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RESEARCH ARTICLE

Perception of the rice growers of Bhadrak district of Odisha towards hybrid rice cultivation

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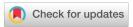
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Abstract

Hybrid rice is of great prominence in the modern farming era due to its potential to enhance productivity, resilience, and sustainability in rice cultivation with the given set of conditions, ultimately towards securing food security and financial progress of the farming community. Even though the folklore of its advantages is well announced in the scientific fraternity, it is of great importance to explore its presence amidst the mindsets of the farming communities who are the real intended beneficiaries of such innovations. In this context, a research study was conducted to evaluate and assess the levels of perception of rice farmers in Odisha. This study was conducted in the Bhadrak district of Odisha. 80 farmers were chosen as samples by multi-stage sampling in a purposive manner. Data collection was executed using a personal interview method, where perception was measured using the Likert scale with modifications. The majority of respondents had a favourable assessment of soil and climate under ecological conditions since they were judged to be acceptable for hybrid rice. Their perception regarding fertilizer, plant protection chemicals, and irrigation was also found to be positive. They expressed negative perceptions regarding rainfall patterns and temperature under ecological conditions, which were found to be unsuitable. The majority had expressed moderate levels of overall extent of perception. The majority of the respondents were middle to aged, coming from medium to large sized family, earning in the range of Rs. 93,247 to Rs. 2,56,442 annually, acquiring moderate to high levels of experience in farming activities, and demonstrating moderate extent nature in case of education, achievement motivation, risk orientation, extension participation, mass media exposure and market accessibility. Parameters like age, education, mass media exposure, and market accessibility demonstrated their significant association with overall perception, indicating the importance of leveraging these factors in initiatives to improve perceptions of hybrid rice.

Keywords

rice growers; hybrid rice; cultivation; overall perception; association; profile

Introduction

The livelihood of the majority of the Indian population is assured by their involvement in farming activities (1) in which rice is a labour-cum-energy exhaustive cereal crop that has been dominating in the spheres of farm production as well as end consumption (2) as currently it is still entitled to

calorie supplier for two-third of the population existing in this planet (3). The prominent reason for the dominance of rice in the farming sector, even in this era, because it is still regarded as the dominant calorie provider for the masses' diet of the nation and covers about 35 percent of the total area under food grains and therefore essaying an important position in Indian agriculture (4). India ranks as the world's second-largest producer of rice, following China (5). A significant portion of the rice grown in India is cultivated and consumed in the eastern region of the country (6, 7). In eastern India, Odisha stands out as a key state for rice production (8). The rice production in Odisha primarily occurs in small land plots, each with varying crop management approaches. Therefore, it can be regarded as rice cultivation galvanizing the livelihood earnings of numerous small farmers, thus ensuring the nutritional security of the state as a whole (9). However, the average rice yields in Odisha fall notably below the national average (10) as these areas face challenges like droughts and floods, which significantly impact rice yields (7). Therefore, it seeks to draw attention from the already existing conventional approaches to the newly designed innovative ones to take a head-on approach to these existing issues. According to (11), innovative solutions such as 'Hybrid rice' can significantly transform the rice production scenario through increment in the productivity and on-farm income of farmers, especially for small farmers. Rice has been one of those crops to show significant hybrid vigor, resulting in an approximate 20 percent boost in yield within the F1 hybrid compared to the original parental strains (12, 13) and thus, in this way, this technology has made a prominent contribution towards employment opportunities, food affluence and environmental sustainability (14).

Rice stands as a crucial staple crop worldwide, with hybrid rice technology significantly augmenting its production, thereby safeguarding global food security. As society advances and living standards improve, there's been a steady rise in the demand for higher-quality rice (15, 16). The true potential of hybrid rice can be achieved by employing effective management practices (17) associated with an effective communicative linkup at different strata with rice growers (18). It has been opined that for hybrid rice at the global level, the seeds market is going to widen by 7.7 percent of the compound annual growth rate, and the market valuation is to be raised from USD 5.1 billion to USD 10.8 billion by 2033 (19). The progressive vibes in hybrid rice technology in India have filled the hopes of both the production and consumption systems of rice with a vile optimism. In the last year of 2022, the area under hybrid rice cultivation was 3.5 million hectares, and around 80 percent of it belongs to the states of Chhattisgarh, Madhya Pradesh, Haryana, Jharkhand, Uttar Pradesh, and Odisha (20). Rice is the primary diet of nearly the entire population of Odisha, accounting for over 69 percent of the cultivated area and contributing just under 63 percent of the total area under food grains (21). Therefore, the technology of hybrid rice can be a bonus to the state's satisfaction with the rice production system.

The evolution of an economical and efficient seed development package becomes necessary for ensuring its expediency regarding the economic and commercial plausibility of hybrid rice technology (22). Quality seed material has become a prominent player in boosting production (23). There exists immense potential for the success of hybrid rice in the state farming system, for which the state departments are continuously working to adopt it by the farmers. Still, there are some roadblocks in its adoption, which might be owed to the impression that the technology concerned has a positive impact on the minds and souls of the farmers. In this regard, research was carried out to assess the perception of rice growers towards hybrid rice in the Bhadrak district of Odisha. This investigation, at first, is about the analysis under different dimensions of the perception followed by the overall perception context, and then the next part concerns the profile studies for drawing out its relevance in the context of the perception of the farmers towards hybrid rice cultivation.

Materials and Methods

The investigation was conducted in the Bhadrak district of Odisha, and the concerned district has been chosen purposively owing to because the rice farmers were found to be upgraded in terms of progressiveness and advancement in their production activities against their counterparts in other regions, which can be witnessed by the significant contribution to the state's rice production levels. The sample for the investigation was drawn out by employing a multistage sampling technique to select villages, blocks, and subdivisions under the concerned district.

