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Constraints in the Adoption of Stress Tolerant Rice Varieties (STRVs) in Odisha

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HIGHLIGHTS

- Low literacy, social inequality, and risk aversion hinder technology transfer.
- High input costs, labor expenses, and loan difficulties restrict adoption.
- Negligence, seed shortages, and inadequate training programs remain major constraints.

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ABSTRACT

The study investigated barriers to the adoption of stress-tolerant rice varieties (STRVs) among farmers in Odisha during 2024-2025. Data from 240 randomly selected farmers, collected via an ex-post facto design and analysed using Henry Garrett's ranking technique. The analysis revealed key constraints across social, economic, managerial, technological, and organisational dimensions. Major barriers identified were low literacy, social marginalization, risk aversion, high input costs, limited financial literacy, weak post-adoption evaluation, insufficient STRV knowledge, inadequate demonstration trials, and poorly designed training programs. The results highlight the complex interplay of these obstacles and emphasise the need for comprehensive interventions–such as targeted literacy and capacity-building initiatives, improved financial support, adaptive extension services, and participatory demonstrations, all tailored to meet the needs of marginalized farmers to enhance STRV adoption in the countryside.

INTRODUCTION

Agriculture remains vital to Odisha's economy, employing 49 per cent of the workforce and supporting over 60 per cent of its population. Despite a declining Gross State Democratic Product (GSDP) share, it remains key for rural employment and food security. Among the different sectors, the crop sector still enjoys the dominance of over 61 per cent of contribution towards agricultural Gross State Value Added (GSVA). With foodgrain production of 143 lakh MT, Odisha ranks fifth among all states in rice production, accounting for eight percent share in the nation's total production and is cultivated in 45 per cent of Gross Cropped Area (Odisha Economic Survey 2024-25, 2025). With agriculture being the cornerstone for the livelihood of countryside and shaping state's economy, rice reigns as the primary player in crop cultivation and production in the state (Murali Krishna et al., 2025). But in contemporary times of changing climate under the aegis of global warming, this also affects the surrounding environment of paddy fields, which has have significant impact on their potential yield. Paddy during the reproductive stage i.e., flowering and grain filling stage, is the most vulnerable phase to stresses due to heat, drought, cold, saline or alkali or even in combinations of these, which are more than their individual effects as well as at low levels (Sinha et al., 2023). So, stress-tolerant varieties prominently come into the picture of managemental strategies of stresses that the crop has to face (Dar et al., 2021).

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Stress-tolerant rice varieties are crucial for farmers in Odisha, India, where droughts and floods significantly impact rice production. Studies show that farmers in both drought-prone and flood-prone regions value stress-tolerant cultivars and are willing to pay a premium for these traits (Arora et al., 2019). Field experiments demonstrate the superior performance of drought-tolerant varieties like Swarna Shreya compared to local checks in various districts of Odisha. Swarna Shreya consistently outperforms other varieties in terms of yield, economic returns, and agronomic characteristics (Mohanta et al., 2024; Mangaraj et al., 2021). For instance, in Bolangir district, Swarna Shreya showed a 13-15 per cent increase in yield compared to the farmers' practice variety (Mohanta et al., 2024). Similarly, in Ganjam district, Swarna Shreya recorded significantly higher grain yield, straw yield, and economic returns compared to farmers' practice (Mangaraj et al., 2021). These findings highlight the importance of adopting stress-tolerant rice varieties to enhance productivity and farmers' income in Odisha's rainfed ecosystems.

Adopting stress-tolerant rice varieties is vital for climate resilience, yet uptake remains limited due to awareness gaps, seed access, and market concerns (Vergara et al., 2023; Khanam, 2023). Extension efforts, peer learning, and public–private collaboration are key to improving adoption in vulnerable regions (Dar et al., 2020). In this regard, an investigative attempt to analyze the constraints affecting the technology transfer of STRVs in Odisha.

