

Farmers' Trait Preferences for Varietal Replacement: A study to boost rice productivity in Odisha, India

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Abstract

The average age of the popular rice varieties being grown in the state of Odisha is higher than the stipulated 10-year timeframe. This is an obstacle to productivity enhancement through varietal replacement. Farmers in Odisha growing these varieties have expressed their desired traits for replacement of these long-grown varieties. The desired characters of an ideal variety have been mapped for major older varieties. Since varietal fitment and farmer's choice vary widely between rice eco logies, the research outcomes were compartmentalized between medium and lowland. Thus, these research outcomes will be crucially helpful for breeding program to develop varieties that match evinced expectation of the farmers. The ranking of trait preferences will also augment the varietal research program to the exact needs of the rice growers in the state. Rice productivity in Odisha is one of the least in the country. Replacement of existing older varieties with a high yielder as per farmers' choice is a strategic way to boost the productivity. The findings with regard to current varietal landscape, farmers' trait preferences are crucially important for augmenting rice productivity and strengthening food security in the state.

Keywords

Varietal replacement; Food security; Varietal landscape

Introduction

The productivity enhancement of rice, being the staple food, overarches the food security program in a state like Odisha. The rice productivity in Odisha is stagnating at 2.04 tons per ha¹ throwing enormous challenge to feed 45 million people in the state. Substantial increment of rice productivity assumes greater significance among policy makers that results in new agriculture initiatives in the state, directed towards boosting rice yield.

Plant breeders across several research institutes are relentlessly engaged in developing new rice varieties, which primarily focus on yield improvement. But research gap exists with respect to the link between rice growers and breeders. Numbers of high yielding varieties (HYVs) are being intensively grown in the states of India, but many of them are quite old (more than 10 years) that require a replacement. A farmer considers a range of parameters other than yield while replacing the old variety by a new variety. Thus, the farmer's preferences are of paramount importance and to be included sufficiently in new variety development strategy (Dar *et al.*, 2014). In the current breeding program specific to the state of Odisha, many a times, breeders develop and release varieties without taking a broad cognizance of farmers' preferences. Though with a 'push' extension mechanism those varieties are adopted by farmers, to some extent, in a short run, but not accepted in the long run. Because of this very reason, those newly developed varieties soon become redundant in the seed system of the state and farmers hardly get the varieties of their choice. This scenario not only inefficiently utilizes resources at breeding program but also jeopardizes state's ambition to attain food security through varietal replacement. The concept of participatory plant breeding (PPB) with larger say of farmers is increasingly being adopted worldwide (Ceccarelli and Grando, 2009). This is more relevant in context of Odisha where participation of farmers in plant breeding program is largely negligible.

Keeping in mind this issue and extent of problems, present study was conducted in Odisha to produce evidence-based critical inputs that can strategically strengthen existing breeding program with farmers' choice and preferences. The specific objectives of the study were as follows:

- I. To generate ecology wise current varietal landscape of Odisha to comprehend varietal spread across regions in Odisha;
- II. To analyse farmers' desired traits in the varieties to replace currently grown older varieties; and
- III. To prioritize farmers' preference of traits in selecting a new variety.

Methodology

This study was conducted during Kharif² season of 2018-19 in 12 districts of Odisha in two main rice ecologies, viz. lowland and upland. Among the 30 districts of the state, 12 districts were selected in such a way that represent both upland and lowland districts. Total 8 districts fall under upland belt and 4 under lowland areas. From each district, 4 blocks were selected randomly following SRSWOR³ method and 15 farmers from each block were chosen in random manner. Thus, total sample size was 720 comprising of 480 farmers from upland districts and 240 from lowland districts. Mobile smartphone-based data collection tool, 'Kobo'⁴ was used to gather data through a pre-tested questionnaire by well-trained 20 field investigators. Collected data were monitored and verified on daily basis to ensure highest possible level of accuracy.

To attain first and second objective as explained in 'Introduction' part above, descriptive statistics were used. For prioritization of trait preference in new varieties, Garrett's ranking tool was employed. As against the simple frequency distribution, Garrett's ranking tool arranges the constraints based on their severity as perceived by the respondents (Zalkuwi *et al.*, 2015). The percent position of each rank was converted into

¹ Directorate of Economics and Statistics, DAC&FW, 2020

² Kharif season, also known as wet season, starts in June and ends in October.

³ Simple random sampling without replacement.

⁴ A widely used mobile based data collection tool (<https://www.kobotoolbox.org/>).

scores using Garrett's table. For each constraint, scores of individual respondents were added together and were divided by total number of respondents for whom scores were added. Thus, mean score for each constraint was ranked by arranging them in descending order.

$$\text{Percent position} = \frac{100 (R_{ij} - 0.05)}{N_{ij}}$$

Where,

R_{ij} is the rank given for i th item by j th individual,

N_{ij} is the number of items ranked by the j th individual.

