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# Transition Pathway for Sustainable Rice Cultivation: A Qualitative Analysis Based on Farmer Perception in Indian State of Punjab.

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#### Abstract:

Punjab's farmers have regularly attained the highest yield in rice production in the country by implementing Green Revolution (GR) practices. Nevertheless, the consequence is the severe deterioration of the ecosystem due to the excessive utilisation of resources and groundwater for irrigation purposes. Although there have been continuous calls for diversification, the farmers persist in adhering to conventional GR methods of cultivating rice. The present investigation focuses on examining the farmers' perception on growing rice in sustainable manner in Punjab. Furthermore, the study aids in comprehending the components accountable for a seamless shift towards sustainable rice agriculture. The research design employed was qualitative. The data was gathered by purposive sampling technique, including semi-structured interviews in the Moga district of Punjab. The data analysis employs the grounded theory approach of theme analysis using MAXQDA 2022. The results indicate that farmers are cognizant of the unsustainable nature of their current practices. However, the lack of appropriate/relevant knowledge on sustainability and a lack of profitability due to absence of a specific market for sustainable produce are the main barriers to adoption. The study illustrates the farmers' anticipation regarding well-designed policies, guaranteed markets, and prices for environmentally friendly agricultural products.

**Keywords:** Sustainability, Sustainable Rice Cultivation (SRC), Adoption, Perception, MAXQDA

## 1. Introduction

Asia is the leading region in rice production with countries like China, India, Vietnam, Thailand, Philippines, Myanmar, Bangladesh, Indonesia, Japan, Cambodia, Republic of Korea, Nepal, and Sri-Lanka contributing to almost 90% of the total production and almost 50% of the total production getting consumed in India and China (Muthayya et al., 2014). The crop of rice engages over 25% of the worldwide agricultural workforce, highlighting its substantial social and economic impact. However, it's the ecological impact of rice cultivation which has become one of the major sustainability concerns. The requirements of extensive irrigation and pest control in rice cultivation results in a significant environmental footprint, which has adverse effects on the health and safety of farmers. In addition, rice cultivation is also held responsible for 10% of global greenhouse gas emissions (Maraseni et al., 2018; Ritchie, 2019; Basavalingaiah et al., 2020).

As we examine Punjab's historical agricultural contribution and current state of rice cultivation, there are significant concerns about its prospects. Rice, a non-indigenous crop in Punjab, has experienced widespread growth throughout the state since the Green Revolution. The shift in cropping pattern in Punjab has resulted in a dismal situation. The rice cultivation area has witnessed a significant expansion, rising from 285 thousand hectare (6.82%), in 1966–67 to 2894 thousand hectare (40.76%), in 2014–15. Wheat and rice together accounted for 76.9% of the total crop production covering around 90.1% of the cultivated land while in contrast, other crops that contributed 54.54% in 1966–67 have significantly decreased to only 9.87% in 2014–15 (Mann, 2017; Vatta & Budhiraja, 2020). The decline in crop diversification is a significant challenge to the sustainability of agricultural production in Punjab. This issue has multiple implications and wide-ranging impact (Dutta & Dhillon, 2020). As per, Punjab Envis Centre, the state has achieved an irrigation level of 99.9% and the main crop that consumes this irrigation is rice, which has a significant influence on the groundwater table (ENVIS Centre: Punjab Status of Environment, 2020). The groundwater table is dropping at a rate higher than its replenishment (A. Singh et al., 2015; Khush, 2015; Gulati et al., 2021). Furthermore, the excessive use of agrochemicals poses a significant challenge due to soil depletion, food contamination, and adverse effects on food quality. This issue has been highlighted by various studies (Pandher et al., 2021; Sharma et al., 2021; Daulta et al., 2022). In addition, the production has remained at a constant level and the agricultural growth has decreased. In 1985–86, the agricultural growth was twice the national level at 5.7%, but it has now decreased to 1.6%, which is half of the national level in 2014–15 (Dutta, 2012; Gulati et al., 2017, 2021).

There is a prevailing belief among certain groups that the Green Revolution has failed in terms of sustainability and its general approach to well-being (Benbi, 2018; Hurt, 2020; John & Babu, 2021). The production-oriented approach of the Green Revolution has significantly depleted the environmental resources, while the economic benefits have reached a point of stagnation. The resulting effect on social structure is characterised by disillusioned young people struggling with the real world and widespread emigration to other countries (Kaur et al., 2021; Nanda et al., 2021; Ohno et al., 2021).

