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ARTICLE

Intention to Participate in the Circular Economy Model: A Case Study of Rice Farmers in Hau Giang, Vietnam

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ABSTRACT

The circular economy is emerging as a vital strategic model to minimize environmental impacts and enhance agricultural production efficiency in Vietnam. In the rice production sector—a core industry in Hau Giang—the shift toward a circular economy has become an urgent priority for sustainable development. This study employs the Theory of Planned Behavior and incorporates an additional factor, Technical and Output Support (TOS), to better capture the substantive support provided by professional agencies, local authorities, and consumer markets. This contextualized factor addresses a notable gap overlooked in previous research. Survey data from 160 rice-farming households in Hau Giang were analyzed using Exploratory Factor Analysis and Ordinary Least Squares regression. The findings indicate that attitude, perceived economic benefits, environmental concern, and technical and output support positively influence the intention to participate in the circular economy model, while subjective norms do not show statistically significant effects. Furthermore, the analysis reveals that TOS plays a particularly critical role in shaping farmers' confidence in adopting new production practices, especially in contexts where market volatility and resource constraints persist. The incorporation of this factor improves the explanatory power of the TPB framework within agricultural settings. These results offer important empirical insights for policy formulation and the design of intervention programs aimed at advancing the circular economy model in rice production in Hau Giang and the broader Mekong Delta region.

Keywords: Circular Economy; Theory of Planned Behavior; Rice Production; Hau Giang; Mekong Delta

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1. Introduction

For decades, the linear agricultural model of "extract–produce–consume–dispose" has played a central role in ensuring global food security, particularly in developing countries such as Vietnam [1]. Intensive farming practices have significantly boosted Vietnam's rice yields, from 2.1 tons/ha in 1980 to 5.8 tons/ha in 2020 [2]. However, the overexploitation of natural resources and excessive use of chemical inputs (e.g., fertilizers and pesticides) have caused soil degradation [3], water pollution, biodiversity loss [4], and the agricultural sector contributes about 23% of global greenhouse gas emissions [5]. These environmental costs highlight the urgent need for more sustainable agricultural pathways.

In response to these challenges, the circular economy (CE) has been increasingly recognized as a viable framework for advancing sustainability in agriculture. Practices such as by-product reuse and integrated farming systems (e.g., garden–pond–livestock) demonstrate the potential not only to reduce environmental pressures but also to enhance farm profitability [6, 7]. At the global level, the Ellen MacArthur Foundation [8] estimates that embedding CE principles into food systems could reduce greenhouse gas emissions by up to 49% by 2050, underscoring the worldwide mitigation potential of CE adoption. Building on this global rationale, the present study examines rice farmers in Vietnam's Mekong Delta, where sustainability challenges are particularly acute. These insights highlight CE as a transformative pathway that links environmental efficiency with economic resilience, making it a relevant framework for empirical investigation in agricultural contexts.

Within this regional context, the Mekong Delta, Vietnam's primary rice-producing region—accounting for more than 56% of national output—is increasingly threatened by climate change and natural resource depletion [9]. Although several CE-based models, such as rice–fish–duck and rice–lotus systems, have been piloted in selected areas, their actual adoption remains very limited and confined to small-scale demonstrations [6, 10]. Specifically, the rice–fish–duck model integrates paddy cultivation with aquaculture and duck rearing, creating a mutually beneficial system that enhances nutrient recycling, improves pest control, and reduces dependence on chemical fertilizers [11]. Likewise, the rice–lotus system diversifies farm income through lotus flowers and seeds while simultaneously maintaining soil fertility and regulating water balance [12]. However, both models remain inadequate for large-scale replication because their performance relies heavily on seasonal water regimes, localized technical capacity, and weak market linkages for by-products and secondary outputs [13].

Hau Giang province has emerged as a pioneer in promoting CE in agriculture under Decision No. 687/QĐ-TTg [14]; however, implementation remains fragmented, lacks value chain linkages, and has yet to engage farmers meaningfully [15]. Given this context, this study seeks to identify the key determinants influencing rice farmers' intention to participate in CE models in Hau Giang province. The findings aim to inform policy design and support the transition toward circular agriculture in the Mekong Delta. This study adopts the Theory of Planned Behavior (TPB) as the underlying theoretical framework to explain farmers' intention to participate in CE models. TPB is widely applied to analyze behavioral intentions through three core components—attitude, subjective norms, and perceived behavioral control—while allowing the integration of context-specific variables such as technical and output support (TOS) to enhance explanatory power in agricultural contexts. To achieve these objectives, the study employs a quantitative research design combining Exploratory Factor Analysis (EFA) and Ordinary Least Squares (OLS) regression to identify the underlying factors influencing farmers' behavioral intentions. This approach is particularly suitable for examining latent constructs within behavioral frameworks such as TPB while enabling empirical validation of context-specific variables, including TOS.