Results And Discussion

Farmers' profile

Respondents were profiled based on key parameters separately for two ecologies. Their characteristics are described as below:

Below poverty line: In lowland districts, 62.92% respondents were below poverty line (BPL) category, whereas 74.58% were in BPL category in upland belt.

Caste: The prevalence of other backward caste (OBC) was more (77.08%) in lowland districts compared to that of upland areas (36.88%). There were no scheduled tribe (ST) found in lowland areas, but in upland districts the STs were 50.42%. The scheduled caste (SC) representation in lowland was only 9.58%, while in lower upland areas it was 6.04% (Table 1).

Gender: The respondents were gender-segregated, and it was found that, in upland areas, 57.71% were males with 70% males in low land districts.

Age and Education: The mean age of farmers was 47 and 42 years, respectively, in lowland and upland districts. Table 1 further reveals that education level of respondents from lowland belt is little higher than upland region.

Categories of Farmers: As usual proportion of marginal farmers having land size of less than 1 ha was high in both the ecologies. Marginal farmers constitute 61.67% and 56.67%, respectively, in lowland and upland regions.

Table 1. Distribution of respondents over important socio-economic parameters

<i>Ecology</i>	<i>No</i>	<i>%</i>
<i>Lowland</i>	240	100
Non-BPL (Below Poverty Line)	89	37.08
BPL	151	62.92
General	30	12.50
OBC (Other backward Caste)	185	77.08
SC (Scheduled Caste)	23	9.58
Other	2	0.83
Male	168	70.00
Female	72	30.00
Marginal (less than 1ha)	148	61.67
Medium (4-10 ha)	6	2.50

<i>Ecology</i>	<i>No</i>	<i>%</i>
Semi Medium (2-4 ha)	19	7.92
Small (1-2 ha)	67	27.92
Mean Age (years)	47	
Mean education years	8	
<i>Upland-Medium</i>	<i>480</i>	<i>100.00</i>
Non-BPL	122	25.42
BPL	358	74.58
General	32	6.67
OBC	177	36.88
SC	29	6.04
ST (Scheduled Tribe)	242	50.42
Male	277	57.71
Female	203	42.29
Large (more than 10 ha)	2	0.42
Marginal (less than 1ha)	272	56.67
Medium (4-10 ha)	5	1.04
Semi Medium (2-4 ha)	44	9.17
Small (1-2 ha)	157	32.71
Mean Age (years)	42	
Mean education years	6	

Current varietal landscape

Lowland districts

This study is aimed at creating a varietal landscape for both lowland and upland districts. The analysis revealed that Pooja⁵, Swarna⁶, Swarna sub-1⁷, CR 1018⁸, CR 1009⁹ and Kalachampa¹⁰ Sarala were the main varieties preferred and grown by farmers in lowland districts during the wet season. In terms of spread, 25.83% farmers have grown Pooja, closely followed by Swarna (24.58%) and Swarna sub-1 (21.67%). In fact, these three varieties together were grown by 72.08% of all farmers. The other reported varieties like CR 1009 (4.58%), CR 1018 (5.83%) and Bina dhan 11¹¹ (5.00%) were also grown by some of the farmers. Swarna sub-1, a recent breeding innovation as a submergence tolerant variety, has gained popularity among farmers. This is corroborated by the seed sale trend of Swarna sub-1 as evident from secondary seed sale

⁵ A late maturing rice variety for lowlands

⁶ A widely grown variety in eastern India, matures in 135 days

⁷ A submergence tolerant variant of Swarna, popular in flood prone areas of eastern India.

⁸ Also known as Gayatri, a long duration bold grained variety

⁹ A long duration variety, suitable for waterlogged conditions

¹⁰ A long duration, semi-dwarf variety, grown in rainfed and irrigated shallow lowland

¹¹ A medium duration variety, suitable for both wet and dry season. More details about these varieties are available at <https://www.rkbodisha.in/rice-varieties-of-odisha>

data obtained from Department of Agriculture and Farmers Empowerment. The seed sale of Swarna sub-1 rose from 12,232.8 quintal to 33,142.5 quintal indicating the adoption of this variety in the state¹².