Therefore, it is important to investigate why the farming community in Punjab, which is typically industrious and enthusiastic, is ignoring the severe effects of massive rice cultivation. What are the reasons behind the lack of adoption of sustainable rice cultivation methods? This study aims to investigate the potential for implementing sustainable rice production practices in Punjab. This study is structured into five pieces. The subsequent section focuses on the literature review, Section 3 outlines the study's aims, followed by section 4 which explains the research methodology. Section 5 then gives the data analysis and discussion, followed by the conclusion and implications of the study.

## **2. Literature Review**

The literature review section examines the concept of sustainable agriculture, its strategy, and the methods employed to attain the desired objectives. Additionally, it examines the reasons accountable for adoption of sustainable practices.

The concept of sustainability is complex and has substantial significance in all aspects of human life. Pretty (1994) has expressed disapproval of the positivist approach that seeks to provide an absolute definition and prescribed course of action for sustainability. Instead, Pretty argues that sustainable agriculture necessitates a system-oriented approach. In a separate study, Pretty (1995) argues that the notion of sustainability is excessively intricate to be encapsulated by a single

definitive explanation. Instead, Pretty emphasises the necessity of adopting a participative approach. Consequently, the term sustainability is subject to diverse interpretations, posing challenges when applying it to agriculture. The concept of 'Sustainable Agriculture' can have varying interpretations and consequences depending on the specific factors of a given location. Thus, the authors have opted to adopt an interpretative methodology for this study.

Due to conflicting interpretations of sustainability, it becomes challenging to determine what exactly defines sustainable agriculture. To address this issue, it is necessary to have an outline that can serve as the foundation for the current study. Velten et al. (2015) through a systematic literature review, have presented a framework based on goals, strategies and the fields of action chosen to achieve the economic, social, and environmental goals, which shall form the context of current research problem (Table 1).

**Table 1** – Themes and categories making up the goals of sustainable agriculture. Source – (Velten et al., 2015).

Goals	Theme	
	General	Specific
Overarching Goals		<ul style="list-style-type: none"> <li>○ ethics</li> <li>○ multifunctionality</li> <li>○ safety</li> <li>○ stability &amp; resilience</li> </ul>
Environment Goals; Production Specific	ecological soundness	<ul style="list-style-type: none"> <li>○ ecosystem function conservation</li> <li>○ natural resource conservation</li> <li>○ providing capacity</li> </ul>
Environmental Goals; Non-Production Specific		<ul style="list-style-type: none"> <li>○ animal well-being</li> <li>○ environment conservation &amp; improvement</li> <li>○ harmony with nature</li> </ul>
Social Goals	social responsibility	<ul style="list-style-type: none"> <li>○ acceptability</li> <li>○ cultural preservation</li> <li>○ equity, justice, fairness</li> <li>○ fulfilment of human needs</li> <li>○ good working conditions</li> <li>○ human health</li> <li>○ nourishment</li> <li>○ quality of life</li> <li>○ strong communities</li> </ul>
Economic Goals	economic viability	<ul style="list-style-type: none"> <li>○ development</li> <li>○ livelihood</li> <li>○ provision of products</li> <li>○ thriving economy</li> </ul>

The environmental goals are classified into two categories: production specific and non-production specific. The non-production specific goals are focused on preserving nature for its intrinsic value, rather than for human-centred purposes. This framework is highly beneficial for understanding academia's interpretation of the notion. However, the true deficiency is in the understanding of sustainable agriculture's intricacies by practitioners at the grassroots level, the farmers, within their own environmental setting. It is imperative to understand the reasons behind this perception. The perspectives adopted by scientists from different fields in the pursuit of sustainable agriculture can be broadly categorised into two groups: Techno-Economic and Agroecological-Ruralist (Velten et al., 2015). The era of Agriculture 5.0, which incorporates the utilisation of

Artificial Intelligence (AI), Internet of Things (IoT), and Machine Learning (ML) all encompassed by the concept of "Precision Agriculture (PA)," has emerged. However, developing nations have not yet prepared themselves for this advancement.

Altieri (2018) had introduced the concept of an Agroecological approach as a means to achieve sustainability. Agroecology is a diverse ecosystem that is peculiar to a particular location and is founded on traditional indigenous knowledge. It can support itself through the management of natural resources and also includes the aspect of ethnoecology. Wezel et al. (2014) have provided a comprehensive description of the many agroecological techniques and how they can be implemented at different levels i.e. field, cropping system, or landscape. This allows for the improvement of efficiency in a farm, crop, or the entire food system. This demonstrates the robustness and flexibility of agroecological techniques. These solutions not only have the ability to be expanded gradually, but they are also cost-effective and environmentally friendly.