The research was conducted in Hau Giang province, located in Vietnam's Mekong Delta—a region that serves as the country's largest rice-producing area and a leading pilot zone for CE implementation in agriculture. Its distinctive socio-economic and ecological conditions make it an appropriate and representative context for investigating the behavioral drivers of CE participation among smallholder farmers.

Accordingly, this study addresses the following research questions:

(1) What factors significantly influence rice farmers' intention to participate in CE models?

(2) To what extent do contextual variables, particularly technical and output support, shape these behavioral intentions?

The remainder of this paper is structured as follows: Section 2 reviews the theoretical foundations and develops the research hypotheses. Section 3 describes the research methodology. Section 4 presents and discusses the empirical results. Finally, Section 5 concludes with key implications, limitations, and recommendations for future research.

2. Literature Review and Research Hypotheses

2.1. Theoretical Background

The concept of the circular economy (CE) emerged in the late 1970s and has since evolved through a growing body of research [16]. CE refers to a closed-loop economic model in which the flow of resources, energy, and materials is maintained within the production–consumption cycle for as long as possible, with the aim of minimizing waste and regenerating value [17]. The foundational ideas of CE can be traced back to Boulding [18], while Pearce and Turner [19] introduced the modern concept of CE, criticizing the linear model of "extract–produce–consume–dispose" and proposing an economic paradigm that optimizes resource efficiency. Subsequent studies—such as Andersen [20], Su et al. [21], and Ghisellini et al. [22] —have further developed the concept, identifying its three core pillars: sustainable economic development, environmental protection, and social well-being [23]. CE is commonly associated with the 3R principle (Reduce–Reuse–Recycle), which has been expanded into the 6R framework [24] and later into the 9R and 10R frameworks [25]. The 6R framework adds strategies such as Recover, Remanufacture, and Redesign, emphasizing material recovery and process optimization. The 9R framework further extends these principles by including higher-order strategies such as Refuse and Rethink, which focus on avoiding resource use at the design stage and reimagining consumption models. Collectively, these frameworks illustrate the evolution of CE thinking—from end-of-pipe waste management toward system-level resource efficiency and preventive innovation across the value chain. In the agricultural sector, CE is recognized as a global strategy to promote sustainable production, reduce emissions, and restore ecosystems [26]. Practices such as by-product reuse, organic fertilization, and integrated pest management (IPM) have been implemented to improve resource efficiency [26, 27]. Moreover, the utilization of agricultural waste contributes to the development of new bio-based value chains [28]. However, many developing countries still face significant barriers—technological, financial, and especially behavioral—that hinder the transition to CE models [29]. This underscores the need for further research into the factors that influence farmers' intentions to participate in CE practices.

In Vietnam, CE has been incorporated into national policy since the enactment of the 2020 Law on Environmental Protection [30]. Several integrated farming models—such as rice–fish–duck, garden–pond–livestock (VAC), and agricultural by-product recycling—have demonstrated effectiveness in reducing emissions and improving rural livelihoods [31]. Nevertheless, adoption remains limited due to technical constraints, a lack of market support mechanisms, and farmers' behavioral resistance to change [10]. Hence, examining the determinants of behavioral intention to participate in CE models—particularly in rice farming in Hau Giang province—has become essential to inform more effective policy interventions.

This study adopts the Theory of Planned Behavior (TPB) proposed by Ajzen [32], a widely used framework for analyzing behavioral intentions. TPB posits that behavioral intention—a key antecedent of actual behavior—is influenced by three main constructs: (i) attitude toward the behavior (ATI), (ii) subjective norms (SJN), and (iii) perceived behavioral control (PBC). TPB has been extensively applied in studies on sustainable agricultural and environmental behaviors [33–35]. Building upon this foundation, the present study applies TPB and extends the model by incorporating context-specific factors, including perceived economic benefits (BOE), environmental concern (EC), and technical and output

support (TOS), to examine rice farmers' intention to participate in CE practices.

