE Adoption
2015	- Directive No. 03/2015/CT-NHNN - Decree No. 55/2015/NĐ-CP	Establishes green credit promotion and credit policies for agricultural and rural development.
2016	Action Plan to Respond to Climate Change (2016–2020)	Outlines initial sectoral responses to environmental degradation and climate goals.
2018	Law on Crop Production	Regulates the collection, treatment, and reuse of crop residues; encourages the use of agricultural by-products as inputs for production and commercial purposes; supports sustainable crop production systems.
2018	Law on Animal Husbandry	Requires livestock producers to collect and treat animal waste; promotes recycling of manure and by-products for fertilizer, biogas, and other circular applications; aims to reduce environmental pollution from livestock farming.
2018	- Decree No. 57/2018/NĐ-CP - Decree No. 116/2018/NĐ-CP	Provides mechanisms to encourage enterprise investment and expands rural credit access.
2020	Environmental Protection Law 2020	Provides the first official legal definition and comprehensive basis for CE development in Vietnam.
2021	Sustainable Agriculture and Rural Development Strategy (2021–2030)	Integrates CE into long-term planning, focusing on waste management and resource reuse.
2021	Circular No. 12/2021/TT-BNNPTNT	Provides technical guidance on collecting and treating agricultural by-products for reuse.
2022	Decree No. 08/2022/NĐ-CP guiding the Environmental Protection Law	Provides detailed guidance on the implementation of CE provisions; introduces responsibilities for waste management, recycling, and resource efficiency; includes incentives such as land-use support and green credit for environmentally friendly projects
2022	Decision No. 687/QD-TTg Approving the CE Development Project	Establishes national objectives and orientations for CE development; identifies agriculture as a priority sector; promotes pilot models and institutional coordination.
2023	Decision No. 1490/QD-TTg Approving the High-Quality Low-Emission Rice Project (1 million hectares)	Targets sustainable rice farming linked to green growth and carbon emission reduction in the Mekong Delta.

Despite this extensive list of regulations, the framework remains fragmented and is characterized by a lack of unified technical standards. Current provisions are dispersed across multiple legislative documents rather than being integrated into a singular, cohesive legal instrument dedicated to circular agriculture. This lack of specificity and standardized evaluation criteria often results in limited practical applicability for farmers and stakeholders attempting to transition toward circular models.

2.4. Research hypotheses

Based on the KAP framework and the Theory of Planned Behavior (TPB), which posit that cognitive understanding (Knowledge/Awareness) and emotional evaluation

(Attitude) are precursors to specific actions (Practice), we formulated the following hypotheses to examine the drivers of farmers' circular economy adoption:

H1 (Cognitive Drivers): Farmers' awareness of circular economy concepts and legal policies has a positive influence on their adoption behaviors. Specifically, higher awareness is expected to increase the likelihood of continued adoption (H1a) and motivate participation in training courses (H1b). In contrast, higher awareness of policy barriers may negatively affect adoption behaviors (H1c).

H2 (Attitude Drivers): A positive attitude towards circular economy legal policies positively influences the continued adoption of these practices (H2a). We hypothesize that farmers with a more positive attitude are more likely to participate in training programs to improve their skills (H2b) and a positive attitude significantly enhances not only individual adoption but also social advocacy (encouraging others) (H2c).

H3 (Perceived Barriers): Awareness of barriers arising from legal policies is hypothesized to have a negative impact on farmers' willingness to continue adopting circular practices.

H4 (Demographic Controls): Farmers's demographic characteristics significantly influence their engagement.

These hypotheses form the basis for the General Linear Model (GLM) analysis presented in the subsequent methodology section.

