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Factors Driving Intention to Adopt Sustainable Farming Practices in India: An Empirical Analysis

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Abstract

Purpose- Despite the benefits of sustainable farming, the uptake of sustainable agricultural methods falls short of the targets set by the 2030 Sustainable Development Goals. This study seeks to examine the determinants influencing farmers' adoption intentions for sustainable farming practices in Rajasthan, India.

Design/methodology/approach- The data was collected from 400 farmers available in 29 villages of Rajasthan India using convenience sampling. Structural equation modelling using SMART PLS4 was applied on data reliability, validity, and testing of hypotheses using measurement model and structural model.

Findings- The analysis revealed that farmers' intentions to embrace sustainable farming are influenced by perceived usefulness, perceived ease of use, personal moral norm, relative advantage, and social influence. However, there was little empirical evidence to support influence of government support and awareness on farmers' intentions to adopt sustainable farming.

Research Implications- The research improves the understanding of the farmer's decisions to adopt sustainable practices by exploring critical influencing factors. It extends the Theory of Planned Behaviour by incorporating additional factors.

Originality- The study contributes to the existing literature on sustainable agriculture by providing original research regarding the intention of farmers to adopt sustainable farming practices in India using survey data. The study focuses on farmer motivation or perception as opposed to previous research which majorly focuses on economic or technological aspects of adopting sustainable farming practices.

Practical Implications- The conclusions drawn from this research provide practical recommendations for those involved in agricultural policy and outreach, while also suggesting future research directions to further elucidate the dynamics of sustainable farming adoption.

Keywords Sustainable farming, Theory of planned behavior, Structural equation model, India

1. Introduction

"Sustainable farming is an integrated system of plant and animal practices with long-term goals of meeting global food demands, improving environmental quality, and preserving natural resources" (Chen et. al., 2024). It also optimizes farm profitability, ultimately enhancing farmers' livelihoods and societal well-being (Visser et. al, 2019; Muhie, 2022). Sustainable farming practices are crucial for boosting productivity, ensuring food security and driving economic growth, while also protecting natural resources through improved soil fertility, efficient water use, reduced erosion, and preserving biodiversity (Mbow et al., 2014; Teklewold et al., 2019; Reimer et al., 2012).

Sustainable agricultural practices focus on minimizing environmental impact by reducing harmful chemicals and utilizing local resources, all while ensuring economic sustainability and competitiveness (Laurett et al., 2021; Wezel et al., 2014). Globally, successful agricultural transformation is largely attributed to advancements in farm technologies, including precision water management, enhanced soil health, high-yielding seed varieties, and optimized fertilizer use (Adnan et. al, 2017, Bhujel & Joshi, 2023). Driven by the imperative of sustainable development, regions worldwide are transitioning their agricultural practices to align with sustainability objectives, ensuring a more environmentally conscious and resilient food system (Durán Gabela et al., 2022).

Research shows that integrated pest management (IPM), intercropping, and precision farming are effective and successful strategies for promoting sustainable agriculture (Angon et. al, 2023; Gawande et. al, 2023; Sharma et. al, 2024). The adoption of advanced technologies and sustainable practices like agroforestry, composting, crop rotation, and water harvesting have boosted agricultural productivity, reducing food insecurity and poverty in several countries (FAO, 2014; Kelsey, 2013; Sharma et. al, 2022).

Despite its proven benefits in climate change adaptation, the acceptance of sustainable farming practices stays surprisingly low (Zeweld et. al, 2017). The barriers to adopting sustainable agriculture practices are multifaceted, spanning from individual farmer perceptions to broader institutional and systemic support gaps (Bravo-Monroy et al., 2016). Research has identified various demographic and socio-economic factors as potential contributors to the limited acceptance of sustainable farming practices (Asfaw et. al, 2019; Abebe et. al, 2013). Despite numerous studies, the factors behind low adoption rates of sustainable agricultural practices remain unclear (Ehiakpor, 2021; Pham et al., 2021). Further in-depth research is necessary to explore the inspirations and barriers to voluntary adoption, and to identify effective strategies for promoting uptake of improved technologies and practices.