Aligned with this theoretical framework, the term "participation" is employed to capture the dual nature of farmers' engagement with CE initiatives. Specifically, it encompasses both the adoption of CE practices at the farm level (e.g., by-product reuse, organic fertilization) and the active involvement in CE-based programs and value chains promoted by cooperatives, local authorities, and market actors. This broader framing reflects the institutional and collective characteristics of CE in the Vietnamese agricultural context, where individual adoption often occurs in tandem with participation in organized models and policy-driven initiatives [36].

2.2. Research Hypotheses

Building on the research gaps identified earlier, this study develops a set of hypotheses to examine the determinants of farmers' intention to engage in CE models in agriculture. Although the Theory of Planned Behavior (TPB) has been extensively applied to explain environmental and sustainable behaviors [37, 38], its application to agricultural CE contexts remains limited, especially among smallholder farmers in developing countries [39, 40]. While the TPB offers a robust foundation for predicting behavioral intentions, prior studies have largely emphasized psychological determinants, overlooking contextual constraints and enabling mechanisms relevant to CE adoption.

To address these theoretical and contextual gaps, this study extends the TPB by incorporating three context-specific factors—perceived economic benefits (BOE), environmental concern (EC), and technical and output support (TOS)—alongside the traditional constructs of attitude (ATI), subjective norms (SJN), and perceived behavioral control (PBC). This integrated framework captures both internal motivations and external enablers influencing farmers' behavioral intentions toward CE participation. Accordingly, six hypotheses are formulated to empirically test these relationships.

2.2.1. Attitude (ATI)

Attitude toward CE models (ATI) reflects an individual's positive or negative evaluation of a specific behavior [32]. Previous studies have consistently identified attitude as a strong predictor of sustainable agricultural practices [33, 34]. Notably, Rodino et al. [35] demonstrated that attitude significantly influences farmers' decisions to transition toward circular farming systems in developing countries. This hypothesis addresses a key research gap identified in the literature, where prior applications of behavioral theories in agricultural CE often overlooked the role of internal motivational factors such as attitude—particularly in resource-constrained rural settings like smallholder rice farming in the Mekong Delta—while focusing mainly on external barriers [41, 42]. By examining ATI, this study extends TPB to better capture how positive evaluations drive intention amid contextual challenges such as limited market access and climate vulnerabilities. As one of the key internal motivational factors within the TPB framework, attitude is expected to directly shape farmers' willingness to engage in CE-related activities.

H1. *Attitude positively influences the intention to participate in CE models.*

2.2.2. Subjective Norms (SJN)

Subjective norms (SJN) refer to perceived social pressures from referent groups—such as family members, peers, or government authorities—that influence an individual's decision-making [32]. Prior studies have shown that subjective norms significantly shape pro-environmental behaviors and decisions to adopt sustainable farming practices [34, 43]. Ren et al. [44] further emphasized the influence of community norms in promoting the adoption of circular farming models in developing contexts. This hypothesis addresses a research gap in the literature, as TPB-based studies in Asian agriculture often report inconsistent effects of subjective norms due to individualistic farming cultures and weak cooperative structures—issues that remain underexplored in the Mekong Delta context [44, 45]. By examining SJN, this study investigates how social pressures and normative expectations operate differently in rural Vietnam compared to more collective agricultural systems elsewhere.

H2. *Subjective norms positively influence the intention to participate in CE models.*

2.2.3. Perceived Behavioral Control (PBC)

Perceived behavioral control (PBC) refers to individuals' perception of their ability to perform a specific behavior, shaped by their access to resources, skills, and external support [32]. Prior research has confirmed that PBC significantly influences pro-environmental behaviors and the adoption of innovative agricultural systems [36, 46]. In the context of the CE, a stronger sense of behavioral control enhances farmers' willingness to implement sustainable practices—particularly among small-scale producers.

This hypothesis addresses a research gap in TPB applications that tend to underemphasize perceived control in developing agricultural settings, where resource limitations and restricted access to technology hinder CE adoption [40, 46]. By incorporating PBC into the CE framework, this study explores how farmers' perceived control interacts with local enablers in Hau Giang province.

H3. *Perceived behavioral control positively influences the intention to participate in CE models.*

2.2.4. Perceived Economic Benefits (BOE)

Perceived economic benefits (BOE) represent the extent to which individuals recognize the financial advantages of CE adoption, such as reduced input costs or additional income from by-product utilization. Economic incentives are often primary drivers of sustainable production and consumption behaviors [47]. When CE is perceived as economically viable, farmers are more inclined to adopt related practices. This hypothesis addresses a critical research gap in the CE literature, where economic considerations are often treated as secondary to environmental motives within TPB-based agricultural studies—particularly among low-income smallholders in regions such as Vietnam's Mekong Delta [48]. By incorporating BOE, this study emphasizes how financial perceptions can mediate contextual constraints and strengthen farmers' behavioral intentions toward CE participation.

