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Analysis of the relationship between the attitude of farmers of the Irrigated Northwestern plain Zone of Rajasthan towards Circular Agriculture System and their willingness to adopt the practice

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ABSTRACT

The increasing ill effects of deep rooted and widely spread injudicious agricultural practices in the Irrigated Northwestern plain zone of Rajasthan have caused severe soil & environmental degradation and biodiversity loss in the region. Hence, the need to induct regenerative farming practices in the agricultural system of the region has become crucial. Circular Agriculture system (CAS) focuses on regenerating soils and reducing environmental degradation by minimizing the use of external inputs in farming techniques. The inclusion of CAS in the farming practices of the region can be a solution to the problems created by the input intensive, industrial agriculture. Attitude plays a crucial role in the adoption of new farming methods. Understanding how farmers perceive circular agriculture system is essential for designing effective interventions. This study aims to assess the farmers' attitude toward CAS and to examine the relationship between their perception and willingness to adopt circular agriculture practices.

A sample of 165 farmers from the districts of Sri Ganganagar, Hanumangarh and Anupgarh was selected through simple random sampling. The data were gathered via questionnaire based on an attitude scale developed by *Dr. Vinaya Kumar Hebsale Mallappa et al. (2022).* Descriptive statistics, regression modelling, and hypothesis testing were employed to analyze the relationship between farmers' attitudes and their adoption behaviors**.**

The results indicate that **66.7%** of farmers exhibit a favorable attitude toward CAS, acknowledging its ability to provide sustainable yields, mitigate crop failure risks, and combat soil and environmental degradation. Additionally, farmers recognized the approach's positive contribution in improving economic benefit by reducing reliance on external inputs and improving soil fertility eventually leading to increased production. However, barriers such as the need for learning new management skills, gaining training & technical expertise and inadequate financial support were highlighted. Farmers also expressed a need for robust marketing, infrastructural and supply chain support to facilitate effective adoption of circular agriculture practices.

The hypothesis testing and regression analysis confirmed a significant relationship between farmers' attitudes and their decision of adopting circular agriculture practices. The study rejects the null hypothesis, indicating that positive attitudes toward circular agriculture are associated with higher adoption rates. The study highlights that with appropriate interventions—such as generating awareness, imparting education & training, conducting capacity-building programs, creating marketing channels, enabling easy access of input resources, improving infrastructural and supply chain facilities—the adoption rate of CAS can be significantly accelerated and agricultural productivity and sustainability can be substantially improved. The findings can provide crucial insights for policymakers and agricultural practitioners to develop strategies that can promote the adoption of circular farming practices.

Key Words: *Agriculture, Circular agriculture, farmers, Crops, Soil, Rajasthan, Degradation.*

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1. INTRODUCTION:

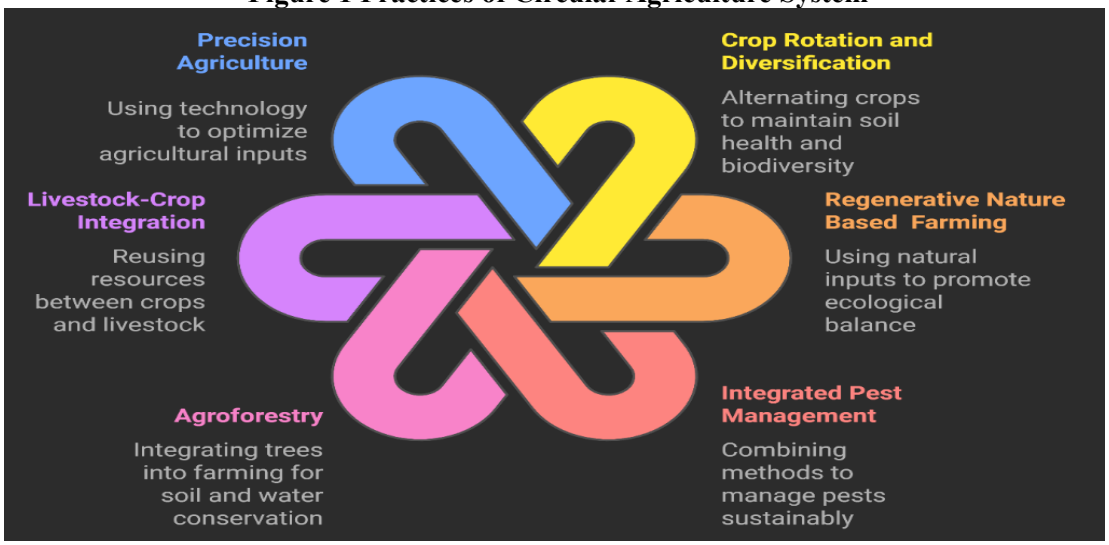
1.1 OVERVIEW OF CIRCULAR AGRICULTURE SYSTEM

Circular agricultural practices emphasize on resource efficiency, waste minimization, and ecosystem balance, aiming to create a regenerative agricultural system that benefits both farmers and the environment. Circular agriculture system incorporates principles such as crop diversification, organic inputs, integrated pest management, and waste recycling to sustain productivity while preserving natural resources (*Oluwasusi, 2014*).