Existing research has largely explored how demographic characteristics and economic capacity effect the acceptance of sustainable farming practices. Research presents divergent perspectives regarding how farmer age influences technological adoption rates. Some studies indicate that older farmers' accumulated experience aids in information processing, while others suggest that younger, better-educated farmers are more likely to embrace new technologies (Begho et al., 2022; Olum et al., 2020; Peterman et al., 2014). Further, research indicates farm size positively influences technology adoption rates, suggesting that larger farms are more likely to adopt new practices due to their ability to absorb costs, manage labor, and allocate time more efficiently (Ren et al., 2019). Such studies have primarily investigated actual acceptance behaviors, overlooking the intentions and motivations that precede the acceptance of Sustainable Agricultural Practices.

This study seeks to bridge the knowledge gap by exploring the key factors influencing farmers' intentions to adopt sustainable agriculture. Ultimately, this research aims to augment the current knowledge base with localized perspectives, advancing a more nuanced understanding of sustainable agricultural adoption.

This study leverages the Theory of Planned Behavior (TPB) framework, which posits that intentions drive behavior (Ajzen, 1991). This research advances the Theory of Planned Behavior (TPB) by incorporating two novel constructs—environmental consciousness and government support—as significant determinants of behavioral intention. Specifically, environmental consciousness captures awareness and concern for environmental issues, while government support encompasses the impact of various incentives, policies, and programs implemented by governments to encourage farmers to adopt these practices. The inclusion of these key variables enables a holistic examination of the determinants shaping farmers' willingness to implement sustainable farming practices. (Ajzen, 2020; Bosnjak et al., 2020).
This study makes an important contribution by investigating sustainable farming intentions in Rajasthan, where previous studies have largely overlooked this critical issue. This study explores the complexities of farmers' decision-making in a unique regional context like Rajasthan, can yield valuable findings. With the rising global emphasis on sustainable farming, understanding the local context and motivations that influence farmers' adoption decisions is vital.

2. Literature Review

2.1 Need for sustainable farming:

In recent years, sustainable agriculture has become a major focus as growing worries about climate change, deteriorating soil quality, contaminated water, and declining biodiversity have come to the forefront (Laurett et al., 2021). It has been observed that intensive farming practices deplete soil fertility, water resources, and fossil fuels (Bhujel & Joshi, 2023; Wang & Azam, 2024). The reckless and excessive application of chemicals has resulted in detrimental consequences for the environment and human well-being. (Dijoo & Khurshid, 2022; Dos Reis et al., 2023; Saroop & Tamchos, 2024). Research has consistently shown that embracing sustainable agricultural methods can effectively lessen the harmful environmental consequences of farming (Allahyari, 2009; Singh & Singh, 2017; Xia et al., 2017). It has been observed that sustainable agriculture provides a holistic solution to food security, boosting agricultural efficiency while concurrently addressing environmental concerns through sustainable soil management, erosion prevention, and minimized chemical application (Preusse et al., 2024; Tang et al., 2022; Teklewold et al., 2013).

2.2 Conceptual Framework

The Theory of Planned Behavior (TPB) introduced by Ajzen (1985) offers a robust theoretical framework for understanding the intention to adopt sustainable agricultural practices. TPB suggests that intention drives behavior and is shaped by three main factors: Attitude - personal opinions about the behavior; Subjective norms - social expectations and pressures; Perceived behavioral control - one's self-assessment of their capability to execute a specific action (Ajzen, 1991, 2011).

Attitudes refer to the emotions people have when assessing the outcome of a task. Research shows that farmers with positive attitudes toward addressing climate change will be more likely to take action (Ataei et al., 2021; Elahi et al., 2022). Social norms and expectations play a key role in driving farmers' willingness to adopt sustainable agricultural practices (Park & Ha, 2012). Previous studies have found that social influences encourage farmers to adopt environmentally friendly practices (Adnan et al., 2019; Hou and Hou, 2019). Perceived behavioral control refers to one's self-assessment of their capability to execute a specific action. Research has identified this concept as a key predictor of sustainable agricultural practices which contributes to environmentally friendly farming (Ren and Zhong, 2022). The adoption of sustainable agriculture practices is influenced by a complex array of factors, including socio-economic conditions, agro-ecological context, institutional support, access to information, psychological elements (habits and intentions), and perceived attributes of the practices themselves (Tey et al., 2014). For this study, TPB has been developed further to develop our conceptual framework (Figure. 1).

