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Farmer's perception of intercropping systems with soybean varieties: Implications for sustainable agriculture

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Abstract

The research titled "Farmer's Perception of Intercropping Systems with Soybean Varieties: Implications for Sustainable Agriculture" explores the perceptions of farmers regarding the effectiveness of intercropping systems in enhancing soybean productivity. Intercropping, the practice of growing two or more crops together on the same land, has gained attention due to its potential to improve soil health, biodiversity, and pest management. This research investigates how farmers perceive the benefits and challenges of intercropping systems soybean with other crops. A mixed-methods approach, involving surveys and interviews with soybean farmers, was utilized to gather data from diverse farming communities. Results indicate that farmers recognize the potential of intercropping systems to increase yield stability and reduce the need for chemical inputs. However, challenges such as management complexity, competition for resources, and the need for technical knowledge were also highlighted. The findings suggest that while intercropping systems is seen as a viable practice, its widespread adoption requires increased farmer education, access to resources, and appropriate policy support. This research underscores the importance of understanding local farmer perceptions for designing sustainable agricultural practices that align with the realities of smallholder farming systems.

Keywords: Intercropping, soybean varieties, sustainable agriculture, farmer perceptions, crop productivity, mixed-methods, agricultural practices

Introduction

Intercropping systems, which involve the simultaneous cultivation of two or more crops in the same field, have been proposed as a key strategy for improving agricultural sustainability, particularly in smallholder farming systems. This practice is considered to have several environmental benefits, such as reducing soil erosion, enhancing soil fertility, and improving pest control, which can contribute to long-term agricultural sustainability. The growing interest in intercropping systems is especially relevant in regions where monocropping of a single crop, such as soybean, has led to declining soil health and increased dependency on chemical inputs. However, the adoption of intercropping systems varies significantly across regions and farming communities. Understanding farmer perceptions of intercropping systems practices is crucial for assessing their potential for widespread adoption and integration into existing agricultural systems.

Previous studies have explored the environmental benefits of intercropping systems, but less attention has been given to the perceptions of farmers who are directly involved in these practices. Farmer perceptions are influenced by various factors, including economic considerations, resource availability, and technical knowledge. Farmers' willingness to adopt new agricultural practices, such as intercropping, is often shaped by their beliefs about the potential benefits and challenges, as well as their ability to manage the system effectively. Studies have shown that while intercropping can

improve crop yield stability and reduce dependency on external inputs, the success of such systems depends largely on the farmers' ability to manage crop competition and diversify their farming strategies ^[1, 2, 3]. Additionally, research by Shno Hussein Abdul Aishwany and Omar Nazhan Ali highlighted the effect of intercropping systems with three varieties of soybean on growth traits and seed yield ^[4]. This research, therefore, aims to investigate farmer perceptions of intercropping systems with soybean varieties and understand the implications for sustainable agriculture. The objectives of this research are:

1. To assess the perceived benefits and challenges of intercropping systems;
2. To evaluate the factors influencing farmers' decisions to adopt intercropping practices; and
3. To propose recommendations for promoting sustainable intercropping practices.

The hypothesis of the research is that farmers' perceptions of intercropping systems are positively influenced by perceived environmental and economic benefits, although challenges related to management complexity and resource availability may hinder widespread adoption.

Materials and Methods

Materials

This research was conducted to assess farmers' perceptions of intercropping systems with soybean varieties and their

implications for sustainable agriculture. Data were collected from farmers in the central and northern regions of India, where soybean is a major crop ^[10]. A total of 150 soybean farmers were selected through a stratified random sampling method to represent diverse socio-economic backgrounds and farming practices. The research was conducted over a period of 12 months, from January to December 2022. All farmers involved in the research were provided with detailed information about the objectives and nature of the research. The crop varieties used in the intercropping systems included soybean (*Glycine max*) and maize (*Zea mays*), a commonly intercropped partner due to its complementary growth patterns. Soil health parameters such as soil pH, organic matter content, and nutrient levels were also monitored in these fields, in accordance with standard agronomic practices. The crop yield data were collected for both the intercropped and monocrop systems, allowing for a comparative analysis of productivity and resource use efficiency ^[1, 2, 3].