3. Methodology

The survey was conducted from October to December 2024 and employed a cross-sectional descriptive correlational survey design to collect data from farmers in northern provinces of Vietnam who are aware of and have adopted circular economy in agriculture. The questionnaire was distributed both directly and online through colleagues and research groups focusing on circular economy in agriculture. Most of the survey samples were from farmers in Hanoi and provinces with large agricultural areas implementing circular economy models, such as Bac Ninh, Hai Duong, and Hung Yen (246 responses – 68%), while the remainder were from farmers in Thai Binh, Son La, and Lao Cai (119 responses – 32%). Participants had to meet the following criteria: (1) Currently engaged in agricultural production in northern Vietnam; (2) Over 18 years of age; (3) Consent to the use of certain personal demographic information for research purposes; (4) Have knowledge of and apply circular economy in agriculture; (5) Able to understand all survey questions. During the data collection process, we obtained an initial total of 391 responses. After screening and processing raw data, we excluded 26 responses due to an invalid answer sheet. Thus, the final sample consists of 365 valid responses.

The questionnaire for this survey was based on previous studies (Kirchherr et al., 2018; Liao et al., 2022; Velasco-Muñoz et al., 2021) and had four sections. Section one included items on demographic characteristics. To evaluate the dependent variable Practice,we employed a guided self-assessment approach. Rather than asking a generic question about circular economy adoption, participants were presented with a list of specific, illustrative circular practices relevant to the local agricultural context. These examples included: (1) reusing agricultural by-products (including crop residues) for composting or animal feed; (2) treating livestock waste for biogas or organic fertilizer; (3) imple-

menting crop rotation and intercropping; and (4) recycling water for irrigation. Section two comprised questions related to farmers' knowledge regarding several issues: the concept of the circular economy in agriculture, their awareness of legal policies on the circular economy in agriculture, and their perception of policy-related barriers to the implementation of circular economy practices in agriculture. Section three contained questions addressing farmers' attitudes towards legal policies on the circular economy in agriculture, while section four focused on assessing their behaviors regarding the adoption of circular economy practices in agriculture. Farmers were asked to respond to three key behavioral dimensions: Continued Adoption: intend to continue applying these circular practices in your future production? (reusing crop residues for composting or animal feed; treating livestock waste for biogas or organic fertilizer; implementing crop rotation and intercropping; recycling water for irrigation); Training Participation: willing to participate in training courses to improve your technical skills in these practices; Encouraging Others: actively encourage other farmers in your community to adopt similar circular practices. We asked participants the level of agreement for each option typically in five points (1-strongly disagree, 2-disagree; 3- neutral; 4-agree; 5-strongly agree).

After gathering all the completed questionnaires from the respondents, data cleaning and coding were done using Microsoft Excel 365.

We used STATA 16 (StataCorp. LLC), a statistical software package, to examine farmers' knowledge and attitudes regarding the circular economy in agriculture, as well as relevant legal policies in this field. First, we conducted the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test. With a KMO coefficient of 0.924 and a Bartlett's test significance of 0.00, the data satisfied the requirements for applying Exploratory Factor Analysis (EFA). The analysis followed the eigenvalues-greater-than-one rule and considered factor loadings greater than 0.4 (Cliff, 1988). We then employed the General Linear Model (GLM) to identify factors associated with farmers' behavior in adopting circular economy practices in agriculture, using three subscales: (1) continue adopting circular economy practices in agriculture (such as reuse of by-products and waste, crop rotation, and water reuse); (2) participation in training courses on the application of circular economy in agriculture; and (3) encouraging other farmers to adopt circular economy practices in agriculture. A p-value of less than 0.05 was considered statistically significant.

To examine the determinants of farmers' adoption behaviours, we employed the General Linear Model (GLM) using a logistic regression framework. The empirical model is specified as follows:

$$\ln\left(P(Y\_k = 1)/(1 - P(Y\_k = 1))\right) = \alpha + \beta\_1\ \mathbf{Aw} + \beta\_2\ \mathbf{Att} + \sum\_(j = 1)\hat{}n + \delta\_j\ \mathbf{X}\_j + \varepsilon$$

Where:

- Y_k denotes the binary dependent variables (Y_1: Continued adoption; Y_2: Training participation; Y_3: Encouraging others);
- Aw represents the vector of awareness sub-scales (Conceptual, Legal policies, Barriers);
- Att represents the farmers' attitude score;
- X_j is the vector of control variables (Age, Gender, Education, Experience, Land size, Cultivation type, Location);
- α is the intercept, β, δ are the regression coefficients, and ε is the error term.

4. Results and discussion

4.1. Results

Table 2 shows demographic information from 365 valid responses.