Selection of blocks

The district is comprised of only one subdivision with the same name, and it comprises a total of seven blocks. Only one block named 'Basudevpur' has been chosen because of its rigorous cultivation scenario, as evidenced by being the highest net sown area under the district and also of its vicinity of KVK-Ranital and Regional Research, and Technology Transfer Station (RRTTS)-Ranital in the aspects of the ease in technological dissemination and consultations as needed for the rice cultivation in both Kharif and Rabi seasons along with the presence of a sound and synchronous marketable accessibility in the post-harvest timeline.

Selection of village

A complete list of all villages covered under the purview of the corresponding blocks was prepared with the help of data provided by block agricultural departments, and then, in total, four villages named Haripur, Sahada, Kuruda, and Kamaragaon were selected randomly from their respective four blocks.

Selection of respondents

Farmers of the concerned region were taken up as respondents who were operationally defined as the personnel either individually or in groups indulged in farming activities. A complete list of all the farmers residing in the sample arena was drawn out from the information provided by the block agricultural departments as well as district agricultural departments and then cross-checked by the sources like sarpanches, teachers, etc.

20 farmers belonging to each of the above-mentioned four villages were selected randomly, which constitutes an aggregate of 80 farmers, as respondents were contemplated in the sample. An interview schedule was prepared with expert guidance, and a literature review was tailored to the objectives of the investigation. The schedule was pretested on 10 % of the sample size, and even though prepared in English language, it was read out to farmers in the local language of Odia to evoke proper responses from them. Feedback was taken from them, and it was later used to improve the schedule structure for relevancy and validity before making the final draft of the interview schedule. Data collection was executed by employing the interview schedule with the support of Kissan Saathi, local leaders, Sarpanch, Gram Panchayat members, and Assistant Agricultural Officers of the respective region at the respondents' homes and workplaces, ensuring an informal environment to ensure evoking appropriate responses and honest answers without any external interference. This process was conducted in the April to November 2022 timeline, coinciding with the state's rice season. The investigation was conducted using an *ex-post facto* research design.

Data Analysis

Perception of hybrid rice

For the study, the 'perception of rice growers towards hybrid rice' has been put into practice as to how the technology of 'hybrid rice farming' has been considered, comprehended, or construed by the rice growers of the area of inquiry. Here, the Likert scale has been used with conceptual modifications as stated by (24), where the analysis of perception has been divided into different dimensions – 'Ecological condition', 'Input supply', 'Advisory services' and 'Government policy system'. The dimension "Ecological condition' has four items against which responses were taken on a three-point continuum, such as Not suitable', 'Suitable,' and 'Most suitable' associated with their assigned scores of 1, 2 and 3, respectively. The dimension 'Input supply' has seven items to which responses were received on a three-point continuum such as 'Easily available', 'Available', and 'Not available' with their corresponding assigned scores of 3, 2 and 1, respectively. The dimension 'Advisory services' was comprised of six items against which responses were collected on a four-point continuum as 'Easily available', 'Available', 'Occasionally available' and 'Not available' with their corresponding assigned scores of 4, 3, 2 and 1. The last one, named 'Government policy system,' constituted five items to which responses were taken on a three-point continuum of 'Available', 'Occasionally available,' and 'Not available' with the scores assigned to them as 3, 2 and 1, respectively. Likewise, the cumulative scores were obtained to whom the mean score and then the gap percentage were calculated by the following:

Total obtained score = Addition of scores from all respondents concerning the variable

$$\text{Mean Score} = \frac{\text{Total Obtained Score}}{\text{Total number of respondents}}$$

$$\text{Gap percentage} = \frac{(\text{Total obtained score} - \text{Mean Score})}{\text{Maximum possible score}} \times 100$$

Here, the gap percentage denotes the distance between the existing perception levels (mean score) and the desired perception levels (total obtained score or maximum score) of farmers towards hybrid rice under different dimensions, which, in a way, would be helpful to analyze in aspects the farmer face lacunae regarding hybrid rice farming, that would be targeted in the action-follow up by the respective stakeholders of farming through the lenses of farmers' mindset.

The scores yielded under each dimension were summed up to get the overall score of perception of the concerned farmer respondent and likewise so obtained for all the respondents. Then, the average and standard deviation of all the scores were calculated and then employed under half standard deviation to determine the lower and higher limits for categorization of the respondents into the levels of 'low,' 'medium', and 'high' the respondent's overall perception towards hybrid rice cultivation. The following tabular illustration gives a brief picture regarding the classification into the categories as depicted in Table 1.

Table 1. Classification of respondents based on the scores obtained for overall perception level

Category	Criteria
Low	Less than (Mean – ½ SD)
Medium	Between (Mean ± ½ SD)
High	More than (Mean + ½ SD)

$$\text{Mean Score (m)} = \frac{\sum_i^N X_i}{N} = \frac{\text{Total Obtained Score}}{\text{Total number of respondents}}$$

$$\text{Standard Deviation of the scores (SD) (s)} = \sqrt{\frac{\sum_i^N (X_i-\mu)^2}{N}}$$

where, X_i = scores of ith individual in the respective variables, N= total number of respondents

The individual respondents were categorized based on their scores obtained, which, in perception, fall under the values of respective criteria. Then, the frequency of respondents falling under each category was enumerated and transformed into percentages to yield the results.

Socio-economic profile of farmer respondents

The investigation of the profile study uses independent variables, which can be classified into two categories. One set comprised of the likes of 'Age', 'Family size', 'Farming experience', and 'Annual income' whereby the data analysis is simple in which the respondents were directly asked to answer against criteria of the variables concerned.

The frequency of the respondents under each categorical classification was enumerated, and their corresponding percentages out of the total sample were calculated.

The other set of variables incorporated the likes of 'Education', 'Achievement motivation', 'Risk orientation', 'Extension participation', 'Mass media exposure', and 'Market accessibility' as they are qualitative. Thus, the data analysis of such variables was implemented by the use of standardized scales and procedures, which were developed, tested, and validated under their respective authors, were selected, and then incorporated into the interview schedule with some slight changes in their composition to remain suitable for the concerned investigation as well as respondents. A brief introduction to the techniques and tools employed in the data analysis of the results obtained for the corresponding variables is considered in the investigation in the following table (Table 2).