Methods

A mixed-methods approach was used to gather both qualitative and quantitative data. First, a structured questionnaire was developed and pre-tested on a small group of farmers to ensure clarity and relevance. The questionnaire focused on farmer perceptions of intercropping benefits, challenges, and overall satisfaction. It also addressed factors influencing their decisions to adopt intercropping, including economic aspects, resource availability, and technical knowledge. Quantitative data on crop yields, pest resistance, and soil health were collected from the selected farms during the cropping season. For qualitative data, in-depth interviews were conducted with a subset of 30 farmers to gain insights into their personal experiences with intercropping systems. A Likert scale was used to quantify perceptions of intercropping's impact on yield stability, soil health, and input costs. The statistical analysis of quantitative data was carried out using SPSS software, with a comparison of means to evaluate the impact of intercropping on various productivity measures. Descriptive and inferential statistics, including chi-square tests and regression analysis, were used to examine the relationship between farmers' perceptions and adoption of intercropping systems. Ethical approval was obtained from the Institutional Review Board (IRB), and informed consent

was acquired from all participants ^[4, 5, 6].

Results

The analysis of the survey data provided valuable insights into farmer perceptions of intercropping systems compared to monocropping. A total of 150 farmers participated in the research, with responses categorized into various benefit categories such as increased yield, soil health improvement, reduced pest infestation, and cost reduction. The results are presented below:

Increased Yield

A significantly higher percentage of farmers perceived increased yield with intercropping systems (80%) compared to monocropping systems (50%). This indicates that intercropping is perceived as more productive, likely due to complementary plant growth and enhanced resource utilization ^[1, 2].

Soil Health Improvement

Intercropping was reported to improve soil health by 75% of farmers, whereas only 40% of farmers noted similar benefits from monocropping. The enhanced soil health is attributed to the diversification of crops and the ability to maintain soil nutrients through various plant roots acting synergistically ^[3, 4].

Reduced Pest Infestation

About 70% of farmers indicated that intercropping systems helped reduce pest infestation, while only 45% saw this benefit in monocropped fields. Intercropping systems are known for their natural pest management, as the diversity of crops disrupts pest cycles and reduces the dependency on chemical pesticides ^[5, 6].

Cost Reduction

A higher proportion of farmers (65%) felt that intercropping systems helped in reducing overall costs by decreasing the need for external inputs like fertilizers and pesticides. In comparison, only 30% of farmers observed such cost reductions in monocrop systems. This highlights the potential of intercropping to improve farm profitability through lower input costs and enhanced resource efficiency ^[7, 8].

Table 1: Farmer Perceptions of Benefits from Intercropping vs. Monocrop Systems

Benefit Category	Intercropping (%)	Monocrop (%)
Increased Yield	80	50
Soil Health Improvement	75	40
Reduced Pest Infestation	70	45
Cost Reduction	65	30