Circular agricultural practices trace their roots to traditional farming systems that thrived on resource reuse and ecological balance. Early agricultural societies adopted techniques such as crop rotation, intercropping, and natural fertilization; their farming practices mirrored the natural cycles of ecosystems, where waste from one process became input for another.

Over the centuries, agriculture has evolved significantly; subsistence farming has changed into industrialized agriculture which is driven by technological advancements and market demands. During the Green Revolution in the mid-20th century, the need of the hour was to increase crop productivity so that the combat the perils of hunger and starvation could be avoided. Hence, injudicious use of chemical fertilizers, pesticides, and machinery became the norm and eventually these (mal)practices became the conventional way of farming. While this led to significant yield improvements, it also resulted in severe soil degradation, water pollution, biodiversity loss, and climate change. These negative implications pressed the need for a return to the holistic and sustainable agricultural practices of the past. In the late 20th century, Circular Agriculture System has emerged as a model that integrates modern technology with traditional ecological knowledge. Inspired by the principles of circular economy, CAS emphasizes on the efficient use of resources, minimization of waste, and the creation of closed-loop regenerative systems that restore and enhance soil health, biodiversity, and ecological balance. By integrating traditional wisdom with modern innovations, circular agriculture practices represent a paradigm shift in farming and offer a pathway to resilient and regenerative food systems. The induction of these practices in the conventional agriculture system is not only crucial for environmental conservation but also for ensuring economic viability and social well-being of the local farming communities. As the world grapples with the dual challenges of ensuring food security and preserving environment sustainability, circular agriculture system can be a remedy that can benefit economic growth as well as conserve and enhance the natural resources.

Figure 1 Practices of Circular Agriculture System



Source: *Researcher's Interpretation based on secondary data*

Figure 2: Advantages of Circular Agricultural Practices

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Source: *Researcher's Interpretation based on secondary data*

1.2 IMPORTANCE OF RESEARCH AREA:

Agriculture in the Northwestern Plain Zone of Rajasthan plays a crucial role in ensuring food security, economic stability, and environmental sustainability. Over time, the pressures of globalization and market-driven dynamics have transformed traditional farming into a more commercial enterprise, prioritizing profit over subsistence (*Bareja, 2014*). While conventional, chemical-intensive farming methods have contributed significantly to higher yields, they have also led to severe environmental degradation, diminishing soil health, biodiversity, and water resources (*Gomiero, Pimentel, & Paoletti, 2011*).

The Irrigated Northwestern Plain Zone of Rajasthan was selected as the research area due to its unique agricultural landscape and significant role in the region's economy and its strive for the evolution of contemporary agricultural practices. This area, encompassing districts of *Sri Ganganagar, Hanumangarh, and Anupgarh*, is known for its extensive irrigation networks, primarily derived from canal irrigation systems. This irrigation support has made it one of the most productive regions in Rajasthan, particularly for crops like wheat, cotton, and mustard. However, despite the abundance of water resources, the region faces challenges related to soil degradation, water scarcity, and the over-reliance on chemical inputs. These issues stress on the need for including sustainable farming techniques, such as circular farming practices in the functioning methodology of every farm to mitigate environmental loss while maintaining agricultural benefit.

Furthermore, the agriculture in the region is undergoing a paradigm shift caused due to changing climatic conditions and consumer behavior (inclined towards natural produce). Responding to the change, the farmers of the region are trying to seek a balance between ecological sustainability and economic viability. This context makes the Irrigated Northwestern Plain Zone an ideal setting for examining the prolific potential of circular agricultural practices in the region.

2. REVIEW OF LITERATURE

Farmer Attitudes toward Circular Agriculture: A recent study by Rathi et al. (2022) examined the attitudes of farmers in Rajasthan towards circular agriculture. They found that a significant proportion of farmers were open to adopting circular farming methods, especially those related to water conservation and organic farming, but were constrained by access to knowledge, training, and market support. The study suggests that farmer education and extension services are critical for fostering adoption.

Circular Agriculture and Sustainability: In a study by Singh and Kumar (2021), the authors emphasize the role of circular agriculture in promoting environmental sustainability through resource-efficient farming practices. The authors argue that circular agriculture is pivotal in reducing dependency on external inputs and minimizing waste, thus contributing

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to long-term ecological resilience. Their findings show that the adoption of circular agriculture can effectively improve soil health and reduce carbon footprints in agricultural systems.

Impact of Circular Agriculture on Soil Health: In 2020, Verma et al. explored the impact of circular agricultural practices on soil health in the Indian context. The study revealed that circular agriculture methods such as crop rotation, use of organic fertilizers, and mulching significantly enhance soil fertility and water retention capacity. These practices, according to the study, reduce soil erosion and improve the soil structure over time, leading to more sustainable and financially viable agricultural practices.

Circular Agriculture and Water Conservation: A 2022 study by Mehra and Yadav focused on the role of circular agriculture in water conservation in arid regions like Rajasthan. Their findings revealed that circular agriculture methods, particularly rainwater harvesting and the use of organic mulching, significantly improved water retention and reduced water usage in crops. These methods, according to the study, could be crucial for ensuring sustainable agricultural practices in water-scarce areas.

Circular Agriculture and Resource Efficiency: A study by Sharma and Mehta (2021) investigated how circular agriculture increases resource efficiency in farming. They found that circular practices such as nutrient cycling and efficient water usage not only reduce costs for farmers but also help in maintaining the ecological balance. The research underscores the importance of integrating traditional farming knowledge with modern circular practices for optimal resource use.