H4. *Perceived economic benefits positively influence the intention to participate in CE models.*

2.2.5. Environmental Concern (EC)

Environmental concern (EC) denotes the level of awareness, commitment, and responsibility individuals feel toward environmental issues, often reflected in eco-conscious decisions and sustainable behaviors. Syed et al. [49] argue that such behaviors stem not only from knowledge but also from an intrinsic sense of environmental responsibility. For farmers, the willingness to alter cultivation practices for environmental protection signals strong concern. This hypothesis addresses a research gap in TPB extensions that tend to undervalue environmental motivations within agricultural CE studies—particularly in climate-vulnerable regions such as Vietnam's Mekong Delta, where pollution from rice farming is severe but research on environmental concern remains limited [49, 50]. Incorporating EC aligns with recent calls to integrate moral and ecological awareness as holistic drivers of behavioral intention in sustainable agriculture.

H5. *Environmental concern positively influences the intention to participate in CE models.*

2.2.6. Technical and Output Support (TOS)

Technical and output support (TOS) reflects the extent to which farmers perceive assistance from agricultural institutions, local authorities, and market systems during the process of adopting CE practices. Bhujel and Joshi [51] found that external support plays a critical role in enhancing farmers' awareness, trust, and behavioral readiness to adopt innovative models. Similarly, Zhou et al. [52] demonstrated that technical and market services significantly influence the uptake of sustainable agricultural technologies. In this study, TOS is conceptualized as an extension of the TPB framework, addressing structural and informational barriers that are not captured by the original model. It is posited to function as a key external enabling factor that strengthens farmers' behavioral intention (see **Table 1**). This hypothesis directly addresses a major research gap in TPB-based CE studies, where contextual enablers such as institutional and technical support remain underexplored in developing-country smallholder contexts—contributing to low adoption rates [51, 53]. By incorporating TOS, the study provides localized insights for the Vietnamese rice sector.

H6. *Technical and output support positively influence the intention to participate in CE models.*

Table 1. Description of variables in the research model.

Variable	Description	Expectation
ATI	Attitude toward CE models	(+)
SJN	Subjective norms	(+)
PBC	Perceived behavioral control	(+)
BOE	Perceived economic benefits	(+)
EC	Environmental concern	(+)
TOS	Technical and output support	(+)
IP	Intention to participate in CE models (Dependent variable)	N/A (Dependent variable)

Note: (+) indicates a hypothesized positive relationship with the dependent variable. "N/A" denotes that the variable functions as the dependent construct in the research model.

Building on the proposed hypotheses, the research framework integrates the core constructs of the Theory of Planned Behavior (TPB)—attitude (ATI), subjective norms (SJN), and perceived behavioral control (PBC)—with three context-specific factors: perceived economic benefits (BOE), environmental concern (EC), and technical and output support (TOS). The conceptual model, illustrated in **Figure 1**, depicts the hypothesized positive relationships between these six independent variables and farmers' intention to participate in CE models.

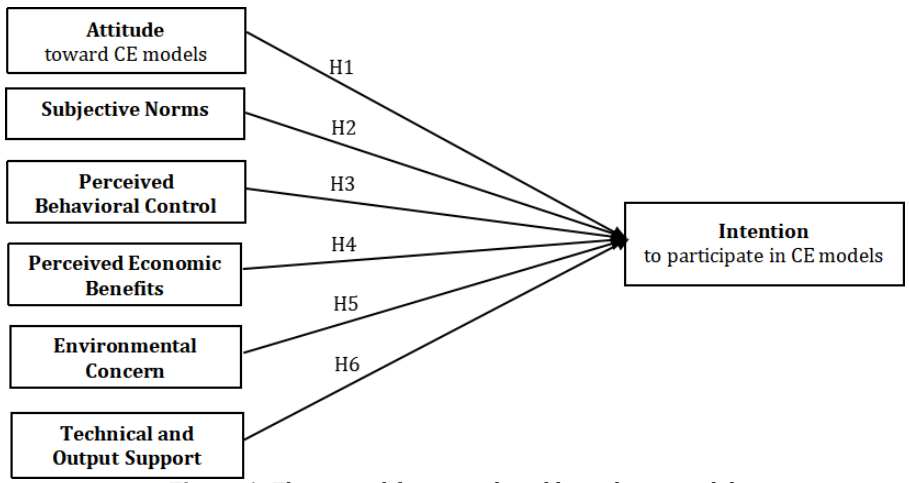

Figure 1. Theoretical framework and hypothesis model.