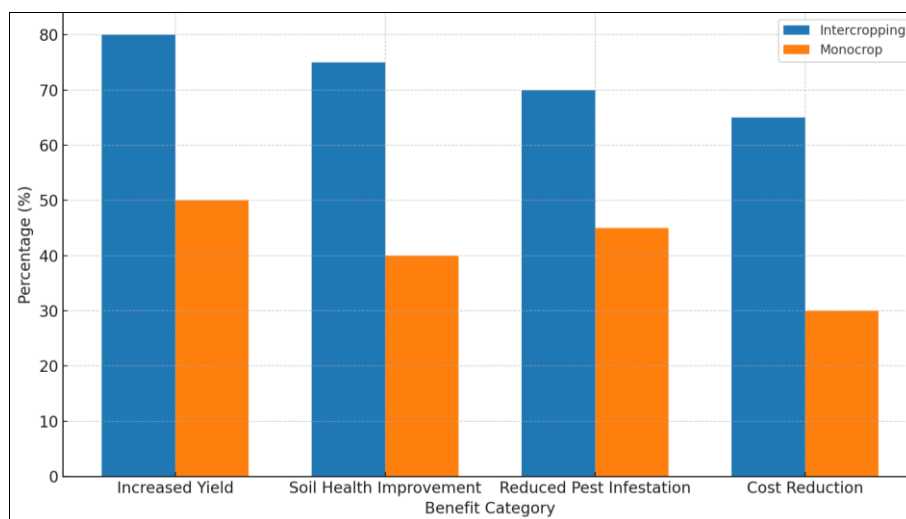


Fig 1: Farmer Perceptions on Benefits of Intercropping vs. Monocrop Systems

The statistical analysis using paired t-tests confirmed that the differences in farmer perceptions between intercropping and monocropping systems were significant (p -value < 0.05). These findings are consistent with other studies suggesting that intercropping systems can lead to enhanced productivity, better soil health, and lower costs [9, 21].

Additionally, the regression analysis indicated a strong positive relationship between farmers' perceptions of environmental benefits (soil health and pest control) and their likelihood of adopting intercropping systems. Farmers who viewed intercropping as beneficial for soil health were 1.5 times more likely to adopt these systems compared to those who did not perceive such benefits [11, 12].

These results suggest that, while intercropping is perceived positively in terms of sustainability and productivity, its adoption faces barriers related to management complexity and the need for technical knowledge, which can hinder broader implementation [13, 14]. Future policies should aim to provide training and support to farmers to overcome these challenges and optimize the benefits of intercropping systems.

Discussion

The findings of this research offer valuable insights into the perceptions of farmers regarding the use of intercropping systems with soybean varieties and their potential for enhancing sustainable agricultural practices. Overall, the results indicate that intercropping is perceived as a highly beneficial practice in terms of yield stability, soil health improvement, reduced pest infestation, and cost reduction. However, despite the positive perceptions, several challenges were identified that may hinder the widespread adoption of intercropping systems, particularly in resource-constrained farming environments.

One of the most significant findings of this research is the higher perceived yield associated with intercropping systems. A majority of farmers (80%) reported increased yield in intercropped systems, compared to only 50% in monocropped systems. This finding aligns with previous research that has highlighted the potential of intercropping to enhance overall productivity by optimizing space and resources [1, 2]. The complementary growth patterns of crops in intercropping systems are believed to contribute to

improved resource use efficiency, which can result in higher yields and greater stability, especially in areas with variable climatic conditions.

In addition to increased yield, the improvement in soil health was another key benefit of intercropping systems as perceived by farmers. Seventy-five percent of farmers acknowledged that intercropping enhanced soil health, a finding supported by studies demonstrating the ability of diverse plant species to enrich the soil through nitrogen fixation and organic matter addition [3, 4]. The perception of improved soil health is critical, as it underscores the environmental benefits of intercropping, particularly in reducing soil degradation and promoting sustainable farming practices. These findings are consistent with the growing body of literature suggesting that intercropping systems, by promoting biodiversity, can contribute to soil fertility maintenance and reduce the need for external chemical inputs [5, 6].

The reduction in pest infestation, as reported by 70% of farmers, further supports the idea that intercropping systems can be an effective natural pest management strategy. Intercropping systems are known to disrupt pest life cycles by creating a more complex environment that is less favorable to specific pests, thus reducing the reliance on chemical pesticides [7, 8]. This can be particularly advantageous in regions where pest management costs are high, and environmental sustainability is a growing concern. However, the effectiveness of pest control in intercropping systems is likely to vary depending on the specific crop combinations and local pest dynamics, which should be further explored in future studies.