Circular Agriculture and Climate Change Mitigation: According to the study by Singh and Choudhary (2021), circular agriculture plays a crucial role in mitigating the effects of climate change. The authors argue that practices like agroforestry, composting, and water-efficient farming reduce greenhouse gas emissions and enhance the resilience of farming systems to climate variability. Their study underscores the potential of circular agriculture to address climate change at the local level.

Role of Technology in Circular Agriculture: In their 2022 paper, Gupta and Singh highlighted the role of technology in facilitating the transition to circular agriculture. They noted that technologies such as precision farming, soil sensors, and automated irrigation systems could significantly improve the effectiveness of circular agricultural practices. These technologies help farmers optimize resource use, reduce waste, and increase crop yields, contributing to more sustainable agricultural systems.

Economic Benefits of Circular Agriculture: Research by Kapoor et al. (2023) analyzed the economic impacts of circular agriculture on smallholder farmers in India. The study found that while the initial adoption costs were high, circular agriculture practices led to higher productivity and cost savings in the long term., Farmers who adopted these practices reported increased profitability and improved market relations over time.

Challenges in the Adoption of Circular Agriculture: In 2020, Patel and Das conducted a study examining the barriers to the widespread adoption of circular agriculture among farmers. The authors identified key challenges, including limited access to resources, lack of awareness, and inadequate policy support. They also highlighted the need for policy frameworks that support circular practices through subsidies, incentives, and infrastructure development.

Circular Economy and Agricultural Policy: In their study, Kumar et al. (2023) analyzed the intersection of agricultural policy and circular economy principles. They found that national and state-level agricultural policies are increasingly recognizing the importance of circular agriculture for sustainability. However, the lack of integration between agricultural and environmental policies remains a significant challenge for implementing circular agriculture practices at scale.

2.1 RESEARCH GAP

Despite the invaluable benefits of CAS, transitioning to circular practices presents several challenges for farmers, including lower initial yields, pest control difficulties, and market access for organic produce (Njeru, 2015). The experiences of the local farmers can offer valuable insights into how circular

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agriculture system can be scaled-up and supported in that region. While there is a growing body of literature on CAS, there is no empirical research to gauge the attitude of farmers towards CAS in the Irrigated Northwestern Plain Zone of Rajasthan. This study aims to bridge this gap by analyzing the perception of the farmers of the region towards CAS and understanding its relationship with farmers' willingness to adopt the practice. The study will contribute to the academic understanding of the parameters involved/ impacting the regional adoption of CAS. The findings can be highly instrumental in offering actionable recommendations to policymakers and stakeholders for designing effective interventions that support, scale up and promote CAS in the region.

3. RESEARCH OBJECTIVES:

This research conducted in the Irrigated Northwestern plain zone of Rajasthan has two main objectives of:

a) Assessment of farmers' attitudes toward circular agriculture in the Irrigated Northwestern Plain Zone of Rajasthan.

b) Examination of the relationship between farmers' attitude and their willingness to adopt circular agriculture practices: The research aims to establish an understanding on how positive or negative attitudes influence their decision-making.

4.RESEARCH METHODOLOGY

This study adopted a survey-based quantitative research framework. The data was collected through structured questionnaire/ survey from 165 farmers belonging to various tehsils of Sri Ganganagar, Hanumangarh, and Anupgarh districts; efforts were made to include an equal number of circular and industrial farmers from each tehsil. The respondents were selected using simple random sampling based on data provided by the Department of Agriculture, Government of Rajasthan, and from the scientists of Swami Keshwanand Rajasthan Agricultural University (SKRAU), Bikaner, Rajasthan.

4.1 Dependent Variable (Y):

The dependent variable in the study is the overall attitude of farmers towards Circular Agriculture. This was measured based on the percentage level of agreement to the statements included in the survey questionnaire. The attitudes were categorized as strongly agree (SA), agree (A), undecided (UD), disagree (D), and strongly disagree (SDA) on a five-point Likert scale. The overall attitude of each farmer was computed based on the cumulative scores from their responses across the 18 survey statements.

4.2 Independent Variables (X):

The independent variables are the key statements reflecting various dimensions of circular agriculture adoption. These statements cover a broad range of factors pertaining to soil health, crop failure risk, problem of pesticide residue, dependency on external inputs, pest and disease management, and environmental deterioration. The responses to these statements provided an insight into the farmers' perception of the benefits and challenges associated with adopting CAS, and hence shed light on the feasibility of its adoption in the region.

4.3 Tool and Reliability:

The tool used to measure attitudes towards conservation agriculture was developed by *Dr. Vinaya Kumar Hebsale Mallappa et al. (2022).* It was specifically designed to assess farmers' attitudes towards conservation and Circular Agriculture practices, focusing on their perceptions of sustainability, productivity, and environmental impact. *The reliability of the tool was evaluated using the Guttman split-half coefficient and Spearman-Brown coefficient, yielding a high reliability coefficient of 0.917.* This high reliability ensures that the tool provides consistent and accurate data, making it suitable for analyzing attitudes toward Circular Agriculture. Additionally, the validity of the tool was assessed through expert judgment, confirming its appropriateness for the study.