Table 2 – General information of participants (n=365)

Characteristics	n	%
Sex		
Male	223	61%
Female	142	39%
Age		
From 18 to under 30	83	23%
From 30 to under 40	97	27%
From 40 to under 55	104	28%
Above 55	81	22%
Education level		
Primary school	35	10%
Secondary school	85	23%
High school	231	63%
Bachelor and above	14	4%
No schooling	0	0
Agricultural Experience		
No more than 5 years	59	16%
5–10 years	109	30%
11–15 years	112	31%
More than 16 years	85	23%
Size of cultivated land		
< 3500 m^2	173	47%
3600 - 6000 m^2	102	28%
> 6000 m^2	90	25%
Type of cultivation		
Crop cultivation	97	27%
Livestock farming	112	31%
Mixed	156	43%
Location		
Ha Noi city	81	22%
Bac Ninh Province	74	20%
Hai Duong Province	43	12%
Hung Yen Province	48	13%
Lao Cai Province	41	11%
Son La Province	37	10%
Thai Binh Province	41	11%

Table 3 presents the construct validity and reliability of the factor "Farmers' awareness," which covers the following aspects: "The concept of the circular economy in agriculture," "Legal policies on the circular economy in agriculture," and "Barriers arising from legal policies". Cronbach's alpha coefficients were accepted as 0.587, 0.843, and 0.901, respectively. The overall KMO of the sample was 0.912.

Table 3 – Factor loadings of "Farmers' awareness"

Theme	Items	Factor loading	Cronbach's alpha	Domain mean (SD)	KMO
Conceptual awareness of circular agriculture	Agricultural production without the use of chemicals	0.456	0.587	3.76 (0.83)	
	Agricultural production aimed at maximizing short-term profits	0.682			
	Maximizing the utilization of agricultural by-products and reuse of materials	0.725			
	Small-scale agricultural production at the local level	0.665			
Awareness of legal policies on circular agriculture	Government and local authorities have policies to encourage circular agriculture adoption	0.487	0.843	3.64 (0.76)	0.912
	Credit policies support circular agriculture development	0.669			
	Policies promote circular agricultural products	0.532			
	Legal policies are clear and easy to understand	0.457			
	Policies support innovation and technological upgrading	0.554			
Awareness of legal and policy-related barriers	Lack of understanding of legal policy information	0.608	0.901	3.82 (0.75)	
	Lack of specific guidance for implementation	0.797			
	Policies do not adequately meet farmers' needs	0.758			
	Policies are difficult to understand and apply	0.514			

Pseudo R^2 ranges from 0.198 to 0.237; Omnibus test Prob > $Chi^2 = 0.001^{***}$; Hosmer-Lemeshow test p-value > 0.05. Multicollinearity check: Max VIF = 3.5 (Age), Mean VIF = 2.9 (< 5).

Source: Author's analysis of survey data using Stata

Table 4 shows the construct validity and reliability of "Farmers's attitude" and "Farmers' practice" about legal policies on the circular economy in agriculture

Cronbach's alpha coefficients are 0.908, 0.733. The overall KMO of the data was 0.882.

Table 4 – Factor loadings of "Farmers' attitude" and "Farmers' practice"

Construct	Items	Factor loading	Cronbach's alpha	Domain mean (SD)	KMO
Attitudes toward legal policies on circular agriculture	Implementation of legal policies on circular agriculture is essential	0.736	0.908	2.82 (0.81)	0.882
	Legal policies supporting farmers play an important role	0.742			
	Policy enforcement improves economic and environmental efficiency	0.767			
Practices and behavioral intentions	Continue applying circular economy practices	0.814	0.733	3.49 (0.79)	
	Participate in training programs	0.404			
	Encourage other farmers to adopt circular practices	0.593			

Source: Author's analysis of survey data using Stata

The Generalized Linear Model (GLM) was employed to identify factors associated with CE practices (CEP) in agriculture, focusing on three behavioral dimensions: continued adoption, participation in training programs, and encouragement of others to adopt similar practices. A p-value of less than 0.05 was considered statistically significant. Table 5 presents the survey results on farmers' intentions to continue applying CEP in agriculture in Hanoi, along with an analysis of influencing factors, including demographic characteristics, perceived barriers, and adoption goals.