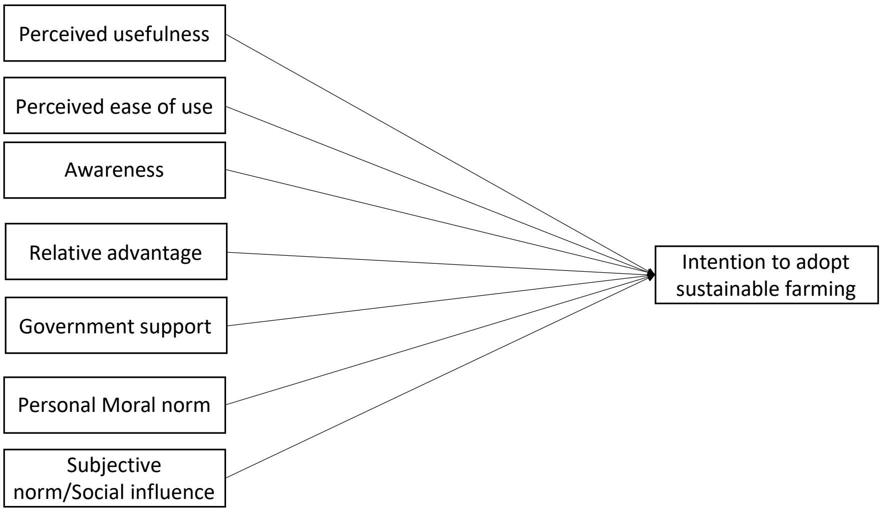

Figure I: *Conceptual Model*

Key Factors Influencing Adoption of Sustainable farming:

Literature depicts that various factors influence the acceptance of sustainable farming practices as discussed below:

- *Perceived usefulness:* This refers to the farmers' confidence in sustainable practices leading to better crop yields and other benefits (Adnan et al., 2017; Muhamadi & Boz, 2022; Wauters & Mathijs, 2014; Zeweld et al., 2017). Studies show that Perceived usefulness positively correlates with the acceptance of sustainable farming practices (Kassie et al., 2015). Hence, we hypothesize that

H1: There is a positive relationship between perceived usefulness and intention to adopt sustainable farming practices.

- *Perceived ease of use:* It is a key construct of the Technology Acceptance Model (TAM), significantly impacts adoption decision. Farmers may find sustainable farming practices too difficult to understand or implement (Kassie et al., 2015). The likelihood of farmers accepting sustainable practices increases when these practices are perceived as simple, practical, and compatible with their existing farming practices (Chiew and Shimada, 2013). Farmers who receive information and training on sustainable practices tend to have higher adoption rates of environmentally friendly farming techniques (Imani et al., 2021, Piñeiro et al., 2020). Thus, we hypothesize that

H2: There is a positive relationship between ease of use and adoption of sustainable farming practices

- *Environmental awareness*: Studies demonstrate that farmers' environmental awareness significantly enhances their adoption of sustainable agricultural practices (Dong et al., 2023; Qiao et al., 2022). Empirical evidence suggests that favorable perceptions of conservation methods—especially regarding profitability and soil improvement—positively influence adoption rates (Liang et al., 2023). Furthermore, robust evidence confirms that environmental consciousness strongly predicts farmers' willingness to implement sustainable techniques (Bhujel & Joshi, 2023; Pestisha & Bai, 2023). Thus, we hypothesize that

H3: There is a positive relationship between environmental awareness and intention to adopt sustainable farming practices

- *Relative Advantage*: Relative advantage of sustainable farming refers to the perceived benefits of sustainable farming practices to conventional farming methods. It has been observed that the decision to adopt a technology is driven by its potential to increase farmers' income and reduce costs (Peshin, 2013; Peshin et al., 2019). Thus, We hypothesize that

H4: There is a positive relationship between relative advantage and intention to adopt sustainable farming practices

- *Government policies and incentives*: Farmers' ability to accept sustainable practices is influenced by their access to essential resources, supportive policies and economic incentives that benefit farmers (Baydur et al., 2023; Savari & Gharechaee, 2020). Research from various countries highlights the critical role of institutional factors in promoting sustainable agriculture, including cooperatives, farmer groups, workshops, loans, financial assistance, and access to credit (Karami and Moghaddam, 2005; Ntshangase et al., 2018). Research findings suggest that well-coordinated institutional support, encompassing social welfare programs, stakeholder engagement, and policy implementation, is essential for promoting sustainable farming practices (Priyadarshini and Abhilash, 2020; Rakesh et al., 2022; Srivastava et al., 2016). Thus, We hypothesize that