Table 2. Variables and their empirical measurement

Sl.No.	Variables	Empirical Measurement
1.	Age	Chronological age of respondents (in years completed)
2.	Education level	Procedure followed by Devarajaiah (2010)
3.	Family size	Schedule developed for the study
4.	Farming experience	Schedule developed for the study
5.	Annual income	Schedule developed for the study
6.	Achievement motivation	Scale developed by Reddy (1976) with modifications
7.	Risk orientation	Scale developed by Supe (1969) with modifications
8.	Extension participation	Schedule developed for the study
9.	Mass media exposure	Procedure followed by Kusumalatha (2018) with modifications
10.	Market accessibility	Procedure followed by Lakshman Reddy (2019)

The implementation of such standardized tools to evoke responses from the respondents is then converted to scores definitive to that particular respondent. The mean and standard deviation of all the obtained scores were calculated, and it was used under the half standard deviation method to determine the lower and higher limits for categorization of the respondents into the levels of 'low', 'medium', and 'high' in the respective variables. The following tabular illustration gives a brief picture regarding the classification into the categories. (Table 3.)

Table 3. Classification of respondents based on the scores obtained for individual variables.

Category	Criteria
Low	Less than (Mean $-$ ½ SD)
Medium	Between (Mean $\pm$ ½ SD)
High	More than (Mean $+$ ½ SD)

$$\text{Mean Score (m)} = \frac{\sum_i^N X_i}{N} = \frac{\text{Total Obtained Score}}{\text{Total number of respondents}}$$

Standard Deviation of the scores (SD) (s) $= \sqrt{\dfrac{\sum_i^N (X_i - \mu)^2}{N}}$

where, X_i = scores of ith individual in the respective variables, N= total number of respondents

The individual respondents were categorized based on their scores obtained in the respective variable, falling under the values of the respective criterion range. Then, the frequency of respondents falling under each category was enumerated and transformed into percentages to yield the results.

Chi-Square analysis

This test is used to find out whether there is an association or relation between the attributes that have a categorical classification in their data. The notion behind the application of such a test is that since the investigation deals with variables with different scales of measures such as ordinal (education level, achievement motivation, risk orientation, extension participation, mass media exposure, and market accessibility) and ratio (age, family size, farming experience, and annual income) levels, any sort of statistical analysis cannot be performed by any of conventional parametric tests like correlation. The chi-square test, being the most powerful non-parametric test, can assess the data irrespective of its measurement scale, where the only condition requisite is that the data be in categories. That is why the chi-square test is suitable for these reasons (25, 26).

The chi-square statistic can be used when two or more categories are involved in attributes)in this case, its independent and dependent variables). The frequency of each category for one variable is compared across the categories of the other variable. The data can be displayed in a contingency table where each row represents a category for one variable, and each column represents a category for the other variable.

$$X^2 = \sum_{i=1}^{r} \sum_{j=0}^{c} \frac{(O_{ij} - E_{ij})}{E_{ij}}$$

Where, O_{ij}= Observed values of the variables, E_{ij}= Expected values of the variables ,Degrees of Freedom (df) = (r-1)(c-1) *r* = Number of rows and *c* = Number of columns

At first, the transformation of the scores obtained in all the dependent variables, as well as the independent variable, is employed by converting the scores obtained in different categories of the concerning variables into '1', '2', '3', and so on up to the number of categories present in that variable. After this assignment procedure, the chi-square technique was employed to determine the relationship between the respective variables of concern. Here, the 'observed values' take the transformed values of inde-

pendent variables, whereas the 'expected values' take the transformed values of dependent variables. After calculating the test statistic, it is compared either to a critical value derived from the chi-square distribution, where the degrees of freedom are determined by the dimensions of the contingency table, or to the p-value associated with the test statistic obtained from software or statistical tables. If the calculated chi-square statistic exceeds the critical value (or if the p-value is below the chosen significance level, typically denoted as 'α'), the null hypothesis is rejected, indicating evidence supporting an association between the two categorical variables. Conversely, if the chi-square statistic does not surpass the critical value (or the p-value exceeds α), there is insufficient evidence to reject the null hypothesis, suggesting no significant association between the variables.

Results and Discussion

Perception of rice farmers toward hybrid rice cultivation

Ecological condition

'Soil' under the ecological component for hybrid rice cultivation opined to be most suitable by nearly half (52.50 %) of the respondents, with the lowest gap percentage of 17.67 percent. 'Climate' was opined to be suitable by 42.50 percent followed by most suitable (35.00 %) and not suitable (22.50 %) with a corresponding gap percentage of 26.00 percent. The opinions of farmers regarding 'Temperature' were divided equally into most suitable (36.25 %), suitable (31.25 %), and not suitable (32.50 %). The same trend can be seen in the case of 'Rainfall' too, where 30.00 percent opined to be most suitable, whereas 33.75 percent and 36.25 percent of respondents stated 'suitable' and 'not suitable' for hybrid rice production. The

in terms of health status, fertility status, and productivity, which indicates the existence of good soil properties accompanied by health management practices. The climate is suitable since it is mostly hot and humid for most parts of the calendar in the region, which makes it homely for hybrid rice. But in the case of temperature and rainfall, where the gap percentage was found to be more than other components of ecological condition, the farmers are in a bit of a vague picture in terms of their suitability because of the day-night temperature variations adversely affecting the physiological as well as reproductive growth such as increased spikelet sterility, delayed germination, reduced tillering, senescence of functional leaves, decreased grain filling, etc. and since it is situated in the Hirakud command area, there is ample supply of water in the form of irrigation especially in summer season accompanied with the uncertainties of rainfall in terms of its intensity and distribution throughout the region.