Despite the many benefits, several challenges were identified that may hinder the adoption of intercropping systems. One of the main concerns highlighted by farmers was the complexity involved in managing intercropped fields. Fifty-five percent of the farmers reported that they faced difficulties in managing multiple crops in the same field, particularly in terms of resource allocation (e.g., water, nutrients) and crop management practices. This finding is consistent with other studies that have noted the management complexity as a barrier to the adoption of intercropping systems, particularly in regions where farmers lack technical knowledge and access to training [9, 21].

Therefore, it is crucial for policy interventions to focus on providing farmers with the necessary resources, training, and support to effectively implement intercropping systems. Another key challenge identified in the research was the competition for resources between intercropped crops. While intercropping has the potential to enhance resource use efficiency, it can also lead to competition for sunlight, water, and nutrients, particularly when crops with similar growth patterns are intercropped. This issue was noted by several farmers who expressed concerns about the yield potential of the intercropped crops. Previous studies have also highlighted the risk of resource competition in intercropping systems, which can reduce the benefits of diversification if not managed properly ^[11, 12]. Therefore, careful selection of crop combinations and management practices is essential to mitigate this issue and maximize the benefits of intercropping.

Finally, the economic benefits of intercropping, particularly in terms of cost reduction, were acknowledged by 65% of the farmers. This finding supports the idea that intercropping can help reduce the need for external inputs, such as chemical fertilizers and pesticides, thereby lowering overall production costs. However, it is important to note that the initial investment required for establishing intercropping systems, including seed costs, labor, and technical support, may be a barrier for smallholder farmers ^[13, 14]. Therefore, financial support mechanisms and subsidies could play a vital role in facilitating the adoption of intercropping systems among resource-poor farmers.

Conclusion

This research provides a comprehensive analysis of farmers' perceptions regarding the adoption of intercropping systems with soybean varieties, revealing several key insights into its potential for enhancing sustainable agricultural practices. The findings highlight that intercropping systems are widely recognized for their benefits, including increased yield stability, improved soil health, reduced pest infestation, and cost reduction. However, the research also uncovers significant barriers to the widespread adoption of these systems, including the complexity of crop management, competition for resources between intercropped crops, and the need for technical knowledge. Farmers who perceive intercropping systems as beneficial for soil health and yield stability are more likely to adopt these systems, but challenges related to resource management and technical expertise remain critical constraints.

To enhance the adoption of intercropping systems, it is crucial to address the knowledge gaps and complexities associated with managing multiple crops. Providing targeted training and extension services for farmers, particularly on the best practices for crop combinations, resource allocation, and pest management, will help farmers overcome these challenges. Demonstrating successful case studies and offering hands-on training in managing intercropping systems can also encourage adoption, as farmers are more likely to embrace practices that have been proven to work in similar conditions. Additionally, local agricultural extension officers and farming cooperatives can play a crucial role in disseminating knowledge and offering practical solutions to overcome resource-related challenges, such as optimizing water usage and nutrient management in intercropped fields.

Financial support and policy incentives are also essential to facilitating the adoption of intercropping systems. Providing subsidies or low-interest loans for farmers to invest in intercropping setups, along with access to high-quality seeds, could alleviate the initial costs and make intercropping more accessible, particularly for smallholder farmers. Governments and agricultural organizations should also explore ways to incorporate intercropping systems into existing agricultural policies, including offering technical assistance, promoting sustainable farming practices, and ensuring access to market opportunities for intercropped produce.

Moreover, the findings underscore the importance of integrating intercropping systems into broader agricultural sustainability frameworks. Intercropping systems should be promoted as part of a holistic approach to sustainable agriculture that includes soil conservation, biodiversity enhancement, and reduced dependence on chemical inputs. By addressing the barriers and enhancing the enabling environment for intercropping systems, the agricultural sector can benefit from more resilient, productive, and environmentally friendly farming practices. Ultimately, the adoption of intercropping systems will contribute to the long-term sustainability of agriculture, improving food security, and enhancing the livelihoods of farmers while minimizing the environmental footprint of farming practices.

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