H5: There is a positive relationship between government policies & incentives and intention to adopt sustainable farming practices

- *Personal norms/values:* Personal norms/values refer to an individual's moral obligations and self-standards, rooted in their values and self-concept, driving intrinsic motivation to perform specific behaviors (Fang et al., 2018). Individuals are likely to engage in environmentally friendly behaviors when their personal norms are triggered (Vaske et al., 2020; Yuan et al., 2022). Thus, we hypothesize that

H6: There is a positive relationship between personal norms and intention to adopt sustainable farming practices

- *Subjective norms*: The adoption of sustainable agricultural methods by farmers is significantly influenced by social factors, encompassing perspectives from community members, authority figures, and technical experts. Farmers' choices to implement sustainable practices are often shaped by societal pressures, including the opinions of family members, peers, local leaders, and agricultural specialists (Bagheri et al., 2021). Studies indicate that encouragement and approval from social circles are key factors in motivating farmers to embrace eco-friendly agricultural techniques (Chaudhuri et al., 2021; Faisal et al., 2020). Thus, we hypothesize that

H7: There is a positive relationship between subjective norms and intention to adopt sustainable farming practices

3. Research Methodology

3.1 Study Area and Sampling Procedure

This research was conducted in the Bhilwara and Ajmer districts of Rajasthan, India, a region known for its susceptibility to drought. A significant portion of the local population faces food insecurity, and migration among youth in search of employment and better opportunities is prevalent. In response to these challenges, various community-based development initiatives have been introduced, encouraging farmers to adopt sustainable agricultural practices aimed at enhancing productivity and mitigating food insecurity. These factors make Bhilwara and Ajmer an ideal location for studying the adoption of sustainable farming techniques.
The study employed a multi-village sampling approach across 29 villages, selecting 400 participants through proportional allocation. Farmers within each village were recruited using convenience sampling techniques for data collection.

3.2 Measures and Questionnaire Development

This study incorporated eight key factors, and 34 corresponding questions (excluding demographic information) based on existing research.

- *Perceived usefulness and ease of use:* Measured using the scale developed by Davis (1989).
- *Awareness*: Assessed using the scale created by Taylor and Todd (1995).
- *Related advantage*: Measured using the scale adapted from Rogers, E. M. (2003)
- *Government support:* Measured using the scale adapted from Wu and Wang (2005).
- *Personal moral norms:* Measured using the scale adapted from Schwartz (1977).
- *Social influence*: Measured using the scale adapted from Venkatesh et al. (2003).
- *Intention to adopt sustainable farming:* Measured using a four-item scale based on Ajzen (1991).

The items of each construct were modified in agricultural context. Participants evaluated each statement using a 5-point Likert scale anchored between 1 ("strongly disagree") and 5 ("strongly agree").

3.2 Data Collection

The data collection process commenced with pilot testing of questionnaire to ensure its relevance, clarity, and overall suitability. Feedback obtained from the pilot study was used to refine and finalize the questionnaire. The questionnaire was structured in two sections: Section I captured demographic information of the respondents, while Section II assessed their perceptions related to the constructs of the proposed study model. The survey for the study was conducted by the authors in August and September of 2024. Data were collected using a structured survey method from a sample of 400 farmers across 29 villages in Rajasthan, India, employing a convenience sampling technique.

3.3 Analytical Approach

The study utilized Structural Equation Modeling (SEM) to examine causal relationships. A variance-based SEM approach (Partial Least Squares) was selected using SmartPLS 4 software. The analysis employed a sequential two-phase approach, beginning with assessment of the measurement model for reliability and validity followed by evaluation of the structural relationships. Bootstrapping was applied to test path coefficients and factor loadings (Hair et al., 2011).

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4. Result

The data analysis process was divided into two main phases. We constructed and evaluated the measurement model in the first phase. The reliability and convergent validity were assessed using a range of measures, such as the Cronbach Alpha value, Composite reliability, and Average variance explained (AVE). The "Heterotrait-Monotrait Ratio (HTMT)" measure and the Fornell-Larcker criterion were used to assess discriminant validity. Path analysis was used in the second step to test the hypotheses and assess the study model (Ray and Sahney, 2018).