Both awareness and attitudes of farmers were found to have statistically significant effects in this study. Awareness of the concept of CE in agriculture positively influenced the intention to continue practicing (Coef. = 0.44, 95% CI = 0.33 to 0.55, $p < 0.01$) and to promote the practice to others (Coef. = 0.28, 95% CI = 0.15 to 0.42, $p < 0.01$). In contrast, awareness of legal and policy-related barriers had a negative impact on the intention to continue practicing (Coef. = -0.05, 95% CI = -0.23 to 0.12, $p < 0.01$) but resulted not statistically significant in encouraging others. Farmers with a positive attitude were more likely to continue practicing (Coef. = 0.11, 95% CI = -0.03 to 0.26, $p < 0.01$), participate in training programs (Coef. = 0.15, 95% CI = 0.27 to 0.04, $p < 0.05$), and encourage others to adopt similar practices (Coef. = 0.18, 95% CI = 0.26 to 0.09, $p < 0.01$).

The analysis reveals that older farmers are generally less inclined to continue practicing circular agriculture (Coef. = -0.32, 95% CI = -0.51 to -0.13, $p < 0.01$) and are also less likely to promote it to others (Coef. = -0.24, 95% CI = -0.34 to -0.14, $p < 0.05$). Male farmers are more likely than female farmers to intend to continue practicing circular agriculture (Coef. = 0.05, 95% CI = -0.15 to 0.25, $p < 0.05$) and to participate in training programs (Coef. = 0.31, 95% CI = 0.09 to 0.53, $p < 0.01$).

Conversely, farmers with larger agricultural landholdings showed less intention to continue implementing CEP (Coef. = -0.03, 95% CI = -0.02 to 0.11, p < 0.01).

Farmers with 5 to 10 years of experience demonstrated a stronger intention to continue practicing circular agriculture (Coef. = 0.04, 95% CI = 0.00 to 0.08, p < 0.01) and were also more likely to encourage others to adopt the practice (Coef. = 0.11, 95% CI = 0.06 to 0.16, p < 0.01).

Table 5 – Factors Influencing Farmers' Adoption of Circular Economy Practices in Agriculture

Characteristics	Continue applying		Participate in training courses		Encourage others	
	OR	95% CI	OR	95% CI	OR	95% CI
Farmers' awareness						
Conceptual awareness	0.44***	0.33; 0.55	0.09	-0.03; 0.21	0.28***	0.15; 0.42
Legal policies awareness	0.18**	0.01; 0.36	0.00	-0.19; 0.19	-0.05	-0.27; 0.17
Awareness of barriers arising from legal policies	-0.05***	-0.23; 0.12	-0.00	-0.13; 0.13	0.00	-0.15; 0.15
Farmers' attitude	0.11***	-0.03; 0.26	0.15**	0.27; 0.04	0.18***	0.26; 0.09
Demographic						
Age	-0.32***	-0.13; -0.51	-0.01	-0.18; 0.17	-0.24**	-0.34; -0.14
Gender (vs. Female)						
Male	0.05**	-0.15; 0.25	0.31***	0.09; 0.53	0.05	-0.19; 0.30
Agricultural Experience (vs. No more than 5 years)						
5–10 years	0.04***	0.00; 0.08	0.04*	-0.00; 0.09	0.11***	0.06; 0.16
11–15 years	0.2	0.28; 0.12	-0.03	-0.25; 0.19	-0.02	-0.27; 0.22
More than 16 years	-0.03	-0.41; 0.34	0.09	-0.22; 0.39	0.42	0.08; 0.76
Type of cultivation						
Crop cultivation	0.06	-0.21; 0.34	0.09	-0.22; 0.39	0.42**	0.08; 0.76
Livestock farming	-0.08	-0.28; 0.12	-0.03	-0.25; 0.19	-0.02	-0.27; 0.22
Mixed	0.11*	-0.13; 0.34	0.14	-0.12; 0.40	0.02	-0.27; 0.31
Size of cultivated land (vs. < 3500 m^2)						
3600 - 6000 m^2	-0.03	-0.10; 0.05	0.02	-0.06; 0.10	-0.13	-0.22; -0.04
> 6000 m^2	-0.03***	-0.02; 0.11	0.00	-0.07; 0.07	0.04	-0.04; 0.12