The selection of sustainable practices depends not only on the farmer's financial capacity but also on the broader environment in which he operates. To fully understand the success and impact of the Green Revolution, it is important to consider the perspective of the farmers and the policy framework in the predominantly agricultural economy of Punjab. The credit for the remarkable success of the Green Revolution is ascribed to the innovative farmers of Punjab, but it is equally important to acknowledge the diligent efforts of the policy makers (Hurt, 2020). A comprehensive and resilient support system was established from production to post-harvest sales, with great efficiency. The implementation of government purchase at licenced mandis, with a guarantee of Minimum Support Price (MSP), significantly boosted production. Therefore, it was rational for farmers to embrace a mono-cropping system and utilise contemporary agrochemicals, whether they be fertilisers or pesticides, for their economic and social advancement.

The adoption of sustainable practices is influenced by various aspects, including demographic, socio-economic, and personal value belief systems. Positive factors influencing adoption include education, farming experience, perceived usefulness, perceived ease of use, environmental concern (Ashari et al., 2019; Suwanmaneepong et al., 2020), small land holding, and lower cost per hectare (Digal & Placencia, 2019). Additionally, farmer's knowledge, skill, and competency contribute to adoption (Roy & Chan, 2015). Government institutions and extension teams have a crucial function in shaping policies and engaging in activities, as highlighted by Digal and Placencia (2019) and Mahdavi et al. (2020). The obstacles to the adoption of this technology encompassed financial considerations, limited productivity, absence of viable markets, and profitability concerns (Singh et al., 2023). Although the socio-economic aspects have been considered, the psychological factors, such as farmer perspective, have not been adequately considered when examining the reasons for adopting sustainable practices (Foguesatto et al., 2020). The existing literature extensively supports the importance of crop diversification. However, there is still room for further exploration on the potential for promoting sustainable rice farming in the region. This study aims to answer the following specific questions:

- i) What is an average farmer's perception of cultivating rice with sustainable methods?
- ii) What are the underlying factors for this perception?

### **3. Objective**

Most of the research work conducted on the selected subject and region is carried out through quantitative approaches, primarily focusing on the larger aspect of agriculture. However, there is dearth of specific analysis and understanding about growing rice sustainably. The present study endeavour seeks to address this deficiency by investigating the perception of farmers which is

affecting the rice cultivation in Punjab. The approach being used is qualitative, while considering the contextual aspects. The research focuses on exploring the perception for sustainable rice growing in Punjab by conducting qualitative interviews with farmers from the Moga district of Punjab. The research aims to figure out means and methods to improve the adoption of growing rice sustainably.

#### **4. Research Methodology**

Qualitative research aids in understanding the perspectives and emotions of individuals, allowing for an understanding of the significance people attribute to a specific topic. Additionally, it helps to avoid the inclination to generalise findings to a larger population (Sutton & Austin, 2015). The research methodology employed in this study was qualitative, and the analysis was conducted utilising the grounded theory approach of theme analysis. Data collection is conducted through semi-structured scheduled interviews with 20 rice farmers residing in the Moga district of Punjab. The sample selection was conducted using the purposive sampling technique to ensure representation of all farmer types in Punjab. The inclusion criteria ensured that the farmers interviewed were landowners and engaged in rice cultivation for at-least last 5 years. In addition, they demonstrated a receptive and inclusive attitude for thorough discussion.

The discussions were conducted in an informal manner and in the local language to promote a comfortable and smooth engagement with the research participants. The average time of the interviews was 25 minutes. During the interviews, notes were recorded while also observing the interviewees' surroundings and body language. The sample size was obtained using the principle of data saturation, as described by Boddy (2016). By the eleventh interview, it appeared that the data was being saturated. To prevent any possibility of missing information, nine more interviews were included in the pool.

The verbal transcripts were translated and uploaded as a project in the software MAXQDA 22, and data immersion was followed by the preliminary round of coding with deductive approach. Furthermore, the coding process was executed using a comprehensive and inclusive strategy, enabling the incorporation of supplementary themes. The second round of coding entailed revisiting the coded segments and re-refining the codes keeping in view the contextual depth. The revised codes were collated in an excel and further compiled according to similarities of views expressed and lead to creation of 16 categories. These 16 categories were further consolidated based on operational consistencies and lead to 9 major themes.