METHODOLOGY

The investigation was conducted in the two districts of Odisha: Puri and Kalahandi as these are prone to cyclones (Bahinipati, 2014) and the drought (Swain et al., 2024), respectively. A multistage random sampling strategy was employed, starting with the random selection of two blocks from each district. Four villages were randomly chosen from each block, resulting in eight villages overall. The study's participants were farmers engaged in paddy cultivation for a minimum of three years, ensuring that respondents had sufficient experience and thus were selected purposively. Each village contributed 30 farmers, leading to a total sample of 240 farmers. To validate the main questionnaire, a pre-test was conducted with 10 per cent of the sample size, prior to the principal data collection. Although the questionnaire was first written in English, it was clearly communicated to respondents in Odia, their local language, to promote understanding and accuracy. The insights gained from pretesting guided the revision and refinement of the final interview schedule. Data were collected using face-to-face interviews in the respondents' homes, fostering genuine and open responses (Jayasingh & Mishra, 2024). This process was conducted between September 2024 and May 2025, following an ex-post facto design. There are number of methods were there at disposal for dealing with constraint analysis but Henry Garrett's ranking technique was executed to assess the challenges faced by farmers in adopting STRVs.

RESULTS

A broad array of factors was found to be restricting the adoption of stress-tolerant rice varieties by farmers. For better understanding, these factors were placed into separate categories and elaborated in the following sub-sections.

Social constraints

The information depicted in Table 1 speaks about the seriousness of the issues that were proving to be roadblocks for technology adoption of rice cultivars which were of stress tolerant in nature. The issue 'Low literacy levels hindering comprehension' was the most serious one with maximum mean scores of 67.52 followed by 'Social inequality and marginalization of resource poor' (59.34) and 'Risk aversion due to fear of crop failure' (54.12) as the next two prominent issues. Likewise, other issues comprised from 'Strict adherence to conventional norms' to 'Dependency on local leaders resisting to change' have been put-together in the list with their respective ranks as given to them on the basis of seriousness seen by the farmers. These findings do draw analogy to that of Muthukumar et al., (2020) & Usha et al., (2021).

Economic constraints

This section speaks about the issues towards technology adoption of stress tolerant rice varieties which are of economic in its nature as depicted in Table 1. The issue 'Higher capital outlay for farming inputs' with the mean score of Garrett value '64.33' was found to be highest, followed by 'Increased labour costs during transplanting and harvesting' (57.87) and 'Lack of comprehensibility towards loan approval' (55.56) as second and third ranked issues. The next in line were from 'Higher rate of interests on loans' to 'Lack of crop insurance coverage for risk mitigation' as ranked on the basis of perception of seriousness of respondents. These results showcase similarities to those studies conducted by Gireeesh et al., (2019); Usha et al., (2021); Sabu & Roy (2024).

Managerial constraints

The information depicted in the Table 1 below the section of economic constraints expresses the issues related to managerial aspects as faced by the respondents. The top-most ranked troubles as rated by the respondents found to be 'Negligence to post-adoption evaluation and feedback system' with mean score value of 77.81 followed by 'Weak linkage with input suppliers and market intermediaries' and 'Gaps in channels to extension agents and researchers' with the corresponding mean score values of 73.22 and 69.33. Likewise, other constraints have been ranked accordingly as per the seriousness perception by farmers.

Technological constraints

Under this section where it speaks about the technological related barriers that proved to be roadblocks for adoption of STRVs for farmers, the first, second and third ranked constraints were found to be 'Limited availability of region specific STRV seeds', 'Insufficient demonstration trials in stress-prone areas' and 'Lack of tools for monitoring and evaluation' with the corresponding mean scores of 74.78, 70.57 and 64.71 respectively. Likewise, from 'Poor integration of STRVs into local cropping systems' to 'Inappropriate system of monitoring and evaluation' have been listed with their corresponding rankings based on seriousness to be dealt with according to the farmers. The findings were quite similar to that of Sangeetha et al., (2018) & Kumar et al., (2023).