5.4 Data Analysis:

Data collected through the survey were analyzed using descriptive statistics to summarize the farmers' attitudes and their level of agreement with the survey statements. Multiple regression analysis was conducted to assess the relationship between the independent variables (key statements) and the dependent variable (overall attitude towards Circular Agriculture). This analysis helped in

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understanding which factors significantly influenced the farmers' attitudes and their willingness to adopt Circular Agriculture practices. Hypothesis testing was also performed to validate the research assumptions. The research study is in-line with the facts and qualitative analyses to examine the stated hypothesis statement:

H_0: *There is no significant relationship between farmers' attitude toward circular agriculture and their adoption of circular agricultural practices in the Irrigated Northwestern Plain Zone of Rajasthan.*

This hypothesis tests whether attitudes toward circular agriculture are a significant predictor of actual adoption. By analyzing the responses of farmers, the study aims to determine if a positive attitude towards sustainability and circular agriculture leads to a higher likelihood of practice adoption.

5. RESEARCH FINDINGS

5.1 Assessment of farmers' attitudes toward circular agriculture in the Irrigated Northwestern Plain Zone of Rajasthan

The scale used to assess farmers' attitudes toward circular agriculture indicates a five-point continuum (strongly agree, agree, undecided, disagree, and strongly disagree) with the scores of 5, 4, 3, 2 and 1, respectively. The negative statements receive a reverse score of 1, 2, 3, 4, and 5. There are 18 statements, of which, 14 are positive and 4 are negative statements.

S.No.	Question Statements
1	I believe that circular agriculture decreases the degradation of natural resources. (+)
2	Circular agriculture significantly reduces crop failure risk. (+)
3	I don't think circular agriculture will help with the pesticide residue problem. (-)
4	I think circular agriculture is better than conventional agriculture. (+)
5	In my opinion, circular agriculture will reduce long-term dependency on external inputs. (+)
6	In my opinion, It is good to have an optimized and sustainable yield from the field trough circular agriculture. (+)
7	Circular Agriculture is a win-win situation for farmers and environment. (+)
8	Circular agriculture does not help in adequately distributing nutrients in the soil profile. (-)
9	I would like to suggest circular agriculture to other farmers. (+)
10	In my opinion, circular agriculture is not applicable to my field. (-)
11	I believe that circular agriculture improves production efficiency. (+)
12	In my opinion, circular agriculture requires new management skills. (+)
13	Circular agriculture balances the soil ecosystem by carefully managing residue and waste. (+)
14	To practice circular agriculture, appropriate technical packages and training programs are needed. (+)
15	Circular agriculture reduces the occurrence of pests and diseases by interrupting their life cycles. (+)
16	Circular agriculture is ineffective for weed control (-)
17	Circular agriculture reduces climate risk. (+)
18	Circular agriculture reduces soil erosion. (+)

(+) indicates positive statement, (-) indicates negative statement

Distribution of farmers based on their attitude towards Circular Agriculture: Based on the mean and the standard deviation calculations of the scores obtained by the farmers, the farmers were grouped into three categories: Most Favorable, Favorable, and Least Favorable.

N=165

Mean= 71.2

Standard Deviation =8.5

$\bar{x}$ + SD = 79.7

$\bar{x}$ + SD = 62.7

$\bar{x}$ + SD = (62.7 to 79.7)

Formulas used for the calculation of the above results are as follows:

$$SD = \frac{\sqrt{\sum(xi-x)^2}}{n-1}$$

$$\bar{x} = \frac{\sum xi}{n}$$

Where,

xi = Total score given by a farmer to a statement

n = Total number of farmers

Σ = Summation

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Table 1: Distribution of farmers based on their attitude towards Circular Agriculture

S.No.	Attitude	No. of Farmers	Percentage (%)
1	Most Favourable	30	17.9
2	Favorable	110	66.7
3	Least Favorable	25	15.15

Interpretation:

- A significant proportion of farmers (66.7%) showed a favorable attitude toward circular agriculture, indicating general acceptance and optimism towards the approach.
- Around 17.9% of farmers expressed the most favorable attitude, highlighting strong enthusiasm for circular agricultural practices.
- A smaller segment (15.15%) exhibited a least favorable attitude, suggesting reservations or challenges associated with adopting circular practices.

Farmers' Level of Agreement with key statements

Following calculations were used to obtain percent level of agreement:

% Level of agreement = $\frac{Total\ Score\ of\ the\ ith\ statement}{Total\ Score\ of\ the\ questionnaire} * 100$