#### **5. Result and Discussion**

##### **5.1 Demographics**

All respondents are married males and predominantly belong to a joint family system, with an average of 5 family members. The size of the family is decreasing and there are very few family members providing support for farm labour. The sample reflects predominance of middle age group as the younger lot is increasingly disengaging from agricultural activities. The sample consists of farmers from various land ownership categories, ranging from those with less than or equal to 5 acres to those with more than 25 acres of operational land holding. The entire farm area is dedicated to rice farming. The most conspicuous is the rice variety distribution. The farmer primarily depends on non-Basmati variety for cultivation, with only three farmers from the sample set engaging in Basmati growing on a small portion of their field. The Basmati variety is a high-quality rice known for its long grains, aromatic fragrance, and delicate taste. It is mostly exported from India, with Punjab accounting for approximately 45% of the overall export share. The

highlight is “GI Tagging” of Basmati from Punjab (APEDA, 2016). Basmati is a kind of rice that has a short growth period. Some benefits of growing Basmati rice include the ability to sow it later in the season, which means it may be irrigated with monsoon water. It also has an early harvest, and it tends to fetch higher prices on the market compared to non-Basmati varieties. Yet, it’s seen as a risky proposition due to lack of institutional support in terms of procurement or Minimum Support Price (MSP). The non-Basmati variety, on the other hand, provides a guaranteed return and instils a sense of assurance in the farmer.

It is noteworthy that farmers do not carry out sustainable or organic rice cultivation but in their kitchen garden and wheat farms (which are meant for self-consumption) they do practice sustainable methods. This clearly is a consequence of rice not being a native crop and lacking a place in their plate as staple food. Furthermore, it does not possess any business benefits due to the absence of government procurement.

### 5.2 Thematic Analysis

A word cloud of top 25 codes that frequented a minimum of 10 times across the scripts reflect ‘Profitability’ as the primary code and a significant issue for the farmer Fig 1. The further highlight is ‘additional effort required’ in carrying out sustainable rice cultivation, ‘lack of exclusive market’, and hope for ‘institutional support’ in the form of policy/subsidy, ‘dislike for chemicals’ and a ‘willingness to learn the new ways’ of farming. The second round of coding entailed revisiting the coded segments and re-financing the codes keeping in view the contextual depth. These revised codes lead to 16 categories. The 9 emergent themes from these categories are reflected with frequency distribution in Fig 2.