3. Research Methodology

Data were collected from 160 rice-farming households across three key districts of Hau Giang province: Phung Hiep, Vi Thuy, and Long My. The survey was conducted between February and May 2025.

The sample size was determined using Slovin's formula[54]:

$$n = \frac{\mathrm{N}}{1 + \mathrm{Ne}^2}$$

The total population of rice-farming households in the selected districts was approximated at around 40,000, based on local agricultural statistics and demographic data from the Hau Giang Department of Agriculture and Rural Development[15]. A margin of error of 8% ($e = 0.08$) was adopted, which is acceptable for exploratory surveys in rural contexts with limited resources[55, 56]. Substituting these values yielded a minimum required sample of approximately 156 respondents. Therefore, a total of 160 farmers were surveyed to ensure adequate representation and to account for potential non-responses.

The use of Slovin's formula is justified by its simplicity and practicality for large or partially known populations, providing a balanced trade-off between precision and feasibility in field data collection[54–56].

Following the sample size determination, participants were randomly selected from the study area. This random sampling approach is crucial because it minimizes selection bias, enhances the external validity of the findings, and ensures that the sample is representa-

tive in terms of geography, production scale, and level of exposure to CE practices. Data were collected through face-to-face interviews with 160 rice farmers using a structured questionnaire.

The survey instrument consisted of three main sections: (i) Demographic and household characteristics; (ii) Measurement scales assessing agreement levels regarding factors influencing the intention to participate in CE practices, using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree); (iii) Farming characteristics and the extent of farmers' engagement with CE models at the local level.

All monetary values are reported in Vietnamese Dong (VND). For international comparability, the average exchange rate during the data collection period (January–May 2025) was approximately 1 USD ≈ 24,800 VND [57].

Exploratory Factor Analysis (EFA) was employed as a multivariate statistical technique to identify the underlying structure among a relatively large set of observed variables. The primary objective of EFA is to identify latent constructs based on the intercorrelations among measured items [58]. In this study, Principal Component Analysis (PCA) was performed using SPSS version 24 [59] to extract latent components related to rice-farming behavior from multiple observed indicators. The orthogonal varimax rotation method was applied to obtain distinct and uncorrelated factor structures. The Kaiser criterion (eigenvalues > 1) was used to determine the number of factors to retain. Items with factor loadings below 0.50 were excluded to ensure construct validity.

Cronbach's alpha coefficients were used to assess the internal consistency of the measurement scales. Finally, OLS regression analysis was employed to evaluate the impact of independent variables on farmers' intention to participate in CE models. All statistical analyses were performed using SPSS [59].

4. Results and Discussion

4.1. Results

4.1.1. Household Characteristics

Table 2 presents the demographic and socio-economic characteristics of the surveyed rice-farming households, which reflect the typical diversity of the Mekong Delta region. The average age of household heads was 49.1 years, and the average education level was 6.18 years of formal schooling (out of a 12-year general education system). On average, farmers had 31.9 years of rice farming experience, ranging from 2 to 61 years, indicating a wealth of practical knowledge but generally limited access to formal agricultural training.

The average cultivated land area was 1.45 hectares, which is comparable to the 1.26 hectares reported by Nguyen Lan Duyen and Nguyen Tri Khiem [60]. The average household size was 4.2 persons, slightly higher than the national rural average of 3.6 persons in 2022 [61], suggesting the dominance of smallholder family-based rice production systems in the Mekong Delta.

In terms of income, the largest share of households (32.5%) reported annual earnings between VND 50–100 million, followed by 27.5% earning VND 100–150 million. Meanwhile, 13.1% and 11.9% of households earned VND 150–200 million and above VND 200 million, respectively, while 15% had incomes below VND 50 million. This considerable income disparity underscores structural constraints in production capacity, particularly with respect to access to technology, finance, and innovation. The adoption of CE models, together with technological upgrading, may thus provide an effective pathway to narrowing income inequality among smallholder rice producers.