Input supply

The results displayed in Table 5 depict that the inputs like 'Fertilizers', 'Plant protection chemicals', and 'Irrigation' were perceived to be accessible to all for hybrid rice cultivation by 82.50 percent, 72.50 percent, and 78.75 percent of the farmers along with their gap percentages of 5.67 percent, 9.67 percent, and 7.00 percent accordingly. Two items such as 'Credit facility' and 'Labour', were perceived as available by 47.50 percent and 55.00 percent of the farmers, with corresponding gap percentages of 25.67 percent and 32.34 percent, respectively. Only in the case of 'Suitable variety' and 'Quality seed', it was 51.25 percent and 56.25 percent, with their respective gap percentages as 42.33 percent and 46.00 percent, which were higher than others and regarded as unavailable.

It can be concluded that regarding input availabil-

Table 4. Perceptions of the farmers towards the ecological condition

Sl. No.	Condition	Most suitable (%)	Suitable (%)	Not suitable (%)	Mean score	Gap (%)
1.	Soil	52.50	32.50	15.00	2.47	17.67
2.	Climate	35.00	42.50	22.50	2.22	26.00
3.	Temperature	36.25	31.25	32.50	2.01	33.00
4.	Rainfall	30.00	33.75	36.25	1.84	38.67

gap percentage in the case of 'Temperature' and 'Rainfall' was found to be 33.00 percent and 38.67 percent, respectively. The results are displayed in Table 4.

It can be concluded that farmers perceive the soil conditions to be advantageous for hybrid rice cultivation

ity, the picture is very good in the case of fertilizers, plant protection chemicals, irrigation facilities, and labour force and credit facilities, which are good things for the cultivation process. However, the problem arises with suitable variety and quality seeds, which can be attributed to their

Table 5. Perceptions of rice growers on supply of inputs

Sl. No.	Input	Easily available (%)	Available (%)	Not available (%)	Mean score	Gap (%)
1.	Suitable variety	26.25	22.50	51.25	1.73	42.33
2.	Quality seed	21.25	22.50	56.25	1.62	46.00
3.	Fertilizer	82.50	17.50	0.00	2.83	5.67
4.	Plant protection chemicals	72.50	27.50	0.00	2.71	9.67
5.	Irrigation	78.75	21.25	0.00	2.79	7.00
6.	Labour force	38.75	47.50	13.75	2.23	25.67
7.	Credit facility	26.25	55.00	18.75	2.03	32.34

absence in the input shops at the right time, showcasing the lack of synchroneity in the demand-supply chain since the concerned region is located quite an interior side. The yield potential of existing cultivars proved to be unsuccessful in the pursuit of meeting the swiftly changing consumption trends of the people. Even if the new hybrid cultivars do arrive in the input market somehow, their high price levels put a heavy dent in the farmer's budget and thus impact the profitable returns of the farmers. These issues need to be addressed swiftly because these are the critical inputs without which all other inputs, along with facilities and services, remain meaningless for hybrid rice cultivation.

Advisory services

The results displayed in Table 6 state that the gap percentage was found to be minimal in the case of literature supply (36.75 %), which means that the literature supply regarding hybrid rice was perceived to be available to them. The gap percentage and the level of 'Not available' of others such as training, demonstration, exposure visit, timely guidance, and close monitoring facilities were found to be

of changing trends in the market (27). Thus, any sort of negativity towards such issues in the farmers' cognition is a discouraging picture in technological dissemination and adoption, thus depriving the farmers of profitable returns thus making farming an unsustainable activity. Therefore, the extension system of line departments and other stakeholders must be improved and upgraded to correct such negative perceptions of the farmers.

Government policy system

The information depicted in Table 7 depicts that the gap percentage of all the items was at least around 40 percent (38.67 % in the case of 'Subsidy') with a maximum of up to 58.67 percent in the case of 'Incentives'. It can also be seen that the majority of respondents opined the nature of availability to be 'not available' in all the items, reporting about as less as 45.00 percent in the case of 'Subsidy' and 75.00 percent in the case of 'Remunerative price'. So, it can be concluded that farmers expressed poor levels of perception in all items under the dimension of 'Government policy system'.

Table 6. Perceptions of rice growers towards advisory services

Sl. no	Advisory service	Easily available (%)	Available (%)	Occasionally available (%)	Not available (%)	Mean score	Gap (%)
1.	Training	6.25	12.25	22.50	58.75	1.65	58.75
2.	Demonstration	18.75	11.25	21.25	48.75	2.01	49.75
3.	Exposure visit	21.25	13.75	17.50	47.50	2.13	46.75
4.	Literature supply	28.75	23.75	22.50	25.00	2.53	36.75
5.	Timely guidance	17.50	10.00	20.00	52.50	1.97	50.57
6.	Close monitoring	8.75	15.00	16.25	60.00	1.78	55.50

Table 7. Perceptions of the rice growers towards government policy system

Sl.No.	Policy system	Available (%)	Occasionally Available (%)	Not available (%)	Mean score	Gap (%)
1.	Incentives	5.00	22.50	72.50	1.24	58.67
2.	Crop insurance	15.00	25.00	60.00	1.52	49.33
3.	Subsidy	26.25	28.75	45.00	1.84	38.67
4.	Procurement	6.25	31.25	62.50	1.47	51.00
5.	Remunerative price	7.50	17.50	75.00	1.31	56.33

near or just above 50.00 percent which means that the perceptions of the majority of farmers for such items were found not available for cultivation.