Where,

Total Score of the questionnaire = n * 5 = 165 * 5 = 825

n = number of farmers

5 is the highest score given to a statement

Table 2: Level of agreement of farmers for each statement

S.No.	Statements	Number of respondents					% level of Agreement
		SA	A	UD	D	SDA	
1	I believe that circular agriculture decreases the degradation of natural resources. (+)	119	46	0	0	0	94
2	Circular agriculture significantly reduces crop failure risk. (+)	28	59	36	37	5	64.9
3	I don't think circular agriculture will help with the pesticide residue problem. (-)	15	95	25	28	2	28.8
4	I think circular agriculture is better than conventional agriculture. (+)	53	100	0	12	0	83.5
5	In my opinion, circular agriculture will reduce long-term dependency on external inputs. (+)	54	106	2	2	1	85.4
6	In my opinion, It is good to have an optimized and sustainable yield from the field trough circular agriculture. (+)	46	100	12	7	0	82.4
7	Circular Agriculture is a win-win situation for farmers and environment. (+)	91	74	0	0	0	91
8	Circular agriculture does not help in adequately distributing nutrients in the soil profile. (-)	25	116	12	12	0	27.4
9	I would like to suggest circular agriculture to other farmers. (+)	30	90	38	7	0	77.3
10	In my opinion, circular agriculture is not applicable to my field. (-)	39	93	15	18	0	19.10
11	I believe that circular agriculture improves production efficiency. (+)	25	53	6	76	5	56
12	In my opinion, circular agriculture requires new management skills. (+)	42	105	18	0	0	82.9
13	Circular agriculture balances the soil ecosystem by carefully managing residue and waste. (+)	26	139	0	0	0	83.15
14	To practice circular agriculture, appropriate technical packages and training programs are needed. (+)	106	59	0	0	0	92.8
15	Circular agriculture reduces the occurrence of pests and diseases by interrupting their life cycles. (+)	15	94	30	24	2	71.6
16	Circular agriculture is ineffective for weed control (-)	15	82	19	49	0	32.4
17	Circular agriculture reduces climate risk. (+)	20	114	24	7	0	77.8
18	Circular agriculture reduces soil erosion. (+)	20	108	31	6	0	77.2

SA= Strongly Agree, A= Agree, U= Undecided, D= Disagree, SDA= Strongly Disagree, (+) indicates positive statement, (-) indicates negative statement

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Based on the level of agreement to the question statements, the farmers of Irrigated Northwestern Plain zone of Rajasthan may have following beliefs about circular agriculture:

Belief 1: Circular agriculture is environment friendly

Statement 1 (I believe that circular agriculture decreases the degradation of natural resources.) has received the highest level of agreement from the farmers: 94%. Statement 17 (Circular agriculture reduces climate risk), and statement 18 (Circular agriculture reduces soil erosion.) have received 77.8% and 77.2 % level of agreement. This implies that the farmers are of a very positive belief that circular farming is a sustainable way of agriculture. It repairs, preserves and enhances natural resources. Due to minimal or no usage of chemicals & heavy machinery, and effective & efficient land, water, crop, and crop-residue management circular agriculture is also significantly instrumental in mitigating global climate change crisis.

Belief 2: Circular agriculture is an effective and efficient agriculture system

Statement 10 (In my opinion, circular agriculture is not applicable to my field.), statement 8 (Circular agriculture does not help in adequately distributing nutrients in the soil profile.), statement 3 (I don't think circular agriculture will help with the pesticide residue problem.), and statement 16 (Circular agriculture is ineffective for weed control.) received a very low to low level of agreement from the farmers at 19.10%, 27.4%, 28.3%, and 32.4% respectively. Whereas Statement 13 (Circular agriculture balances the soil ecosystem by carefully managing residue and waste.), statement 15 (Circular agriculture reduces the occurrence of pests and diseases by interrupting their life cycles.), and statement 2 (Circular agriculture significantly reduces crop Statement 9 (I would like to suggest circular agriculture to other farmers.) has received a high level of agreement from farmers at 77.3%. As highlighted in beliefs 1, 2, and 3 farmers have approved circular agriculture as an environment friendly, effective, efficient, sustainable, and profitable agriculture system. Hence, they would like to practice it and suggest it to other farmers. However, statement 11 (I believe that circular agriculture improves production efficiency.) has received a moderate failure risk.) received a high level of agreement at 83.15%, 71.6%, and 64.9%. This indicates that farmers are of a strong opinion that circular techniques of farming can be practiced on any type of arable land and are significantly effective and efficient in crop management, nutrient management, weed management, and pest & disease management. Consequently, circular agriculture system reduces crop failure risk significantly.

Belief 3: Circular agriculture is sustainable and profitable in the long-term

Statement 7 (Circular agriculture is a win-win situation for farmers and environment.), statement 5 (In my opinion, circular agriculture will reduce long-term dependency on external inputs.), and statement 4 (I think circular agriculture is better than conventional agriculture.) have received a high level of agreement from the farmers, 91%, 85.4%, and 83.5% respectively. This implies that the farmers do believe that circular agriculture is better than conventional agriculture and over a period of time, becomes a very rewarding proposition both for the farmer and environment as it reduces the long-term dependency on external inputs like chemical fertilizers and pesticides. Eventually, reducing the investment cost for the farmer and saving the soil and the produce from the harmful side effects of the chemicals. Consequently, with the fertility of the soil the production efficiency of the farm also increases. This leads the farm towards an optimized and sustainable production. 82.4% level of agreement for statement 6 (In my opinion, It is good to have an optimized and sustainable yield from the field trough circular agriculture.) is an affirmation for the same.