4.1 Analysis of measurement model

Table I. Measurement Model Analysis Results

Latent constructs	Items	FL	CA	CR	AVE
awareness	awar1	0.857	0.848	0.849	0.768
	awar2	0.901			
	awar3	0.870			
government support	gs1	0.803	0.866	0.902	0.709
	gs2	0.797			
	gs3	0.885			
	gs4	0.880			
intention to adopt sustainable farming	iasf1	0.829	0.898	0.902	0.765
	iasf2	0.874			
	iasf3	0.900			
	iasf4	0.895			
perceived ease of use	peou1	0.888	0.863	0.863	0.785
	peou2	0.899			
	peou3	0.870			
perceived usefulness	pu1	0.907	0.908	0.910	0.784
	pu2	0.891			
	pu3	0.902			
	pu4	0.841			
personal moral norm	pmn1	0.861	0.842	0.848	0.760
	pmn2	0.890			
	pmn3	0.863			
relative advantage	ra1	0.854	0.799	0.812	0.712
	ra2	0.809			
	ra3	0.867			
social influence	si1	0.898	0.798	0.865	0.707
	si2	0.891			
	si3	0.722			

Table I presents the factor loadings, composite reliability indices, internal consistency measures (Cronbach's α), and average variance extracted values.

Internal consistency reliability

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"Composite reliability" was used as the metric for assessing internal consistency (F. Hair Jr et al., 2014; Ray and Sahney, 2018). The composite reliability values for each construct in the final model were higher than the recommended threshold level of 0.70, indicating a high degree of internal consistency reliability among all the reflective latent variables (see Table I). The measurement model's internal consistency was also confirmed using Cronbach's alpha (better than 0.70).

Convergent validity

Convergent validity was assessed at the construct level using Average Variance Extracted (AVE). Table I shows that, in accordance with the recommendations of (F. Hair Jr et al., 2014; Ray & Sahney, 2018), the AVE for each latent construct is more than the recommended cut-off of 0.50. This is why convergent validity is so validated.

Discriminant validity

Table II. Fornell-Larcker criterion: Results of Discriminant Validity

Latent Variables	awareness	government support	intention to adopt sustainable farming	perceived ease of use	perceived usefulness	personal moral norm	relative advantage	socia influ
awareness	0.876							
government support	0.254	0.842						
intention to adopt sustainable farming	0.493	0.196	0.875					
perceived ease of use	0.529	0.171	0.492	0.886				
perceived usefulness	0.560	0.198	0.532	0.560	0.886			
personal moral norm	0.474	0.246	0.585	0.385	0.489	0.872		
relative advantage	0.529	0.181	0.561	0.558	0.578	0.483	0.844	
social influence	0.369	0.427	0.467	0.399	0.361	0.412	0.417	0.84

The discriminant validity of the constructs was evaluated using the Fornell–Larcker criterion, which is frequently thought of as the most cautious assessment technique (F. Hair Jr et al., 2014). According to the recommendations of Fornell and Larcker (1981), each construct's square root of average variance extracted (AVE) is greater than its correlation with other constructs, as indicated in Table II. As a result, the study has effectively shown the discriminant validity of the constructs.

Table III. Heterotrait-monotrait ratio (HTMT): Results of Discriminant Validity

Latent Variables	awareness	government support	intention to adopt sustainable	perceived ease of use	perceived usefulness	personal moral norm	relative advantage	social influence

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			farming					
awareness								
government support	0.299							
intention to adopt sustainable farming	0.564	0.214						
perceived ease of use	0.619	0.209	0.555					
perceived usefulness	0.640	0.222	0.586	0.633				
personal moral norm	0.560	0.268	0.669	0.447	0.560			
relative advantage	0.638	0.225	0.654	0.671	0.669	0.579		
social influence	0.442	0.557	0.522	0.461	0.406	0.473	0.498	

Table III uses the 'Heterotrait-Monotrait Ratio (HTMT)' tool to evaluate discriminant validity. After analysis, it was discovered that all of the final model's constructs had HTMT values below the suggested cutoff of 0.90. As a result, the study shows that the constructs have excellent discriminant validity.