Training has been able to transform the behaviour of individuals in a positive, desirable manner with the increment in their knowledge bank about particular farming practices. Demonstration, since ages, has been able to not only showcase the impact of technologies on the field but also support the efforts of developing skill competencies of the farmers in executing innovative and productive ways of cultivation. Exposure visits help widen mindsets of the farmers by providing them a chance to see, feel, and understand things farm-related that they have never imagined ever before. Proper supervision by the resource persons through close monitoring and in-time guidance has been able to uplift and upgrade the farmers to venture into upcoming opportunities and produce accordingly because

Poor perception towards incentives for hybrid rice can be attributed to a lack of awareness regarding the incentives in terms of their existence as well as the steps to take to avail of them. The deficiency of market news and market intelligence has failed the farmers to assess the demand-supply dynamics of rice, thus being unable to fetch high prices at the right opportunity, leading to its distressed sale. In the advent of distressed sales, the option of procurement is marred by issues like irregularity in token allotment and distribution, along with the inability to accept harvest due to the absence of enough storage space, which pushes the farmers to the cobwebs of cartelization. The negative picture of crop insurance and subsidies can be owed to the procedural complexities associated with bureaucratic red-tapism, which has retarded its efficiency in disseminating its benefits to the farmers. These can also be owed to the poor performance of advi-

sory services as perceived by farmers, as expressed in the previous section.

Comparative analysis amongst different dimensions of perception

A subsequent attempt was made to perform a comparative examination of the farmers' perceptions of the responses collected against different sub-sections of items related to hybrid rice growing. Here, instead of considering item-wise, dimension-wise was taken into account in which the total score obtained in each dimension was calculated and then subtracted from the maximum score possible under each dimension, then divided by the total score possible under that dimension and converted into percentages respectively to yield gap percentages for each corresponding dimension. From Table 8, it can be

Table 8. Comparative analysis of different dimensions of perceptions

Sl. No.	Condition	Mean score	Gap (%)
1.	Ecological condition	2.14	28.67
2.	Input supply	2.28	24.00
3.	Advisory service	2.10	30.00
4.	Government policy	1.46	51.33

stated that there is a prevalence of an appreciable amount of gap percentages in all of the dimensions, starting from 24.00 percent (Input supply) to 51.33 percent (government policy). This fact concludes the point that there exists a negative perception of farmers in the matters of hybrid rice, which is contradictory to the findings and conclusions drawn by (28).

Respondents expressed positive responses in the case of 'input supply' and 'ecological conditions' in comparison to 'advisory services', and 'government policy system', which opines to the point that there should be more stringent efforts in improving the system of governmental policies with a special focus on procurement, remunerative prices, and crop insurance. There is a need for a strong and dynamic system of advisory services with a strong impetus on the matters of demonstrations, exposure visits, and training programs, which would add a feather cap to the competency levels of farmers regarding hybrid rice cultivation. The findings are in line with (29).

Overall level of perception towards hybrid rice cultivation

The information depicted by Table 9 states that nearly half (47.50 %) of the farmers had expressed the extent of perception towards hybrid rice cultivation to be medium level, whereas the extents of low level and high level were expressed by 33.75 percent and 18.75 percent of farmers

Table 9. Overall levels of perception towards hybrid rice cultivation

Sl. No.	Category	Criteria	farmers			
			No.	%	Mean	SD
1	Low	<1.68	27	33.75		
2	Medium	1.68-2.66	38	47.50	2.17	0.98
3	High	>2.66	15	18.75		

respectively. It confers that the overall levels of perception under the investigation were found to be low to the medium extent of the farmers, which can be owed to the less positive or negative values of discernment with a lack of proper insights regarding the different aspects of hybrid rice cultivation which can be attributed to field conditions, environment, infrastructure, input availability, and institutional support. The findings yielded under the analysis of perception under different dimensions, as mentioned in previous subheadings, provide us with the real causes of the conveyance of such low to moderate levels of the overall perception of the farmers.

This confers to the importance of measures and steps needed to be taken to further push up the existing levels of perception to their better-improved versions because there would be of no use whatsoever the benefits and advantages of the hybrid rice technology until and unless it tends to be accepted as unsuitable for farming by those farmers to sustain their livelihood. There should be a systematic approach comprising the identification of issues downgrading the farmer's perception, which might be at the physical or psychological level, to be taken care of with their corresponding remedies as suitable for the farmers' surroundings.

Socioeconomic profile of the farmers

The analysis of socio-economic status is a joint evaluation of an individual's or group's position in terms of social and economic affairs concerning others in the concerned society. It engages in prominent roles of determining one's access to resources availability, livelihood pattern accompanied with food and nutritional security of the households **(30)**. In this study, various independent variables representing the socio-economic profile of the farmers in the Bhadrak district have been depicted in the following sections.

Age

It was found that 48.75 percent of the farmers were middle-aged followed by old (36.25%) and young (15.00%). This showcases that there is less youth in the sampled respondents as there are more middle-to old-aged people.

Education

In terms of education, 43.75 percent of the farmer respondents possess medium extent, whereas the low and high extent is held by 36.25 percent and 20 percent respectively. It can be inferred that the farmers' background remains devoid of the educational sphere in an affluent manner as the majority of them had passed only schooling education up to the standards of classes 10th and 12th.

Family Size

Concerning family size, half (51.25%) of the farmers come from medium levels, whereas 18.75 percent and 30.00 percent of them come from low and high levels of size. This denotes the prevalence of joint family settings in farming societies where at least two to three families reside under one ceiling.

Farming experience

46.25 percent of the farmers had acquired medium levels of farm experience, and 30.00 percent of the farmers had acquired high levels of farm experience. The low level was possessed by a meagre portion of 18.00 percent of them. It can be said that the overall extent of experience in the matters of farming was found to be predominantly moderate to high, which means that these farmers were quite enriched with the amounts of profound experience in the matters of their farming and its allied occupations, which can be put to their better use for the overall development of the farming community.

Annual Income

The majority (62.50 %) of the respondents accounted for earning at the medium level of annual income, whereas low and high levels accounted for 23.75 percent and 13.75 percent, respectively. There should be ample efforts from all the stakeholders involved in the aspects of agriculture and allied sectors, directly and indirectly, to galvanize the incremental net earnings of the farmers towards much higher as possible to ensure their household's livelihood sustainability owing to the uncertainty and risky nature of the farming occupation.