Table 1. Constraint as opined for transfer of STRVs

S. No.	Statements	Mean	Rank
	Social constraints		
1.	Low literacy levels hindering comprehension	67.52	I
2.	Dependency on local leaders resisting to change	36.33	VII
3.	Risk aversion due to fear of crop failure	54.12	III
4.	Strict adherence to conventional norms	47.54	IV
5.	Peer pressure and fear of criticism	42.17	V
6.	Social inequality & marginalization of resource poor	59.34	II
7.	Restricted networks to their closely knitted groups	39.33	VI
	Economic constraints		
1.	Higher capital outlay for farming inputs	64.33	I
2.	Limited access to proper marketing channels	46.35	V
3.	Limited access to institutional credit	38.88	VI
4.	Lack of comprehensibility towards loan approval	55.56	III
5.	Lack of crop insurance coverage for risk mitigation	34.33	VII
6.	Higher rate of interests on loans	49.11	IV
7.	Increased labour costs during transplanting and harvesting	57.87	II
	Managerial constraints		
1.	Absence of record keeping to keep track on activities	58.33	IV
2.	Lack of decision-support tools to assess and act	37.59	VI
3.	Weak linkage with input suppliers and market intermediaries	73.22	II
4.	Proactive approach to climatic issues instead of reactive one	46.44	V
5.	Negligence to post-adoption evaluation and feedback system	77.81	I
6.	Inadequate integration of STRVs into broader enterprises	29.79	VII
7.	Gaps in channels to extension agents and researchers	69.33	III
	Technological constraints		
1.	Absence of digital platforms for advisory and trouble-shooting	44.31	VI
2.	Availability of sub-standard quality of farming inputs	37.84	VII
3.	Limited availability of region specific STRV seeds	64.71	III
4.	Insufficient demonstration trials in stress-prone areas	70.57	II
5.	Lack of technical knowledge of STRVs	74.78	I
6.	Limited access to climate resilient agronomic practices	50.27	V
7.	Poor integration of STRVs into local cropping systems	56.75	IV
	Organizational constraints		
1.	Training locations far-away from the villages	54.49	IV
2.	Less number of exposure visits	67.71	II
3.	Training timings unsuitable for most of the farmers	61.38	III
4.	Training programmes were less practical oriented	47.23	V
5.	Lack of season long training programs	76.73	I
6.	Fragmented linkage in inter-organizational relations	33.89	VII
7.	Lack of field day visits	41.22	VI

Organizational constraints

As depicted in table, the primary issue was found to be the first ranked 'Lack of season long training programs' (76.73) followed by second and third with 'Less number of exposure visits' and 'Training timings unsuitable for most of the farmers' with their respective mean Garrett scores of 67.71 and 61.38 respectively. The other issues from 'Training locations far-away from the villages' to 'Training timings unsuitable for most of the farmers' were accordingly ranked down based on the mean Garrett scores. The findings were similar to that of Das et al., (2014); Hareesh (2017) & Usha et al., (2021).

DISCUSSION

Under social constraints, at first was the low literacy which impairs farmers' ability to interpret agronomic instructions, evaluate varietal benefits, and engage with extension materials, thereby limiting their capacity to adopt STRVs and thus reducing productivity gains. Dar et al., (2021) & Mehar et al., (2022) have also concluded on the same lines of the context that educational disadvantage of farming communities keeps them deprived of any sort of technological innovation. Social inequality and marginalization of resource-poor farmers restrict access to extension services, quality inputs, and credit facilities, thereby impeding the adoption of STRVs and reinforcing vulnerability in stress-prone regions. Dar et al., (2020) had showcased how marginalized farm sections face pronounced barriers to accessing from the likes of agri-extension services, seeds and other resources. Risk aversion driven by fear of crop failure discourages farmers from adopting unfamiliar STRVs, stifles experimentation, delays trials, and reduces feedback, ultimately hindering technology transfer, institutional learning, and wider regional adoption. According to Akter et al., (2025), it has been observed that in most of the cases, risk managing farmers tends to better adoption of STRVs since uncertainties in the yield production can compel them towards reduced adoption.

In the banner of economical constraints for adoption of STRVs, higher capital requirement for inputs such as irrigation systems, fertilizers, and machinery, limits the resource-poor farmers' ability to adopt STRVs, despite their low-risk benefits. Raghu et al., (2025) revealed that smallholder farmers face economic challenges adopting STRVs due to limited finances, which hinder technology adoption and widen productivity gaps in vulnerable regions. Rising labour costs during transplanting and harvesting increase production expenses, discourage adoption of new rice varieties, and strain smallholder budgets. This reduces experimentation, delays uptake, and hampers the effective technology transfer as affirmed by Das et al., (2025). Owing to their low levels of educational background, limited understanding of loan approval processes deters farmers from accessing financial support for adopting STRVs This restricts input purchase, delays experimentation, and ultimately hampers widespread technology transfer and adoption. Patil & Veettil (2024) had pointed out in their study about the issues of higher transplanting and harvesting costs deterred variety adoption, strain budgets, and reduce experimentation accompanied with limited financial literacy which has hindered the access to credit, stalling input use and technology transfer.