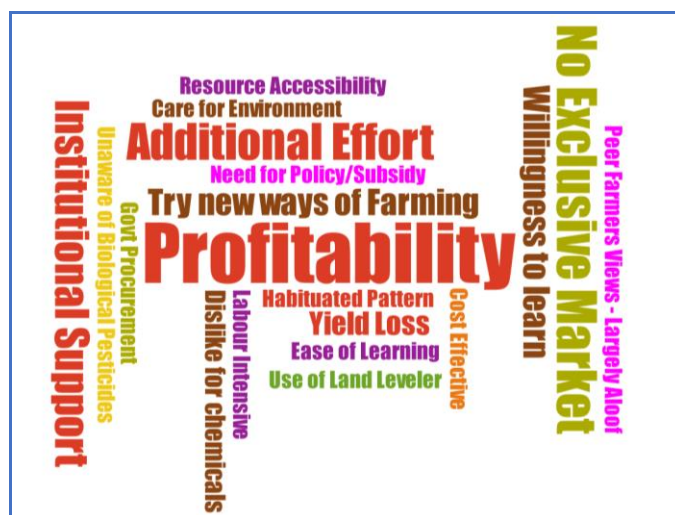


Figure 1– A word cloud of top 25 codes with minimum frequency 10

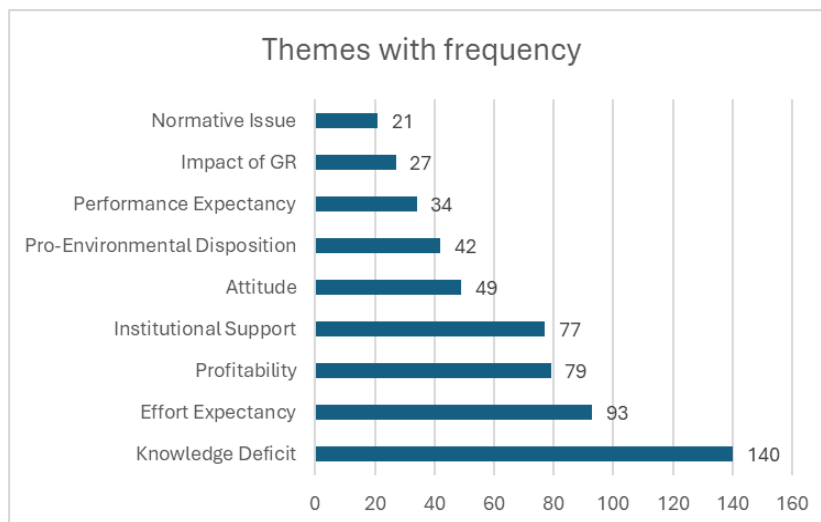


Figure 2 – A graphical representation of emergent themes with frequencies

### 5.2.1 Knowledge Deficit–

As a response to question that what they understood of Sustainable Agriculture, the repeated answer equated with natural farming which has no usage of chemicals and relies exclusively on nature. A couple of them referred that their elders did farming that way and how they themselves dislike the agrochemicals and the mechanical method which leads to disengagement at a deeper level.

“We used to spend the whole day in the fields but now no-one can spend time in the fields, there is smell of pesticides and so much heat, no chirping of birds who used to visit the field for eating the pests. The pesticides have taken away the beauty of Punjab's farms.”

The data analysis also reflects that their usage of sustainable methods is at rudimentary level. However, if they recognise the advantages of a certain practice, they do demonstrate the perseverance to consistently engage in it in a thoughtful manner. A prominent example is usage of land-leveller (a computer aided technique for levelling the farm to conserve water in irrigation) in rice farming. Except one farmer, none had heard of Precision Farming. The Knowledge deficit is discernible from their repeated insistence that it is just not possible to do farming without agrochemical. In addition, they express their dislike for latter by using the term “zehran” (the poisons) for it.

### 5.2.2 Effort Expectancy

Effort expectancy is the second significant element. The prevailing belief is that adopting sustainable techniques would involve abstaining from the use of pesticides, thereby transforming farming into a demanding and time-consuming endeavour that requires physical work. Family members do not provide sufficient help as farm labour. Despite the potential use of locally sourced resources such as compost or Jeevamrit (a pest control remedy derived from Neem, Cow-dung, and buttermilk) for sustainability, the labor-intensive nature of these methods poses challenges for them. Furthermore, the traditional method has been deeply rooted in rice cultivation to the point where it is virtually an automatic routine that does not require any conscious thought. Given their persistent habit, it is logical that farmers exhibit resistance to change and show no enthusiasm towards transitioning to sustainable practices in the present for future.

### **5.2.3 Profitability**

The multiple references to profit with respect of use of Sustainable Agricultural Practices (SAP) are made in terms of fear of yield loss, no price premium, extra cost of labour and its training, no extra advantage of sustainable produce. In addition, the contractual land rates are prohibitive. Farmers also lack an entrepreneurial approach. The side business of dairy is also not lucrative. Farmers are aware of looming environmental dangers, but the economic concerns take precedence. Farmers quote, “Why would I grow other crops which do not fetch me price and profit?” and “If we do not care for our soil, it will get destroyed but I have immediate needs (economic) and that is a harsh reality too.”

### **5.2.4 Institutional Support**

Farmers lament having no policy framework for sustainable rice. There is no Minimum Support Price (MSP), the sustainable produce will sell at the same price as regular crop. There are no exclusive market avenues, neither any storage facility nor extension support. While Basmati is a promising proposition from profit and environmental aspects but there is lack of Basmati focussed export-oriented policy. The government's implementation of a supporting policy framework has played a crucial role in driving the increase in agricultural production and profitability during the Green Revolution. By ensuring the availability of high-quality hybrid seeds and providing free bags of urea for trial, actively engaging the extension team with farmers at the field level to provide guidance and support and establishing cooperative societies to assist farmers with their credit requirements, every aspect related to the goal of increasing production was addressed. This resulted in improved economic profitability and social advancement for the farmers.

It is evident from the information provided that the profitability of rice growing in Punjab is closely linked to the existing institutional framework. There is a scarcity of private companies in the market, and the few that exist are limited to specific areas. In addition, the presence of facilitating environment is also necessary. Despite farmers' awareness of sustainable techniques such as the benefits of sowing green manures, the absence of timely electrical supply for irrigation purposes inhibits their implementation. Although Basmati has the potential to be a sustainable crop in Punjab due to the characteristics mentioned previously in the text, the marketing infrastructure does not support its growth. Due to the absence of storage facilities provided by either the government or market agencies, the farmer is compelled to sell his valuable produce at the merchant's discretion, without the option to wait for a favourable price. It is crucial to note that the markets are not genuinely competitive at now. Evidently, the farmer lacks motivation to implement Sustainable Agricultural Practices for growing rice. The achievement of the Sustainable Development Goals can only be within reach when the fundamental theme of the policy framework is established as such.