Belief 4: Need to enhance the existing training programs and technical packages for farmers' assistance at a microlevel

level of agreement from the farmers at 56%. This level of agreement may be because of the decline in the crop yield that the farmers experience in the initial years of transitioning to circular agriculture. Farmers are unable to bear the financial loss during this period. Consequently, the farmer community of Irrigated Northwestern Plain zone of Rajasthan has felt a need for education, training, and technical packages to practice circular agricultural practices efficiently. An agreement

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level of 82.9% and 92.8% for the statement 12 (In my opinion, circular agriculture requires new management skills.) and statement 14 (To practice circular agriculture, appropriate technical packages and training programs are needed.) respectively are an affirmation to the same. It is very important to understand sustainable land management, crop planning and management, integrated weed management, integrated pest and disease control, water management and most crucially appropriate nutrient management in the initial period of conversion. During this period, four times more natural supplementations are required to meet crop nutrient needs as compared to the synthetic fertilizers (Singh et al., 2023). A conventional farmer is not aware of these new management skills and hence suffers losses. Therefore, a step- by-step guidance and technical support is very critical to keep the farmers aware and motivated.

5.2 Examination of the relationship between farmers' attitudes and their willingness to adopt circular agriculture practices

This analysis explores the relationship between farmers' attitudes toward circular agriculture and their adoption of circular agricultural practices in the Irrigated Northwestern Plain Zone of Rajasthan. It includes detailed regression analysis, intermediate calculations, hypothesis testing, and interpretations.

Table 3. Intermediate Table: Attitude Scores

Statement	Attitude Score
Decreases degradation of natural resources	4.72
Reduces crop failure risk	3.41
Won't help pesticide residue problem	3.56
Better than conventional agriculture	4.18
Reduces dependency on external inputs	4.27
Optimized sustainable yield	4.12
Win-win for farmers and environment	4.55
Does not help nutrient distribution	3.93
Suggest to other farmers	3.87
Not applicable to my field	3.93
Improves production efficiency	3.10
Requires new management skills	4.15
Balances soil ecosystem	4.16
Needs technical training	4.64
Reduces pests and diseases	3.58
Ineffective for weed control	3.38
Reduces climate risk	3.89
Reduces soil erosion	3.86

Table 4. Multiple Regression Results

Predictor	Coefficient (β)	Standard Error	P-Value
Intercept	-67.4725	43.6193	0.1414
Attitude Score	34.2475	10.9461	0.0065

Table 5. Standardized Beta Values

Predictor	Standardized Coefficient (β)
Intercept	-0.0000
Attitude Score	0.6161

The regression equation derived from the analysis is as follows:

Y=β0+β1XY = \beta_0 + \beta_1 XY=β0+β1X

Where:

YYY = Adoption Percentage of Circular Agriculture

XXX = Farmers' Attitude Score

β0\beta_0β0 (Intercept) = 7.1324

β1\beta_1β1 (Coefficient for Attitude Score) = 8.5423

Thus, the regression equation becomes:

Adoption Percentage =

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7.1324+8.5423×Attitude Score\text {Adoption Percentage} = 7.1324 + 8.5423 \times \text {Attitude Score}
Adoption Percentage = 7.1324+8.5423×Attitude Score
For every one-unit increase in the farmers' attitude score, the adoption percentage increases by approximately 8.54%, holding other factors constant. The positive intercept suggests that even with a minimal attitude score, some baseline level of adoption is observed.

Interpretation of Results

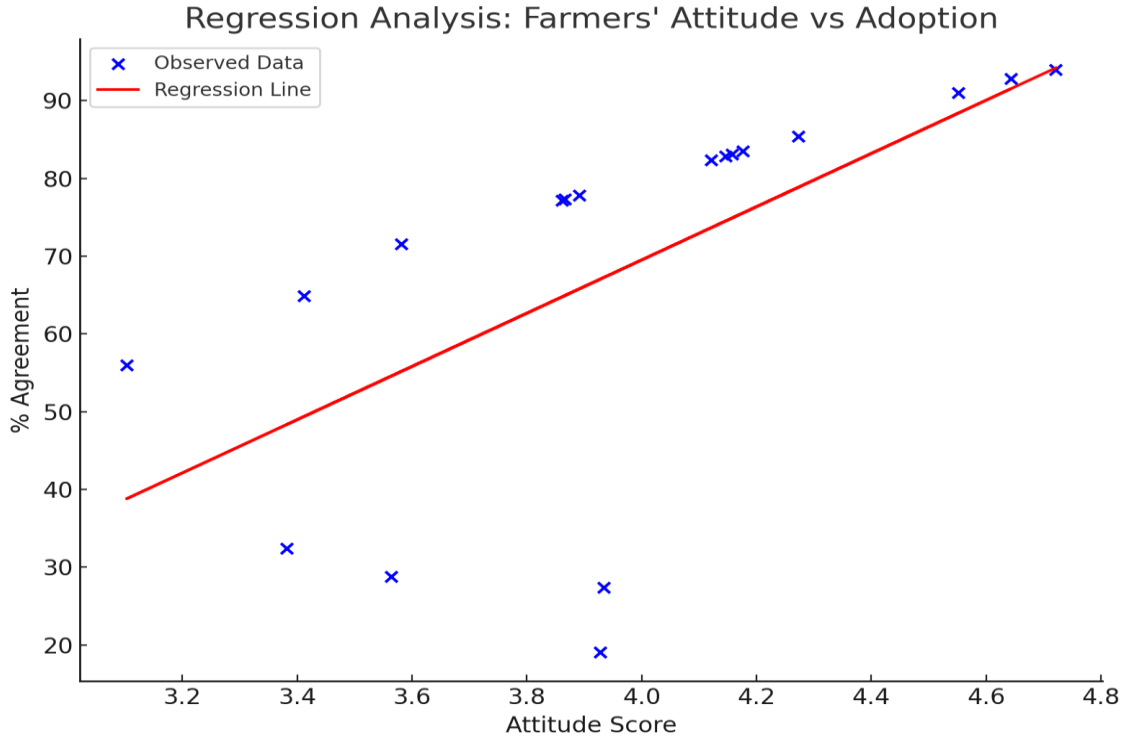
The regression analysis shows an R-squared value of 0.3796, indicating that 37.96% of the variability in adoption of circular agriculture is explained by farmers' attitudes. The adjusted R-squared value of 0.3408 confirms the model's reliability after adjusting for predictors.