Achievement Motivation

33.75 percent and 47.50 percent of farmers had demonstrated a low and medium extent of achievement motivation, whereas only 18.75 percent had demonstrated a high extent of achievement motivation. This can be owed to the fact that since the majority of the farmers were middle to aged, more experienced, and with fewer educational qualifications, as stated in the previous sections, it becomes quite natural of a reduced tendency to succeed and gain something as set as a goal or any objective. Their main purpose would be to take care of their families instead of personal ambitions to be set up at an individual level.

Risk orientation

27.50 percent of respondents reported high levels of risk orientation, whereas low and medium levels of risk orientation were reported by 35.00 percent and 37.00 percent of them. Low to medium extent risk orientation is dominant amongst most farmers, which states the farmer's mindset of not taking much risk even though they are very experienced in these occupations. As discussed in the previous subheading of 'Achievement motivation', since they exhibit less achievement motivation, the inner drive to try out things differently or different things also vanishes naturally amongst those farmers. Therefore, there must be a solution-oriented approach in the best possible way to uplift the levels of achievement motivation as well as risk orientation, as these two traits have been the fuel of progress and development of anything considering an individual or an organization.

Extension participation

The extent of extension participation was conveyed to be medium level by 38.75 percent whereas the extent of high and low levels was conveyed to be 28.75 percent and 32.50 percent respectively as opined by the farmers. The extension arm has been regarded as the bridge link between research and farmers. Therefore, steps are to be taken to upgrade the level of participation of the farmers in the extension activities, which are being conducted at the expense of lots of efforts and resources for the sake of development, deeming it less meaningful.

Mass media exposure

The level of mass media exposure, as opinionated by the farmers, yielded low by 51.25 percent whereas it was to be medium and high by 32.50 percent and 16.25 percent respectively. This states the lower levels of farmers' subjection to the dynamics of mass media, which is a matter of concern as this is quite opposite to the contemporary trends of digitization and the Internet of Things, whereby everyone remains connected globally. These can be attributed to the nature of the respondents, who were aged with less education yet more experience in their fields, meaning they are not so sound in the current era of smartphones.

Market accessibility

Two-fifths of the farmers accounted for medium levels of market accessibility, whereas the low and high levels accounted for 33.75 percent and 26.25 percent, respectively. In this context, the market accessibility has predominantly ranged from low to moderate due to limited affordable transportation, a lack of efficient communication networks for timely market information, and inadequate regulated storage and transit options for the harvested goods from various enterprises. The findings were in line with that of previous reports (31-33). The whole of the data is well depicted in Table 10.

Relation between profile characteristics of farmers and their perception towards hybrid rice

This section deals with the dynamics of association between the independent variables under the profile study and the overall extent of perception towards hybrid rice. It was conferred that among all of the variables, the positively significant association was demonstrated by education and mass media exposure at a one percent level of significance along with market accessibility, whereas the negative association has only been portrayed by age at a five percent level of significance. Since the farmers belong to the middle and old-aged category, they have been following a conventional system of rice farming since their parental times and are thus willing to bring any change in their existing setup of livelihood, which makes them less interested in modern innovations in comparison young aged counterparts and in this way explains the negative yield of age over perception. An educated farmer always tends to remain a well well-informed individual in any sphere as it drives them to be in touch with the advancements and progress made in their concerned areas, which contributes to a fine understanding of these innovative ideas, and thus, it, explains the positive association of education with perception. Mass media exposure as it enjoys

Table 10. Profile characteristics of farmers

Sl.No.	Variables	Category	Criteria	Respondents	
				Number	**Percent**
1.	Age	Young	<35 years	12	15.00
		Middle	35-50 years	39	48.75
		Old	>50 years	29	36.25
2.	Education	Low	<2.54	29	36.25
		Medium	2.54-4.87	35	43.75
		High	>4.87	16	20.00
3.	Family Size	Small	<4	15	18.75
		Medium	4-6	41	51.25
		Large	>6	24	30.00
4.	Farming Experience	Less	<11 years	15	18.75
		Moderate	11-20 years	37	46.25
		High	>20 years	28	35.00
5.	Annual Income	Low	<Rs. 93,247	19	23.75
		Medium	Rs. 93,247-2,56,442	50	62.50
		High	>Rs. 2,56,442	11	13.75
6.	Achievement Motivation	Low	<16.24	27	33.75
		Medium	16.24-24.47	38	47.50
		High	>24.47	15	18.75
7.	Risk orientation	Low	<13.21	28	35.00
		Medium	13.21-15.22	30	37.50
		High	>15.22	22	27.50
8.	Extension participation	Low	<4.11	26	32.50
		Medium	4.11-7.44	31	38.75
		High	>7.44	23	28.75
9.	Mass media exposure	Low	<4.89	41	51.25
		Medium	4.89-7.19	26	32.50
		High	>7.19	13	16.25
10.	Market accessibility	Low	<35.67	27	33.75
		Medium	35.67-48.57	32	40.00
		High	>48.57	21	26.25

significant association with perception can be attributed to the fact that in the existing time of digital cyberspace where the library of farm-related knowledge bank can be placed into their palms, the tools of mass media play a key role in enhancing the connectivity to the spirits of globalization as anyone with little bits of tech-knowledge can dive into the ocean of information available at their disposal which would be very helpful to upscale their farm-related operations. The positively significant association between market accessibility and the perception of the farmers can be explained as the market is the point of buying and selling trade-off, which would give proper as well as reliable insights on the hybrid rice at the successive distribution as well as end consumption end which would eventually contribute to its perception amongst those farmers. Barring age, parameters like education, mass media exposure, and market accessibility are very much related to the perception of farmers and therefore, must be considered while designing the action for improvement

in the perception of the farmers towards hybrid rice. The

Table 11. Association between profile characteristics of farmers and their perception

Sl. No.	Profile Characteristics	Contingency Coefficient	Chi-square value
1.	Age	0.441	-9.876*
2.	Education	0.667	15.698**
3.	Family size	0.883	8.873[NS]
4.	Farming experience	0.112	9.123[NS]
5.	Annual income	0.388	5.557[NS]
6.	Achievement motivation	0.332	7.129[NS]
7.	Risk orientation	0.988	8.682[NS]
8.	Extension Participation	0.445	6.778[NS]
9.	Mass Media Exposure	0.554	14.783**
10.	Market accessibility	0.422	9.891*

information regarding the association is well depicted in Table 11.