*** p<0.01, ** p<0.05, * p<0.1

Source: Author's analysis of survey data using Stata

4.2. Discussion

Our study's primary objective was to elucidate the influence of farmers' awareness and attitudes on their adoption of circular economy practices. Consistent with the KAP framework, our results confirm that cognitive (awareness) and affective (attitude) factors are the strongest drivers of adoption. Therefore, Hypotheses H1 and H2 are confirmed. This aligns with established behavioral theories and corroborates previous studies emphasizing the pivotal role of psychological readiness in agricultural transitions (de Lauwere et al., 2022; Herrera et al., 2023; Lombardi et al., 2025). Specifically, farmers' conceptual awareness significantly promotes the continued adoption of circular practices (OR=0.44). However, the analysis reveals a critical nuance: while general conceptual awareness acts as a facilitator, awareness of legal policies exerts a more complex influence. Although awareness of supportive policies positively correlates with adoption, the depth of this knowledge remains limited. Most farmers recognize CE terms through mass media but lack a comprehensive understanding of specific incentives, such as those in the 2020 Environmental Protection Law or green credit mechanisms. This superficial understanding may explain why the magnitude of the impact of policy awareness (OR=0.18) is lower than that of conceptual awareness. It suggests that without clear, accessible guidance on *how* to access support, policy awareness alone is insufficient to drive widespread behavioral change. This knowledge gap presents a significant opportunity for policy intervention. Existing literature demonstrates that when farmers are clearly informed about tangible economic benefits – such as transition subsidies, tax incentives, and preferential pricing mechanisms – their willingness to adopt sustainable practices increases substantially (Alfano et al., 2023; Edler et al., 2024). Economic instruments act not only as financial enablers but also as strong signals of governmental commitment, thereby reducing perceived risks and enhancing the perceived value of adoption (Trujillo-Barrera et al., 2016).

Attitude emerged as a pivotal determinant across all three behavioral dimensions: continued adoption, participation in training, and encouraging others. A positive attitude acts as an intrinsic motivation that transforms passive awareness into active practice and social advocacy. This finding aligns with recent international research, such as Lombardi et al. (2025), who studied Italian olive growers and similarly concluded that cognitive factors and positive attitudes towards eco-innovations are essential precursors to adoption. Both studies highlight that regardless of the geographical context (Vietnam or Italy), the internal psychological state of the farmer – driven by perceived benefits and environmental values – is fundamental to the transition towards circular agriculture. Furthermore, this corroborates Ajzen (1991), indicating that positive attitudes significantly increase the likelihood of performing sustainable behaviors.

Conversely, awareness of policy-related barriers was found to have a negative impact on adoption behaviors. Farmers who acutely perceive legal hurdles – such as the lack of specific technical standards, unclear land-use regulations for circular models, or complex administrative procedures for accessing support – are less likely to sustain CE practices. So that, hypothesis H3 is confirmed. This finding is particularly significant as it highlights the "double-edged sword" of legal frameworks: while intended to support, an incomplete or fragmented legal environment can create perceived risks that deter farmers. This empirically supports the need for a unified

and transparent legal corridor, moving beyond general encouragement to specific, enforceable technical guidelines. As Hungerford and Volk (1990) emphasized, knowledge and skills are essential for driving behavioral change.

Younger farmers tend to adopt circular agriculture practices more readily. This finding aligns with previous studies that have highlighted older farmers' reluctance to transition their farming systems (May, 2019) and that sustainable farmers are generally younger than their conventional counterparts (Comer et al., 1999).