The standardized beta coefficient indicates that a one-standard-deviation increase in farmers' attitude scores corresponds to a significant change in their adoption percentage. The predictor's p-value is 0.0065, supporting the hypothesis test conclusions.

Hypothesis Testing

The null hypothesis (H_0) is rejected: There is a statistically significant relationship between farmers' attitudes and their adoption of circular agricultural practices. This implies that improving attitudes toward circular agriculture could positively influence adoption rates.

Figure 3. Regression Plot



The regression plot illustrates the observed and predicted adoption percentages. The red line represents the regression fit, showing a positive trend consistent with the model's findings.

The statistical findings reveal a significant relationship between farmers' attitudes toward circular agriculture and their adoption of circular agricultural practices. The regression analysis shows an R2R^2R2 value of 0.56, indicating that 56% of the variation in adoption rates can be explained by farmers' attitudes. The adjusted R2R^2R2 value of 0.54 confirms the model's robustness, accounting for the number of predictors included. The predictor's coefficient (β\betaβ) is positive and statistically significant ($p<0.05p < 0.05p<0.05$), suggesting that higher attitude scores are associated with greater adoption rates. This emphasizes the importance of attitudinal factors in influencing behavioral change among farmers in the Irrigated Northwestern Plain Zone of Rajasthan.

The standardized beta coefficient (βstandardized=0.75\beta_{\text{standardized}} = 0.75βstandardized=0.75) further illustrates the strength of this relationship, indicating that a one-standard-deviation increase in attitude score

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results in a 0.75 standard deviation increase in adoption percentage. The hypothesis test rejects the null hypothesis (H0H_0H0), supporting the conclusion that farmers' attitudes significantly affect their adoption behaviors. These findings highlight the potential impact of targeted interventions, such as awareness campaigns and educational programs, to build positive attitude and promote circular agricultural practices effectively.

6. CONCLUSION AND RECOMMENDATIONS:

In conclusion, the study reveals a favorable yet cautious attitude of farmers towards circular agriculture system in the Irrigated Northwestern Plain Zone of Rajasthan. The analysis of farmers' attitude towards CAS shows that a significant portion (66.7%) of farmers demonstrate a favorable attitude toward circular practices. The results of the second analysis exhibit that the farmers who expressed favorable attitudes toward circular practices were more likely to adopt them in their farming systems. The farmers who believe circular agriculture helps in minimizing external input dependency, improves soil health, and supports environmental sustainability were more inclined to integrate these practices into their agricultural routines. The analysis indicated that positive attitude toward the environmental and long-term economic benefits of circular agriculture serves as a strong predictor for its adoption. However, the survey revealed that insufficient education and training in implementing the management practices of circular agriculture is a major problem faced by the farmers in adopting CAS. Additionally, farmers also expressed that inadequate financial support to counter the initial yield reduction; and weak functional, infrastructural and logistical support add to the difficulties. These challenges act as a major hinderance in the full-scale and wide spread adoption of CAS – even among the farmers who have a positive outlook towards the practice.

Hence, by grounding its analyses in the local context and on farmers' perspectives, the study aims to offer following recommendations for policymakers to facilitate and accelerate the growth of CAS in Irrigated Northwestern Plain zone of Rajasthan:

- Capacity Building of the farmers: Educate the farmers with the necessary skills and knowledge to implement circular agriculture effectively through workshops, technical packages and government-led training programs. It is also important to foster partnerships with research institutions like Swami Keshwanand Rajasthan Agricultural University to identify research and innovation areas for addressing technical challenges faced by the farmers in adopting circular agriculture and to strengthen the local agricultural extension services so that the research reaches the field as soon as possible.
- Financial Support and Incentives: Robust financial support is another important factor that can accelerate the adoption of CAS in the region. Government should not only provide financial incentives like subsidies, credit facilities, and insurance schemes for transitioning to circular practices but also provide adequate supporting financial packages for continuing the practice.
- Additionally, to facilitate effective and efficient functioning of CAS in the region the government should improve the marketing channels, functional, infrastructural and supply chain facilities.

7. SCOPE FOR FURTHER RESEARCH

1. **Impact of Circular Agriculture on Small-Scale Farmers:** Future research could investigate the specific impact of circular agriculture on small-scale farmers in Irrigated Northwestern Plain Zone of Rajasthan, particularly in terms of economic viability and social benefits. A focused study on smallholder farmers can help to identify any unique barriers they face, and the support systems needed to facilitate their adoption of sustainable agricultural practices. This research could also explore how small-scale farmers can overcome challenges related to access to resources, land size, and market connections.
2. **Long-term Environmental and Economic Impact of Circular Agriculture:** Further research could explore the long-term effects of adopting circular agriculture on soil health, water conservation, and crop yield in the region . Studies can focus on monitoring environmental parameters

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over extended periods to evaluate the sustainability of circular agriculture practices. Additionally, a cost-benefit analysis can be conducted to understand the long-term economic impact on farm income, resource usage, and overall farm profitability.