In terms of income, the largest group of households (32.5%) earned between VND 50–100 million per year, followed by those earning VND 100–150 million (27.5%). Only 13.1% and 11.9% of households earned between VND 150–200 million and over VND 200 million, respectively, while 15% had incomes below VND 50 million. This relatively wide income disparity highlights significant constraints in production capacity, particularly regarding access to technology, finance, and innovation. The adoption of CE models, alongside technological upgrading, may therefore represent a pathway for reducing income inequality among smallholder rice producers.

4.1.2. Reliability and Exploratory Factor Validity

Seven measurement constructs were included in the EFA: perceived economic benefits (BOE), technical

and output support (TOS), environmental concern (EC), attitude toward CE (ATI), subjective norms (SJN), perceived behavioral control (PBC), and intention to participate (IP). Among these, six are independent variables (BOE, TOS, EC, ATT, SJN, and PBC), and one is the dependent variable (IP). The selection of these constructs was theoretically grounded in the TPB (Ajzen [32]), which identifies attitude, subjective norms, and perceived behavioral control as core determinants of behavioral intention. Criteria for selection emphasized alignment with research gaps in sustainable agriculture, where standard TPB often overlooks context-specific factors in developing countries [37, 62]. To strengthen explanatory power within the agricultural CE context, three context-specific constructs—BOE, EC, and TOS—were incorporated, following prior empirical studies that highlighted the dual role of motivational and enabling drivers in shaping sustainable behavior [26, 37, 39, 52]. Collectively, these seven constructs capture both internal psychological drivers and external contextual enablers that jointly shape farmers' behavioral intention to participate in CE models.

Table 2. Characteristics of rice farming households in Hau Giang province.

Characteristics of Household	Unit	Mean	Standard Deviation
Age	Years	49.1	11.96
Education level	Years	6.18	3.47
Rice farming experience	Years	31.9	12.79
Rice cultivation area	Hectares	1.45	0.56
Household size	Persons	4.21	1.38
Annual household income			
Less than 50 million VND	%	15.0	-
50–100 million VND	%	32.5	-
100–150 million VND	%	27.5	-
150–200 million VND	%	13.1	-
More than 200 million VND	%	11.9	-

Reliability and factor-analytic procedures followed established statistical standards. Internal consistency was assessed using Cronbach's alpha with a minimum threshold of 0.70 [63]. Sampling adequacy was confirmed through the Kaiser–Meyer–Olkin (KMO) measure ($\geq$ 0.50), and Bartlett's test of sphericity was significant ($p < 0.05$) [64]. Factors with eigenvalues greater than 1.0 were retained (Kaiser criterion), and items with loadings below 0.50 were excluded to ensure construct validity [58]. A varimax rotation was applied to improve the interpretability of the factor structure. These thresholds align with previous behavioral and managerial studies in developing-country contexts.

Cronbach's alpha values ranged from 0.724 to 0.877, exceeding the minimum reliability threshold (0.70) recommended by Nunnally and Bernstein [63]. All observed variables had corrected item–total correlations above 0.48, indicating satisfactory internal consistency. The data were suitable for factor analysis, with a KMO value of 0.752 (above the 0.50 cutoff) and a significant Bartlett's test ($p = 0.000$). Seven components with eigenvalues ≥ 1 were extracted, explaining a cumulative variance of 69.37%, which exceeds the 50% benchmark suggested by Hair et al. [64], confirming the robustness of the factor structure (see **Table 3**).

Four observed items were excluded from the analysis due to low corrected item–total correlations ($<$ 0.30) and insufficient factor loadings ($<$ 0.50), including: BOE4: "CE helps mitigate economic losses caused by weather, disease, or price volatility"; BOE5: "CE helps reduce the cost of waste and by-product treatment during production"; EC1: "Concern about agricultural waste polluting the environment"; EC4: "Interest in accessing information on environmentally friendly farming practices."

4.1.3. Research Model Testing

Following the assessment of reliability and factor validity, the research model was tested using multiple linear regression based on the OLS method. The regression results, presented in **Table 4**, indicate that the overall model is statistically significant, with an F-value

of 11.982 and a significance level of $p = 0.000$ ($p < 0.05$). This confirms the presence of statistically significant linear relationships between the independent variables and the dependent variable.

The coefficient of determination (R^2) was 0.446, suggesting that the independent variables collectively explain 44.6% of the variance in farmers' behavioral intention to participate in CE models. Although this value reflects a moderate explanatory level, it remains acceptable for behavioral and socio-economic studies, where human decisions are inherently influenced by numerous unobserved psychological and contextual factors [65, 66]. In such research domains, R^2 values in the range of 0.30–0.50 are commonly regarded as indicative of meaningful yet partial explanatory power rather than precise prediction [64, 67]. Therefore, while the obtained R^2 suggests that the model captures relevant behavioral patterns, it also implies that other unmeasured factors—such as institutional, cultural, or psychological influences—may further affect farmers' participation decisions.