4.2 Analysis of structural model and testing of hypotheses

Table IV. Results of structural model analysis

Hypotheses	Paths	Beta	T statistics	P values	Results
H1	awareness -> intention to adopt sustainable farming	0.078	1.564	0.118	Insignificant
H2	government support -> intention to adopt sustainable farming	-0.046	1.382	0.167	Insignificant
H3	perceived ease of use -> intention to adopt sustainable farming	0.103	2.062	0.039	Significant
H4	perceived usefulness -> intention to adopt sustainable farming	0.127	2.246	0.025	Significant
H5	personal moral norm -> intention to adopt sustainable farming	0.299	5.982	0.000	Significant

H6	relative advantage -> intention to adopt sustainable farming	0.182	2.847	0.005	Significant
H7	social influence -> intention to adopt sustainable farming	0.172	3.374	0.001	Significant

As seen in Table IV, every hypothesis that was modeled was put to the test. The results showed empirical support for five of the seven hypotheses (H3, H4, H5, H6, and H7).
The findings demonstrate that adoption intentions are strongly predicted by five key factors: perceived usefulness, perceived ease of use, personal moral norm, relative advantage, and social influence. Conversely, governmental support and environmental awareness showed negligible predictive power in the analysis.

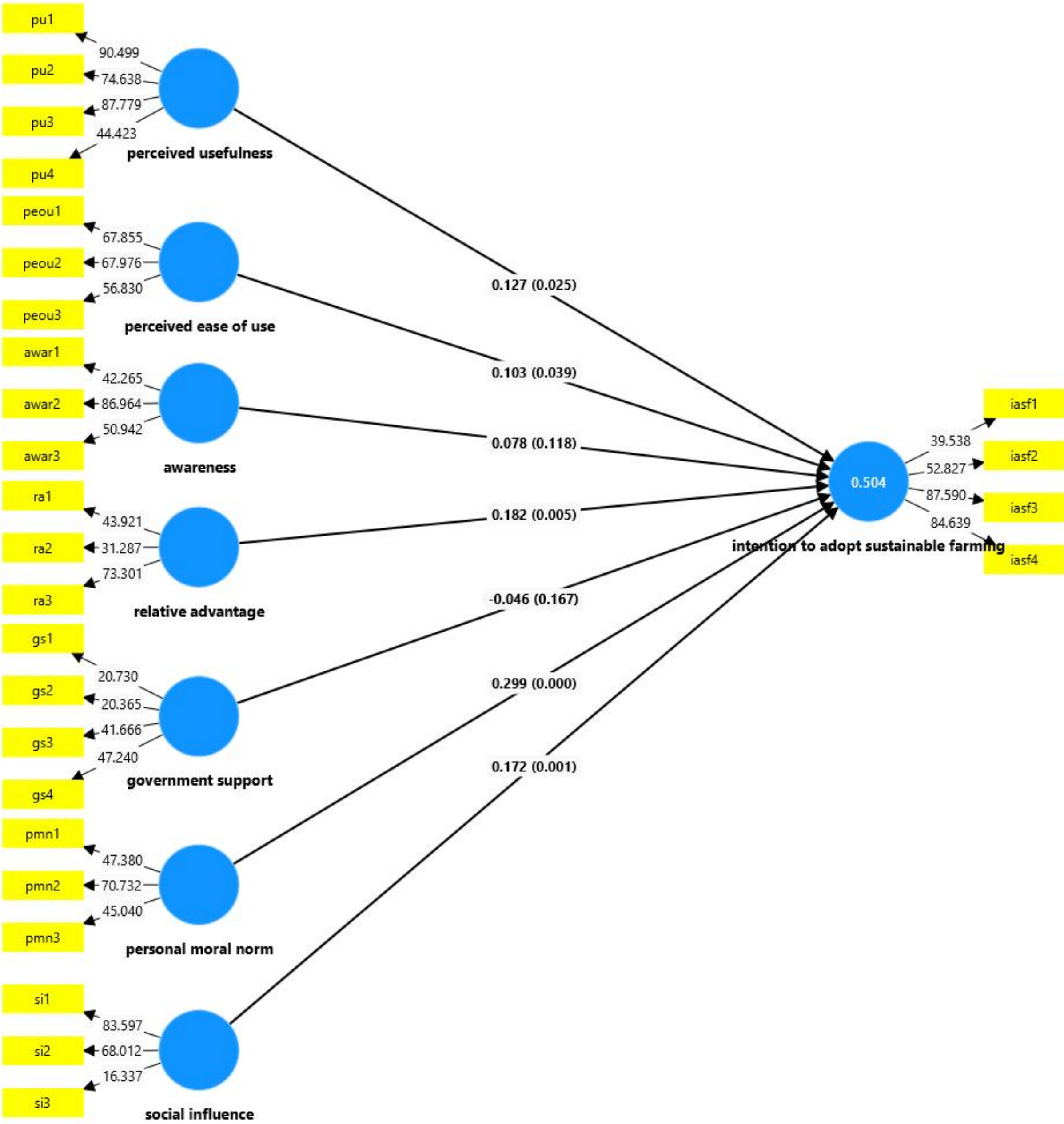

Figure II: SEM diagram

5. Discussion

This study investigates the factors influencing farmers' intentions to adopt sustainable farming practices by employing a structural equation model. The results, as presented in Table IV, include path coefficients and their statistical significance. As illustrated in the conceptual framework (Fig. 1), the intention to adopt sustainable farming is influenced by several variables, including perceived usefulness, perceived ease of use, awareness, relative advantage, government support, personal moral norms, and social influence. Collectively, these factors account for approximately 50.4% of the variance in farmers' intentions to adopt sustainable practices.

Among these determinants, perceived ease of use emerges as a significant positive predictor, with a standardized coefficient of 0.103. This indicates that farmers perceive sustainable farming practices as straightforward to comprehend, learn, and implement. Similarly, perceived usefulness, personal moral norms, relative advantage, and social influence also positively and significantly enhance farmers' intentions to adopt sustainable practices, with standardized coefficients of 0.127, 0.299, 0.182, and 0.172, respectively.
However, awareness and government support did not achieve statistical significance in this study.

6. Theoretical and Practical Implications of the study

Theoretical Contributions

This research advances the understanding of farmers' decision-making processes regarding the adoption of sustainable practices by examining a comprehensive set of influencing factors. It extends established theoretical frameworks, such as the Theory of Planned Behavior (TPB), by incorporating additional dimensions like personal norms, social influence, and perceived benefits.