The constraints under managerial section has been discussed further in the incoming passage. Neglecting post-adoption evaluation hinders learning from farmers' experiences, obscures performance data, and blocks iterative improvements. It weakens trust, disconnects researchers from field realities, and impairs future outreach which leads to stalling technology transfer and compromising long-term success of STRV adoption. This same nature of obstruction to technology adoption due to lethargy towards evaluation in post-adoption phase has been reported by Vaiknoras & Larochele (2025) in their research ventures conducted in Nepal. Poor linkage with suppliers and intermediaries limits farmers' access to seeds, fertilizers, and buyers which in turn hinders adoption of STRVs. It disrupts support networks, impairs coordination, and stifles market flow, leads to weakening overall effectiveness of technology adoption initiatives. The disruption of input accessibility and market coordination due to incapacitation of supplier-intermediary connective bonds which leads to limitation of scalability of STRV technologies has also been reported in studies conducted by Mehar et al., (2022) in eastern India comprised of eastern Uttar Pradesh, Bihar, Odisha and West Bengal. Limited connectivity with extension agents and researchers weakens advisory support, delays information flow, restricts farmer training, and reduces feedback loops—hindering the effective dissemination and adoption of STRV technologies. In analogy to this, Ojo et al., (2024) inferred that feebleness in the bond between extension agents and researchers lags the advisory system, limits training and eventually deprives of technological transportation of STRVs as observed in the farmers of north-Central Nigeria.

Under the technological viewpoint, lack of technical knowledge of STRVs limits farmers' ability to apply recommended practices, assess performance, and manage inputs effectively. This reduces confidence, leads to poor outcomes, and ultimately hinders technology adoption. Vaiknoras & Larochelle (2025) reiterated on the emphasis laid on the know-how on the STRVs along with the awareness regarding newer cultivars of STRV types and older available ones by the farmers. Insufficient demonstration trials in stress-prone areas erode farmer confidence, obscure real-world performance, and limit practical learning. Without visible proof of effectiveness under local conditions, adoption stalls, reducing stakeholder buy-in, delaying feedback, and hindering the technology transfer of STRVs. The importance of demonstration trials have been laid by Dar et al., (2021) in their study which advocates that head-to-head trials in farmers' fields with the support of KVKs and NGOs, has enhanced the altitudinal boost needed for adoption of STRVs in Eastern India's undeserved region. Insufficient monitoring and evaluation tools hinder performance tracking, feedback collection, and impact assessment (Saha et al., 2024). This limits refinement, discourages evidence-based scale-up, and ultimately impedes effective technology transfer of STRVs to farmers. Yamano et al., (2018) also laid emphasis on the continuous monitoring and evaluation on the farming operations of Sahbhagi Dhan in the farmer's field.

Without season-long training, farmers lack critical knowledge on stress tolerance traits, agronomic practices, and optimal timing for implementation. This knowledge gap leads to misapplication, reduced confidence, and poor adoption of STRVs, weakening the effectiveness of technology transfer. Prasad Babu et al., (2021) in their study also reaffirmed the importance of season long training programme on the knowledge level of personnel targeted in the training programme. Fewer exposure visits limit farmers' first-hand experience with STRVs, reducing trust, practical understanding, and peer influence, which were the crucial factors of adoption and thereby undermining technology transfer effectiveness. The studies conducted by Vergara et al., (2023) also supports the pre-eminence of the exposure visit for the effective transfer of STRV technology. Unsuitable training timings often overlapping with peak farming activities, restrict farmers' participation and attention, resulting in poor knowledge absorption and delayed adoption of STRVs. The issue of timing mismatches in technology transfer is critical as effective contact between farmers and extension workers is essential as concluded by Dibba et al., (2019).

CONCLUSION

The study underscores the multifaceted constraints that hinder the transfer and adoption of stress-tolerant rice varieties among resource-poor farmers in vulnerable regions. Social barriers such as low literacy and marginalisation limit engagement with extension services and technological innovations. Economically, high input costs, rising labour expenses, and limited financial literacy prevent farmers from investing in STRVs. Managerial challenges, particularly weak post-adoption evaluation and inadequate supply-advisory linkages, further impede technology diffusion. Technologically, inadequate knowledge, insufficient demonstration trials, and limited monitoring reduce confidence and practical learning. Organizational limitations, including mismatched training schedules, minimal exposure visits, and a lack of season-long capacity-building, further restrict adoption. The interconnected constraints stall institutional learning and reduce farmers' ability to adopt climate-resilient practices requires integrated, context-specific strategies are needed, such as enhancing literacy, expanding financial access, strengthening extension networks, and tailoring participatory learning models to improve the uptake of STRVs and fortify agricultural resilience across stress-prone landscapes.

DECLARATIONS

Ethics approval and informed consent: Informed consent was sought from the farmer respondents of the study.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author declares that they have thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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