All regression coefficients were positive, indicating that the independent variables exerted a favorable influence on farmers' intention to participate in CE models. Multicollinearity diagnostics using the Variance Inflation Factor (VIF) showed that all VIF values were below 2, with the highest being 1.376—well within the acceptable threshold recommended by Hair et al. [64]. In addition, the Glejser test for heteroscedasticity yielded a p-value of 0.353 (> 0.05), indicating the absence of heteroscedasticity in the model. Overall, the fundamental assumptions of linear regression were met, confirming the reliability of the model for hypothesis testing.

Table 3. Results of Cronbach's Alpha and Exploratory Factor Analysis (EFA).

Factor	Item	BOE	TOS	EC	ATI	SJN	IP	PBC
Economic Benefits (BOE)	BOE3	0.888	–	–	–	–	–	–
	BOE2	0.827	–	–	–	–	–	–
	BOE1	0.826	–	–	–	–	–	–
Technical and Output Support (TOS)	TOS2	–	0.765	–	–	–	–	–
	TOS4	–	0.698	–	–	–	–	–
	TOS1	–	0.691	–	–	–	–	–
	TOS3	–	0.600	–	–	–	–	–
Environmental Concern (EC)	EC3	–	–	0.804	–	–	–	–
	EC5	–	–	0.734	–	–	–	–
	EC2	–	–	0.641	–	–	–	–
Attitude (ATI)	ATI1	–	–	–	0.727	–	–	–
	ATI2	–	–	–	0.667	–	–	–
	ATI3	–	–	–	0.580	–	–	–
	ATI4	–	–	–	0.570	–	–	–
Subjective Norms (SJN)	SJN2	–	–	–	–	0.821	–	–
	SJN3	–	–	–	–	0.681	–	–
	SJN1	–	–	–	–	0.672	–	–
Intention to Participate (IP)	IP1	–	–	–	–	–	0.896	–
	IP3	–	–	–	–	–	0.759	–
	IP2	–	–	–	–	–	0.697	–
Perceived Behavioral Control (PBC)	PBC2	–	–	–	–	–	–	0.721
	PBC1	–	–	–	–	–	–	0.715
	PBC3	–	–	–	–	–	–	0.701
Eigenvalue		5.31	2.59	2.07	1.89	1.63	1.47	1.00
Alpha		0.877	0.785	0.791	0.724	0.774	0.851	0.751
Total Variance Explained (%)					69.37			
KMO					0.752			
Bartlett test of sphericity					0.000			

Table 4. OLS Regression Estimation Results.

Independent Variables: Intention to Participate	Unstandardized Coefficient (B)	Standard Error	*p*-Value	Hypothesis Testing
Economic Benefits (BOE)	0.142	0.060	0.020**	Accepted
Technical and Output Support (TOS)	0.342	0.088	0.001***	Accepted
Attitude (ATI)	0.264	0.081	0.001***	Accepted
Environmental Concern (EC)	0.294	0.067	0.001***	Accepted
Perceived Behavioral Control (PBC)	0.188	0.077	0.017**	Accepted
Subjective Norms (SJN)	0.109	0.071	0.127	Not accepted
Control Variables				
Age	−0.000	0.004	0.960	–
Education	−0.012	0.015	0.423	–
Income	0.028	0.040	0.488	–
Rice cultivation area	−0.021	0.091	0.814	–
Constant	−1.192	0.632	0.061	–
R^2		0.446		
Sig.		0.000		
Number of Observations (N)		160		
Max VIF		< 2		
Glejser test (Sig.)		0.353		

Note: *** $p < 0.01 = 1\%$; ** $p < 0.05 = 5\%$; * $p < 0.1 = 10\%$.