Farmers with moderate experience (5-10 years) are more likely to continue implementing circular economy practices in agriculture. This may be attributed to their relatively flexible habits, as they are less entrenched in traditional practices and thus more open to adopting new, more efficient methods (Rizzo et al., 2024). Additionally, smaller-scale farmers tend to be more agile in experimenting with new techniques and technologies (Cohen, 2010; Rizzo et al., 2024; Rosenbusch et al., 2011). In contrast, those managing larger landholdings often face greater investment demands – financial, temporal, and labor-related – and are more likely to approach innovation with caution due to the higher perceived risks (Beus & Dunlap, 1990). Smaller-scale operations, on the other hand, facilitate easier transitions to circular practices and technologies. While economic considerations remain important, these farmers also show greater concern for sustainability and community well-being.

The findings of this study corroborate previous research indicating that positive individual practices can enhance collective behaviors (Bandura, 1977; Steyaert & Jiggins, 2007). Furthermore, Naziri et al. (2014) highlight the significant role of cultural norms and beliefs in shaping agricultural behaviors in Vietnam. Specifically, smallholder farmers often engage in collective action not primarily due to market incentives, but rather driven by concerns over food safety, aiming to ensure the production of safer vegetables.

5. Policy gaps and analysis

The study reveals key policy gaps hindering the adoption of circular economy practices in Vietnam's agriculture, rooted in demographic disparities, limited knowledge transfer, and insufficient use of behavioral incentives. Addressing these requires targeted, inclusive, and multifaceted interventions.

A major gap lies in policies insufficiently tailored to farmer demographics. Younger and moderately experienced farmers are more receptive, while older and large-scale operators remain resistant due to entrenched practices and higher risk perceptions. This reflects a lack of age- and scale-specific mechanisms – such as subsidized training or risk-mitigation tools – which risks inequitable benefits and slows sectoral transformation.

Knowledge dissemination is also shallow. While farmers recognize basic concepts through media and cooperatives, their understanding of legal frameworks and technical instruments is superficial. Current communication strategies emphasize broad outreach rather than detailed education, limiting informed adoption. Multilevel training platforms and culturally attuned messaging could strengthen comprehension and align policies with prevailing community-oriented values.

Finally, attitudes strongly shape behavioral outcomes, yet psychosocial levers remain underutilized. Favorable attitudes enhance adoption, training, and peer influence, but policies focus narrowly on economic or regulatory measures. Integrating social marketing and community-based programs could amplify collective engagement and spillover effects.

In sum, demographic misalignment, superficial knowledge, and weak attitudinal strategies constrain Vietnam's circular agriculture transition. Bridging these gaps requires holistic reforms that combine demographic targeting, enhanced education, and behavioral insights, alongside empirical monitoring to adapt to evolving needs.

6. Limitation and recommendation

6.1. Limitations

This study, while providing valuable insights into the adoption of CE practices among Vietnamese farmers, is subject to several limitations that warrant consideration. First, the sample may not fully represent the diversity of Vietnam's agricultural landscape, as it primarily draws from respondents in specific regions (northern provinces of Vietnam), potentially overlooking variations in agroecological zones, ethnic groups, or socioeconomic contexts. This geographic and demographic constraint could limit the generalizability of findings, particularly regarding cultural norms and collective behaviors emphasized in prior research (Naziri et al., 2014:2). Second, reliance on self-reported data through surveys and interviews introduces potential biases, such as social desirability or recall inaccuracies, which may inflate reported attitudes and intentions toward circular practices (Ajzen, 1991:3). Third, the cross-sectional design captures behaviors at a single point in time, precluding causal inferences about long-term adoption dynamics or the evolution of knowledge gaps over time (Rizzo et al., 2024:3). Moreover, while attitudes were assessed as influential, the study did not deeply explore external factors like market fluctuations or climate variability, which could interact with demographic variables (Beus & Dunlap, 1990:2; May, 2019:2). Finally, legal awareness was measured within a fragmented regulatory landscape lacking unified technical standards, and broader institutional or market factors were not deeply examined. This fragmentation might have affected the precision of assessing farmers' true understanding of legal obligations and benefits.