Conclusion

In summary, the study offers a detailed insight into the factors shaping farmers' attitudes towards hybrid rice farming. It indicates a generally positive sentiment among farmers concerning soil quality, climate suitability, and the availability of inputs such as fertilizers, pesticides, irrigation, labour, and credit. However, significant challenges persist, notably in accessing suitable seed varieties, highlighting supply chain issues, particularly in remote areas. Additionally, the study reveals shortcomings in current cultivars that are unable to meet changing consumption patterns, compounded by the high costs of new hybrid strains, impacting farmers' profitability. Addressing these challenges promptly is crucial, as they are essential components without which other resources for hybrid rice cultivation lose significance. The study emphasizes the pivotal role of training, demonstrations, exposure visits, and supervision in fostering positive behavioral changes among farmers and enhancing their skills. Negative perceptions towards advisory services, government policies, and incentives must be tackled urgently. Strengthening governmental policies, especially in procurement, pricing, and crop insurance, is vital to address farmers' concerns and bolster their confidence in hybrid rice farming. Education, media exposure, and market accessibility play significant roles in shaping farmers' perceptions. While older farmers tend to hold more traditional views, education, media exposure, and market access positively influence perceptions, underscoring the importance of leveraging these factors to improve attitudes toward hybrid rice. The study highlights the need for a comprehensive approach to effectively address farmers' perceptions, aligning extension services, government policies, and market dynamics with their needs. By tackling systemic challenges, improving access to information and resources, and promoting technological advancements, stakeholders can ensure the sustainability and profitability of hybrid rice cultivation, benefiting both farmers and the agricultural sector as a whole. This research provides valuable insights for future researchers and policymakers, informing them about the knowledge gaps and the necessity for extension activities in hybrid rice production adoption.

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Authors' contributions

DSR conducted field visits, collection of data, and performed the design of the research analysis. AN was involved in the collection of literature review drafting of the manuscript. DJ analyzed the data and communicated for approval of the final manuscript.

Compliance with ethical standards

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References

1. Pradhan S, Naberia S, Harikrishna YV, Jallaraph V. Livelihood security of small farmers in Jabalpur district of Madhya Pradesh. Indian Journal of Extension Education. 2020;56(4):98-102. https://epubs.icar.org.in/index.php/IJEE/article/view/108326

2. Bhatt R, Singh P. Farmer's field evaluation of direct seeded rice vis-à-vis puddled transplanted rice in Kapurthala, Punjab. Indian Journal of Extension Education. 2022;58(2):42-46. https://epubs.icar.org.in/index.php/ijee/article/view/122566

3. Huang J, Gao L, Luo S, Liu K, Qing D, Pan Y, et al. The genetic editing of GS3 via CRISPR/Cas9 accelerates the breeding of three-line hybrid rice with superior yield and grain quality. Molecular Breeding [Internet]. 2022 Apr;42(4). https://doi.org/10.1007/s11032-022-01290-z

4. GOI. Government of India. Directorate of Rice Development. Rice Varieties; 2023. https://drdpat.bih.nic.in/Rice%20Varieties%20in%20India.htm

5. GRiSP. (Global Rice Science Partnership) Rice Almanac, 4th edition. Los Baños, Philippines: International Rice Research Institute; 2013. http://irri.org/resources/publications/books/rice-almanac-4th-edition

6. Singh VP, Singh RK (Eds.). Rainfed rice: A sourcebook of best practices and strategies in Eastern India. International Rice Research Institute, Los Baños, Philippines. 2000;pp:292. ISBN:81-86789-022. http://books.irri.org/8186789022_content.pdf

7. Sharma S, Rout K, Khanda C, Tripathi R, Shahid M, Nayak A, et al. Field-specific nutrient management using rice crop manager decision support tool in Odisha, India. Field Crops Research. 2019; 241:107578. https://doi.org/10.1016/j.fcr.2019.107578

8. Dar MH, Chakravorty R, Waza, SA, Sharma M, Zaidi NW, Singh AN, et al. Transforming rice cultivation in flood prone coastal Odisha to ensure food and economic security. Food Security. 2017;9:711-22. https://doi.org/10.1007/s12571-017-0696-9

9. Jena D, Mahapatra B. Exploring the effects of energy consumption on millets and rice yields in Odisha, India. Energy Nexus. 2023;12:100253. https://doi.org/10.1016/j.nexus.2023.100253

10. Das SR. Rice in Odisha. IRRI Technical Bulletin No. 16. Los Baños, Philippines: International Rice Research Institute; 2012. http://books.irri.org/TechnicalBulletin16_content.pdf

11. Spielman DJ, Ward PS, Kolady DE. The economics of hybrid rice in Asia: Technology adoption, public expenditures and private incentives. In: Proceedings of the Regional Expert Consultation on "Hybrid Rice Development in Asia: Assessment of Limitations and Potential". 2-3 July, Bangkok, Thailand; 2014.