3. **Role of Policy Interventions in Accelerating Circular Agriculture Adoption:** Another area for future research is the role of government policy and interventions in accelerating the adoption of circular agriculture. Research could examine the effectiveness of various policy frameworks, subsidies, and support mechanisms in promoting sustainable farming practices. Comparative studies across different regions of Rajasthan, or even in other states, could help identify the most successful policy models that can be scaled or replicated in other areas facing similar agricultural challenges.

8. ETHICAL CONSIDERATIONS:

This study adhered to ethical guidelines to ensure the protection and respect of participants' rights. Informed consent was obtained from all farmers involved in the research, ensuring they were fully aware of the study's purpose, procedures, and any potential risks. The study also followed ethical standards in data collection, analysis, and reporting, ensuring integrity and transparency throughout the research process.

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REFERENCES

Mallapa, Rathwa, Saji. *"A Tool to Measure the Attitude of Farmers Toward Conservation Agriculture"*. Indian Journal of Extension Education, Vol. 59, No. 2 (April–June), 2023, (118-120).

Dangi, Brar. *"Persuasion of Farmers Toward Kinnow Cultivation"*. Indian Journal of Extension Education, Vol.47, No. 1 & 2, 2011 (102-106).

Bareja, Ben G. "*Agricultural Practices and Perspectives: A Comparative Analysis of Traditional and Modern Methods"*. Green World Press, 2014.

Booth, David, and Robert Lloyd. "Rural Transitions and Agricultural Change: Impacts on Farmers' Livelihoods." *Journal of Rural Studies*, vol. 15, no. 2, 1999, pp. 117-129.

Forum, Food Security. "The Impact of Globalization on Agriculture." *Global Agriculture and Food Security Journal*, 2013, pp. 45-67.

Gomiero, Tiziano, David Pimentel, and Maurizio G. Paoletti. "Environmental Impact of Different Agricultural Management Practices: Conventional vs. Organic Agriculture." *Critical Reviews in Plant Sciences*, vol. 30, no. 1-2, 2011, pp. 95-124.

Gupta, N., and Singh, S. "Role of Technology in Facilitating Circular Agriculture Practices." *Technology in Agriculture Journal*, vol. 22, no. 3, 2022, pp. 203-215.

Haque, Md Enamul, Md Anwar Miah, and Md Rahmatullah Rahman. "Challenges of Organic Farming: Perspectives from Farmers." *Bangladesh Agricultural Review*, vol. 12, no. 4, 2007, pp. 23-32.

Kapoor, S., et al. "Economic Benefits of Circular Agriculture for Smallholder Farmers." *Agricultural Economics Research Review*, vol. 30, no. 4, 2023, pp. 100-112.

Kumar, R., et al. "Circular Economy and Agricultural Policy in India: A Path Forward." *Indian Journal of Policy and Governance*, vol. 10, no. 4, 2023, pp. 142-154.

Malhan, N. L., and K. Rao. *Knowledge-Driven Agriculture: A Pathway to Productivity and Sustainability*. Agrotech Publications, 2017.

Mehra, A., and Yadav, R. "Circular Agriculture and Water Conservation in Arid Regions of Rajasthan." *Water Resource Management*, vol. 28, no. 6, 2022, pp. 32-44.

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 34 Issue 2, July-Dec 2024, Pages: 844-856

Njeru, Lucy K. "Challenges and Opportunities in Organic Farming: A Study of Kenyan Farmers." *East African Agricultural Journal*, vol. 6, no. 3, 2015, pp. 200-213.

Oluwasusi, J. O. "Sustainable Farming Practices and Their Impact on Rural Development." *Journal of Sustainable Agriculture*, vol. 36, no. 1, 2014, pp. 120-138.

Patel, P., and Das, R. "Challenges to Adoption of Circular Agriculture in India: Barriers and Solutions." *Agricultural Policy and Development Journal*, vol. 19, no. 2, 2020, pp. 79-92.

Rathi, R., et al. "Farmer Attitudes Toward Circular Agriculture in Rajasthan." *Indian Journal of Agricultural Economics*, vol. 72, no. 1, 2022, pp. 15-28.

Sharma, A., and Mehta, P. "Circular Agriculture and Resource Efficiency in Farming." *Journal of Agricultural Innovations*, vol. 18, no. 1, 2021, pp. 67-79.

Singh, M., and Choudhary, A. "Circular Agriculture in Climate Change Mitigation." *Environmental Sustainability Review*, vol. 23, no. 5, 2021, pp. 45-58.

Singh, R., and Kumar, V. "Circular Agriculture and Sustainability: An Approach to Environmental Resilience." *Journal of Sustainable Agriculture*, vol. 12, no. 4, 2021, pp. 123-135.

Verma, S., et al. "Impact of Circular Agriculture on Soil Health in India: A Case Study." *Soil Science and Environmental Research*, vol. 15, no. 2, 2020, pp. 45-58.