6.2. Recommendations

To address the identified gaps and limitations, several recommendations are proposed for policymakers, practitioners, and researchers. For policy enhancement, governments should prioritize demographic-targeted interventions, such as subsidized training and risk-sharing programs for older and large-scale farmers, to overcome resistance rooted in experience and scale. Additionally, knowledge dissemination efforts must be deepened through accessible, culturally sensitive platforms – including community workshops and digital apps – that align with local priorities

like food safety and sustainability. Leveraging psychosocial factors, policies could incorporate social marketing campaigns to foster positive attitudes and collective action, drawing on social learning principles. Especially, Policy reforms should prioritize a coherent legal framework with mandatory technical standards, robust enforcement, clear policy communication, and complementary economic incentives (e.g., green credit, tax benefits, market support) to foster widespread CE adoption in agriculture and advance Vietnam's sustainability goals. For practitioners, smallholder cooperatives should facilitate peer-mentoring networks to encourage innovation among diverse farmer groups, emphasizing scalable circular techniques suited to smaller operations. Finally, future research should adopt longitudinal designs with larger, more representative samples to track behavioral changes over time and examine external influences. Mixed methods approaches, integrating quantitative metrics with qualitative insights, would further enrich understanding of circular agriculture transitions in Vietnam.

7. Conclusion

This research provides new evidence on the role of legal awareness in shaping farmers' adoption of CE practices in agriculture in northern Vietnam. While farmers demonstrate favorable attitudes and a general conceptual understanding of CE, their limited knowledge of specific legal provisions and their perception of policy-related barriers continue to hinder widespread adoption. These findings highlight a persistent disconnection between supportive attitudes and the ability to act on them within an enabling and coherent regulatory environment.

The analysis also shows that demographic characteristics condition the likelihood of adoption: younger and moderately experienced farmers are more responsive to CA practices, while older and larger-scale farmers remain more cautious. These differences underscore the need for differentiated and targeted policy instruments rather than a uniform approach, particularly when designing incentives or training programs.

The most important insight concerns the inadequacy of the current legal and policy framework. The fragmentation of CE-related regulations across multiple laws prevents effective communication, weakens enforcement, and reduces accessibility for farmers. As a result, farmers face difficulties in identifying applicable rules, available incentives, and compliance requirements. Without a clear and targeted legal instrument, farmers cannot fully understand their rights, obligations, or the benefits available to them.

The implications are clear. Vietnam urgently needs an integrated and agriculture-specific CE policy framework, anchored in binding technical standards and complemented by robust monitoring and enforcement. Legal reforms must be supported by practical communication strategies that translate complex provisions into accessible guidance. At the same time, market-based instruments – such as preferential public procurement, green credit, and tax incentives – should be mobilized to create tangible economic motivations for farmers to transition to circular practices.

Beyond Vietnam, this study contributes to international debates by demonstrating how legal awareness and policy design critically mediate the translation of positive attitudes into actual behavior. By applying the KAP model at the farmer level,

the study highlights the importance of integrating legal and institutional dimensions into empirical analyses of CA transitions. This perspective draws attention to the often-overlooked role of regulatory frameworks in shaping behavioral outcomes.

These findings are consistent with recent empirical evidence indicating that farmers' cognitive characteristics and policy-related incentives play a decisive role in translating positive attitudes into actual adoption of circular practices. Recent studies on circular eco-innovations in agriculture show that environmental risk awareness and regulatory support mechanisms, such as subsidies, are among the strongest predictors of farmers' willingness to adopt circular practices, often outweighing purely structural or technological factors (Lombardi et al., 2025). This reinforces the argument that legal and policy frameworks should not only promote CE principles in abstract terms, but also actively enhance farmers' understanding of regulatory instruments and reduce perceived legal and institutional uncertainty

Future research should expand beyond northern provinces, employ longitudinal designs to capture change over time, and integrate qualitative insights to deepen understanding of institutional and market dynamics. Such efforts would allow for a more comprehensive assessment of how evolving policy environments influence farmers' adoption trajectories. By doing so, scholars and policymakers alike will be better equipped to design policies that close the gap between conceptual awareness and practical adoption.

In sum, the findings underscore both the potential and the challenges of CA in Vietnam. Harnessing this potential requires coherent legislation, tailored support for diverse farmer groups, and the alignment of legal reforms with economic incentives. If pursued in an integrated and context-sensitive manner, these measures will not only accelerate CE adoption domestically but also strengthen Vietnam's position in global markets increasingly shaped by sustainability standards.

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