1. **Integration of Ethical Considerations** By introducing personal moral norms as a key factor, this study emphasizes the ethical dimensions of agricultural decision-making. It highlights the importance of aligning farming practices with farmers' intrinsic values and moral principles, moving beyond purely utilitarian considerations.
2. **Validation of Established Factors** The study reaffirms the relevance of perceived usefulness, ease of use, and social influence in predicting behavioral intentions, thereby strengthening existing literature on sustainable agriculture adoption.
3. **Reassessment of External Interventions**

Contrary to expectations, awareness campaigns and government support did not significantly influence farmers' intentions. This challenges conventional assumptions about the effectiveness of external interventions and calls for a re-evaluation of their design and implementation, particularly in specific regional or cultural contexts.

Practical Implications

The findings of this study offer actionable insights for policymakers, agricultural extension services, and other stakeholders aiming to promote sustainable farming practices.

1. **Highlighting Practical Benefits and Ease of Use** Efforts to encourage adoption should focus on demonstrating the tangible advantages of sustainable farming, such as increased yields, profitability, and product quality. Training programs should emphasize the simplicity and practicality of these methods to reduce perceived barriers to adoption.

2. **Leveraging Community Influence** Community-based strategies, such as farmer cooperatives and peer networks, can be highly effective in promoting sustainable practices. Sharing success stories and experiences from early adopters can inspire broader acceptance within farming communities.
3. **Appealing to Ethical Values** Campaigns should resonate with farmers' intrinsic motivations by framing sustainable farming as a moral and environmental responsibility. Messaging should emphasize stewardship and the long-term benefits of sustainable practices for future generations.
4. **Refining Policy and Awareness Strategies** The limited impact of current government support and awareness campaigns suggests the need for more targeted and context-specific approaches. Policymakers should design programs that address local challenges and provide tangible incentives, such as subsidies, technical assistance, or improved market access. Awareness efforts should move beyond generic information to offer practical, localized solutions that address farmers' specific needs and concerns.

7. Limitations of the study and scope for future research

The study has some limitations which can be explored in future research on the topic. First, results are derived based on the survey conducted in the few villages of two districts of Rajasthan, India, and hence, may not be extended to the whole country. Further multi-region studies are needed to verify whether the identified adoption drivers remain consistent across India's varied agricultural landscapes. Second, results of the study could also be influenced due to the personal biases of the respondents. Future research on the topic may include mixed-method approaches with observational data to reduce such biases and enhance the robustness of findings.

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