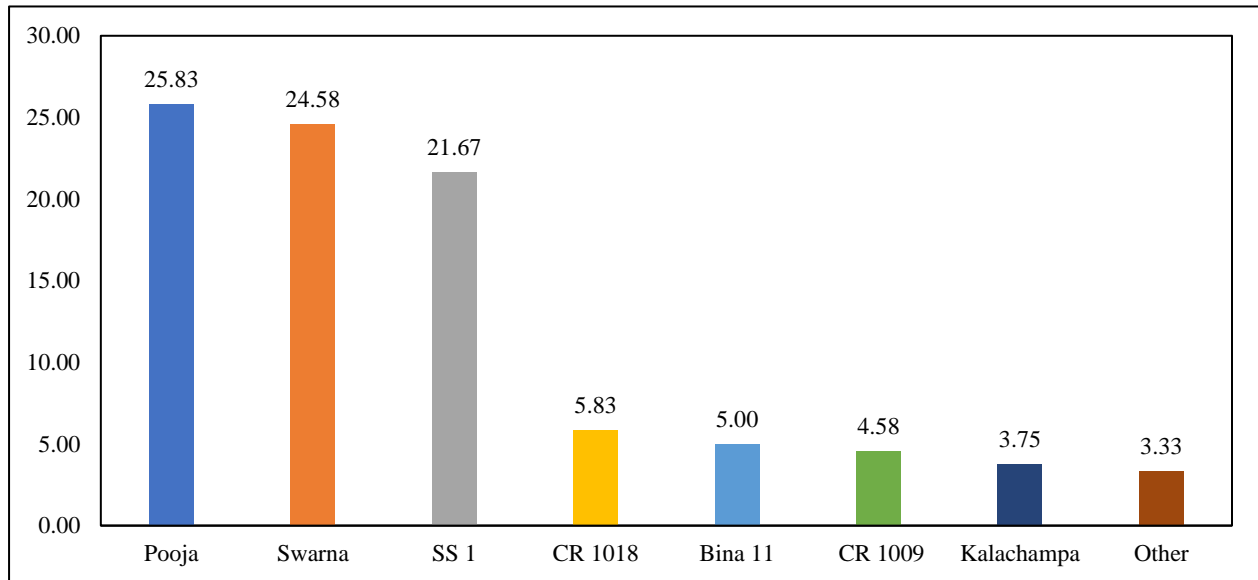


Figure 1: Percentage of farmers growing different varieties in lowland districts

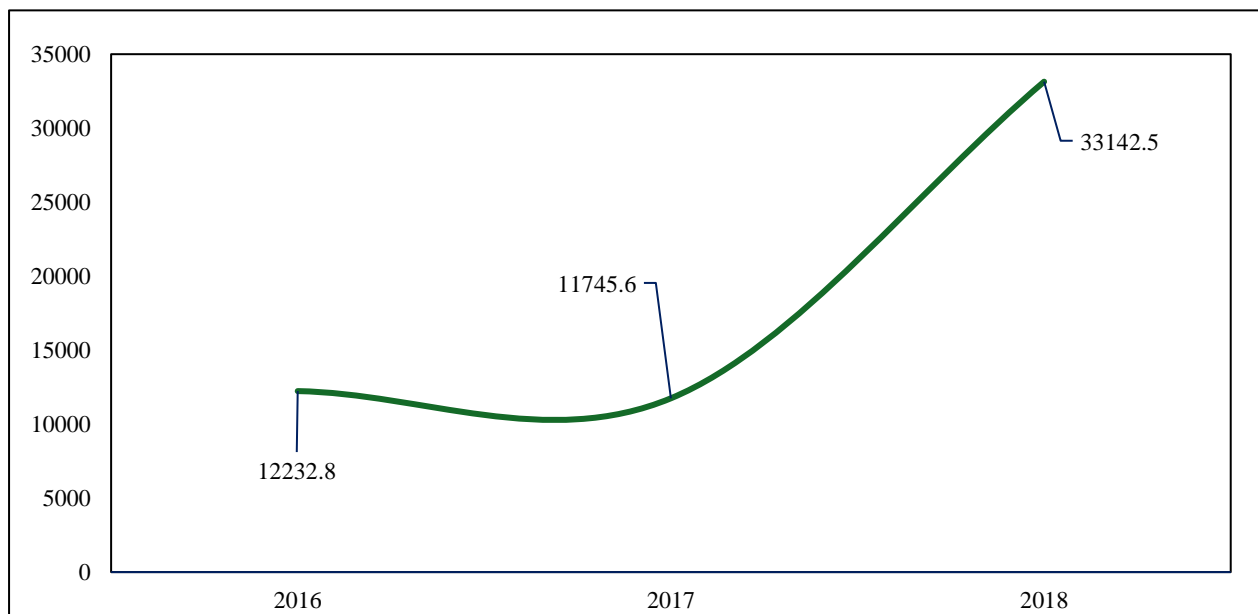


Figure 2: Seed sale trend of a new submergence tolerant variety Swarna sub 1 (Units in quintal)
 (Source: Odisha State Agriculture Department)