12. Guo-hui M, Long-ping Y. Hybrid rice achievements, development and prospect in China. Journal of Integrative Agriculture [Internet]. 2015 Feb;14(2):197-205. https://www.sciencedirect.com/science/article/pii/S2095311914609229

13. Chen Z, Wu J, Deng XW, Tang X. Establishment and advances of third-generation hybrid rice technology: a review. Rice [Internet]. 2023 Dec 1;16(56). https://doi.org/10.1186/s12284-023-00670-z

14. Yan W, Chen Z, Hong H. A short review of the hybrid rice seed

industry in China. In: Xie, F. and Hardy, B. (eds) Accelerating Hybrid Rice Development. International Rice Research Institute, Los Baños, Philippines; 2010.pp 517-22.

15. Li L, Zheng X, Wang J, Zhang X, He X, Xiong L, et al. Joint analysis of phenotype-effect-generation identifies loci associated with grain quality traits in rice hybrids. Nature Communications [Internet]. 2023 Jul 4;14(3930). https://doi.org/10.1038/s41467-023-39534-x

16. Chen R, Li D, Fu J, Fu C, Qin P, Zhang X, et al. Exploration of quality variation and stability of hybrid rice under multi-environments. Molecular Breeding [Internet]. 2024 Jan 1;44 (2024). https://doi.org/10.1007/s11032-024-01442-3

17. Sharma I, Tyagi BS, Singh G, Venkatesh K, Gupta OP. Enhancing wheat production-A global perspective. Indian Journal of Agricultural Sciences. 2015;85(1):3-13. https://www.researchgate.net/profile/Gyanendra-Singh-4/publication/270271799_Enhancing_wheat_production_-_a_global_perspective/links/54bf77de0cf2f6bf4e04eee1/Enhancing-wheat-production-a-global-perspective.pdf

18. Adnan N, Nordin SM, Bahruddin MA, Tareq AH. A state-of-the-art review on facilitating sustainable agriculture through green fertilizer technology adoption: Assessing farmers behavior. Trends in Food Science and Technology. 2019;86:439-52. https://www.sciencedirect.com/science/article/abs/pii/S0924224418303194

19. Future market insights research. Hybrid Rice Seeds Market. Future Market Insights; 2022. https://www.futuremarketinsights.com/reports/hybrid-rice-seeds-market

20. AICRIP. Draft copy of hybrid rice progress report-2022. AICRIP-Intranet Indian Institute of Rice Research; 2022. http://aicrip-intranet.in/Documents/AicripSite/Draft%20copy%20of%20Hybrid%20Rice%20progress%20report-2022.pdf

21. Panda BB, Nayak AK, Roul PK, Ghosh A, Pathak H. Bringing green revolution to Eastern India: Experiences and expectations in Odisha. ICAR-National Rice Research Institute. Cuttack. 2019;35-45. https://krishi.icar.gov.in/jspui/bitstream/123456789/32082/1/9.pdf

22. Maiti D, Banerjee M. Hybrid rice seed production technology. SATSA Mukhaptra Annual Technical Issue, Department of Agriculture, Government of West Bengal. 2013;17:100-13. https://www.cabdirect.org/cabdirect/abstract/20133268092

23. Odisha. Directorate of Agriculture and Food Production. Odisha Agriculture Statistics 2017-18. Bhubaneswar: Department of Agriculture and Farmer's Empowerment, Government of Odisha; 2020https://agri.odisha.gov.in/sites/default/files/2022-04/ODISHA%20AGRICULTURE%20STATISTICS1_2017-18.pdf

24. Joshi A, Kale S, Chandel S, Pal DK. Likert scale: Explored and explained. British Journal of Applied Science and Technology. 2015;7(4):396-403. https://doi.org/10.9734/BJAST/2015/14975

25. Siegel AF, Wagner MR. Chi-squared analysis: Testing for patterns in qualitative data. In: Practical Business Statistics [Internet]. Seattle, USA: Academic Press; 2022. pp. 171-75. https://doi.org/10.1016/C2019-0-00330-5

26. Vierra A, Razzaq A, Andreadis A. Categorical variable analyses. In: Eltorai AEM, Bakal JA, Newell PC, Osband AJ, editors. Handbook for Designing and Conducting Clinical and Translational Research [Internet]. Academic Press; 2023. pp. 171-75. https://doi.org/10.1016/B978-0-323-90300-4.00095-1

27. Husain AMM, Hossain M, Janaiah A. Hybrid rice adoption in Bangladesh: a socio-economic assessment of farmers' experiences. Research Reports (2000), Economic Studies. 2000;XV:154-206. http://hdl.handle.net/10361/12492

28. Shah MI, Grant WJ, Stocklmayer SA. Farmers' attitudes towards cultivating hybrid rice in Bangladesh. Indian Journal of Extension Education. 2016;52(1&2):1-8. https://acspublisher.com/journals/index.php/ijee/article/view/5095

29. Julfiquar AW, Hassain J, Azad M, Anwar AK, Hossain M. In: Proceedings of the 4th International Symposium on Hybrid Rice. Vietnam; 2002.14-17.

30. Roy ML, Chandra N, Kharbikar HL, Joshi P, Jethi R. Socio-economic status of hill farmers: An exploration from Almora district in Uttarakhand. International Journal of Agriculture and Food Science Technology. 2013;4(4):353-58.

31. Lakshman Reddy BS. A study on attitude of farmers towards livelihood diversification in Kolar district of Karnataka. Ph.D. Dissertation. University of Agricultural Sciences-Bangalore. 2019. https://krishikosh.egranth.ac.in/handle/1/5810152613

32. Shankara MH. Vulnerability of farmers due to climate change in the central dry zone of Karnataka– a critical analysis [Internet]. krishikosh.egranth.ac.in. University of Agricultural Sciences-Bangalore, Bengaluru; 2019. https://krishikosh.egranth.ac.in/handle/1/5810152555

33. Puneethraja R. Impact of Kisan Call Centre (KCC) advisories on farmers in Chamarajanagar district of Karnataka - a study [Internet]. Ph.D. Dissertation. University of Agricultural Sciences -Bengaluru; 2023. https://krishikosh.egranth.ac.in/handle/1/5810197250