4.2. Discussion

The multiple regression analysis revealed that five factors had a statistically significant and positive influence on rice farmers' intention to participate in CE models in Hau Giang province: perceived economic benefits (BOE), technical and output support (TOS), environmental concern (EC), attitude toward CE (ATI), and perceived behavioral control (PBC). Among these, TOS ($\beta = 0.342$), EC ($\beta = 0.294$), and ATI ($\beta = 0.264$) exerted the strongest positive effects. These results align with prior studies underscoring practical assistance, environmental awareness, and positive attitudes toward CE as primary drivers of CE adoption in agricultural contexts [35, 42, 68]. Comparable studies have reported similar standardized effects—for instance, Seerasarn et al. [69] highlighted the importance of technical support in facilitating the transition to organic farming in Thailand, while Priya and Singh [70] found that attitude and environmental awareness were decisive in sustainable practice adoption among Indian farmers. These findings collectively support the theoretical propositions of the Theory of Planned Behavior (TPB), which posits that behavioral intention is jointly shaped by attitudinal and contextual determinants [32].

However, subjective norms (SJN) did not reach statistical significance ($p = 0.127$), diverging from several prior studies [34, 43]. This may reflect the production context in Hau Giang, where individual decision-making and economic self-interest dominate over perceived social expectations. In rural Vietnam, while community norms play a role in social life, they may not necessarily translate into group pressure in decisions related to technical practices or production models. In contrast, in countries like Thailand and Indonesia—where sustainable farming initiatives are often implemented through cooperatives and producer groups—subjective norms are positively influenced by collective structures [45, 71]. The lack of significance for SJN in this study thus reflects both contextual differences and the need to adapt TPB frameworks to account for local institutional structures and the prevalence of the production model in question.

In addition, control variables such as age, education, income, and farm size did not have a statistically significant effect on farmers' intention to adopt CE. This finding reinforces the view that while demographic factors serve as a foundational backdrop, it is the psychological and behavioral constructs—such as attitude, perceived behavioral control, and technical support—that play a more decisive role in driving sustainable behavioral change. This is consistent with the TPB framework [32] and prior research in sustainable consumer behavior [38, 72].

5. Conclusions

Grounded in the Theory of Planned Behavior (TPB), this study identifies the key determinants influencing rice farmers' intention to participate in CE models. Technical and output support, environmental concern, and attitude emerged as the most influential factors, while demographic variables were found to be statistically insignificant. These findings contribute to advancing behavioral theory in the context of agricultural transformation in developing countries.

Theoretically, the study extends the TPB by integrating context-specific variables—particularly technical and output support (TOS)—into the behavioral framework, thereby enriching its explanatory power for sustainability-oriented behaviors in agriculture. This highlights the importance of combining psychological determinants with external enabling factors when modeling pro-environmental intentions in developing-country contexts.

From a practical and managerial perspective, the results suggest that enhancing farmers' access to technical guidance, output markets, and environmental knowledge can strengthen their behavioral readiness to engage in CE practices. Extension officers, agribusiness managers, and local cooperatives should prioritize farmer-centered programs that connect innovation with daily production decisions.

Despite its contributions to both theory and practice, this study has several limitations. First, the data were collected exclusively from Hau Giang province, which may constrain the generalizability of the findings to other regions. Second, the study employed a linear OLS regression model without testing potential mediating or moderating relationships, which could be further explored using structural equation modeling (SEM). Third, the construct of technical and output support (TOS) is context-dependent and should be validated in different agricultural sectors to ensure its robustness and transferability.

From a policy perspective, the results emphasize the need to strengthen training and knowledge-transfer programs related to CE-based rice production. Such programs should focus on practical competencies, including biotechnology applications, by-product recycling, and closed-loop production management. Local governments are encouraged to establish CE training centers in pilot communes and promote experiential learning through demonstration farms and model farmers. In addition to capacity-building, economic and institutional incentives are essential. Green credit programs, subsidized inputs, and contract farming schemes for CE products can reduce market risk and enhance farmers' confidence to adopt CE practices. Policymakers should also foster the development of circular agricultural value chains by linking farmers with processors and distributors to ensure stable markets and equitable benefit-sharing.

Regarding communication, awareness campaigns tailored to rural contexts—via community radio, village meetings, and local organizations—can strengthen environmental consciousness. Although subjective norms (SJN) were not significant in this study, promoting community recognition through CE farmer clubs, local awards, and integration into the "Good Farmer" movement can gradually build collective engagement.

Overall, this study underscores that transitioning toward circular agriculture requires a combination of behavioral incentives and institutional interventions to create a sustainable motivational framework for farmers, who remain central agents in advancing CE participation across Vietnam's rice sector.

Author Contributions

L.T.M.N. and D.D.H. jointly designed and developed the study framework. L.T.M.N. conducted data collection, analysis, and manuscript drafting. D.D.H. supervised the research process, provided critical revisions, and approved the final version. Both authors have read and approved the final version of the manuscript.

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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