## **6. Conclusion**

This study used an interpretive methodology to investigate the attitude of farmers in Punjab regarding the sustainable farming of rice. The analysis of semi-structured interviews conducted using MAXQDA 2022 indicates that the farmer lacks a comprehensive understanding of sustainable agriculture and is unaware of the potential options to preserve his natural environment. His perspective on sustainability is limited to reducing the use of agrochemicals, which he believes is not feasible because he needs to protect his production and profits. He does not perceive any differentiation between terminology such as Organic Farming or Natural Farming. He considers these terms to be interchangeable. His understanding of the Techno-Economic approach to



sustainable rice growing is limited to outdated machinery such as tractors and land-levelers. He lacks knowledge about advanced techniques in agriculture such as Precision Agriculture, Internet of Things (IoT), and big data. His sustainable practices under the Agroecological Ruralist approach include the use of Farmyard manure, periodic seeding of green manure, and a consistent use of micro-nutrients without conducting soil tests. He is not yet aware of the full potential of green chemicals and biologicals, which will undoubtedly play a crucial role in the future of sustainable farming. The coded segments from verbal scripts of farmers reveal nine significant factors: Knowledge deficit, Effort Expectancy, Profitability, Institutional Support, Attitude, Pro-environmental disposition, Performance expectancy, Impact of green revolution, and Normative issue. If these variables are effectively handled, they can lead farmers towards sustainable rice agriculture and halt the ongoing deterioration of Punjab's soil and water resources. The primary purpose of a farmer is to maximise profitability in their farming business, as their social status is closely tied to financial gains.

The understanding and insight gained through this research work helps us appreciate the debate around three pillars of sustainability. A farmer quotes on adoption of sustainable practices, "My son is studying right now; he would be in +2 in three years and then I intend to send him off to Canada for which I need money. Once this project is taken care of, I will resort to organic farming."

This response can be understood as emphasising the importance of immediate economic goals, such as profitability. It also suggests that sending the son to Canada is a social goal that can be achieved by pursuing economic goals. Additionally, it indicates a pro-environmental attitude with an intention to adopt environmentally friendly behaviours in the future, although this may be postponed. Lastly, it questions the feasibility of achieving environmental goals through organic farming, as it may not generate as much profit as conventional farming. Another response goes as, – "I could be doing a service to future generations and mankind by using SAP in rice cultivation, but I must make profit for myself too. Yield loss due to not using the chemicals can affect me badly."

It is clear that economic gains are given priority. We must also be aware that while working with farmers in Punjab, we are not dealing with individuals who lack resources, knowledge, or training, and who are struggling to make ends meet. They possess exceptional intelligence, boundless energy, a strong entrepreneurial spirit, and remarkable skill. As the first to introduce an agricultural revolution in the country, they have the capacity and opportunity to lead the way in the next transformation. A Punjabi farmer has the potential to smoothly shift from being a representation of the green revolution to becoming a symbol of sustainable rice agriculture.

## **7. Implications**

The need for sustainable agriculture in Punjab has been of primary concern for decades now. The findings of this research advance our understanding on the scope of sustainable rice cultivation from farmer's point of view. The current study has its value in the policy formulation as the farmers have freely expressed their reservations and expectations regarding the adoption of sustainability. The foremost aspect is the need to bridge the knowledge gap through mobilisation of extension teams. The latter can collaborate with local farmers at the grassroots level in different locations to establish 'successful model farms', which can then be replicated by other farmers. This study confirms the necessity of implementing a specific strategy that encourages sustainable production via the use of differential pricing and favourable market infrastructure. This research

effort emphasises the necessity of implementing certain measures to support the growth of the 'GI tagged Basmati variety'.

### 8. Limitations and Future Scope of Work

The analysis is based on the perspectives of farmers from Moga district, Punjab, who exclusively employ conventional farming techniques and do not engage in any sustainable practices. Future research could be extended to a wider geographic area of Punjab. In addition, the future study could utilise a combination of qualitative and quantitative research methods to enhance the credibility of the results, followed by conducting a survey on a broader sample size to validate the findings.

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