¹² Unpublished data accessed from Department of Agriculture, 2018

Upland-Medium districts

In upland and medium districts, major varieties grown by farmers were Swarna (26.25%), MTU 1010¹³ (20.63%), MTU 1001¹⁴ (16.46%), Lalat¹⁵ (8.75%). Other important varieties preferred by the farmers in this rice ecology were Pratikshya¹⁶ (7.92%), Sahabhagi¹⁷ (5.21%) and DRR dhan 44¹⁸ (2.5%). Among these, Sahabhagi was drought tolerant variety recently introduced in the seed chain of the state and quickly received acceptance by farmers as evident from the sales records of state seed corporations. Surprisingly, a large number (10.2%) of farmers reported growing Swarna despite its longer duration of maturity and water scarcity in upland ecology. Swarna, a lowland specific variety, is misplaced by farmers in upland belt (pers. comm. Dr. D.D. Sinha). This calls for a strategic approach in mobilizing farmers for best fit varietal selection. Sahabhagi is a recent short duration drought tolerant variety that has made inroads in upland areas for its ability to withstand water scarcity. The increasing sale trend of new variety Sahabhagi (Figure 4) proves its fast adoption in this ecology.

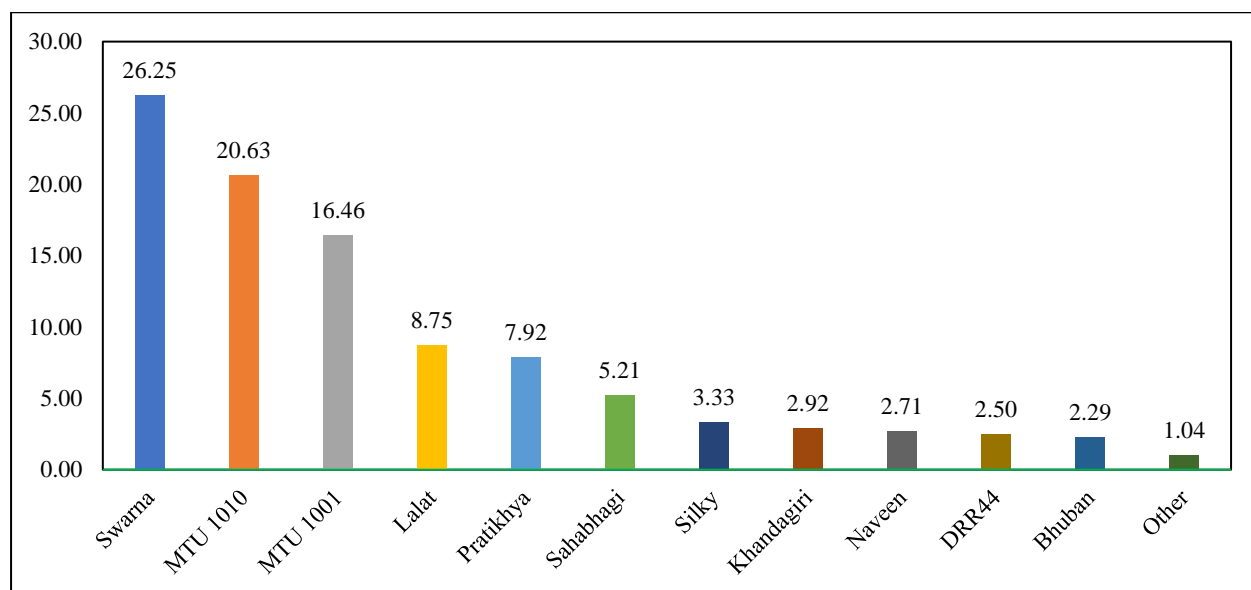


Figure 3: Percentage of farmers growing different varieties in upland-midland districts

Farmers' trait preferences in two ecologies

Lowland ecology

CR 1009

This is a popular high yielding variety in the districts like Bhadrak, Puri, Kendrapara and Jajpur. But farmers want a replacement with a variety a week shorter in duration and potential to give a yield of 6.5 tonnes per ha. The grain size preference is small bold, which is the character of CR 1009. Therefore, if a breeder designs strategy to replace CR 1009 with a better one, s/he must take duration and yield preference into consideration. About 36.8% farmers have expressed their choice for CR 1009 sub-1, an improved version of CR 1009.

¹³ A semi dwarf mega variety cultivated in irrigated and medium lands

¹⁴ Popularly known as Vijetha, suitable in both wet and dry season

¹⁵ A semi dwarfed long slender grained variety, adapted in rainfed and irrigated medium lands

¹⁶ A long duration semi dwarf variety, widely cultivated by framers in Odisha, India

¹⁷ A short duration variety suitable for water deficit condition in upland areas

¹⁸ A medium duration variety, recommended in water deficit areas. More details about these varieties is available at <https://www.rkbodisha.in/rice-varieties-of-odisha>

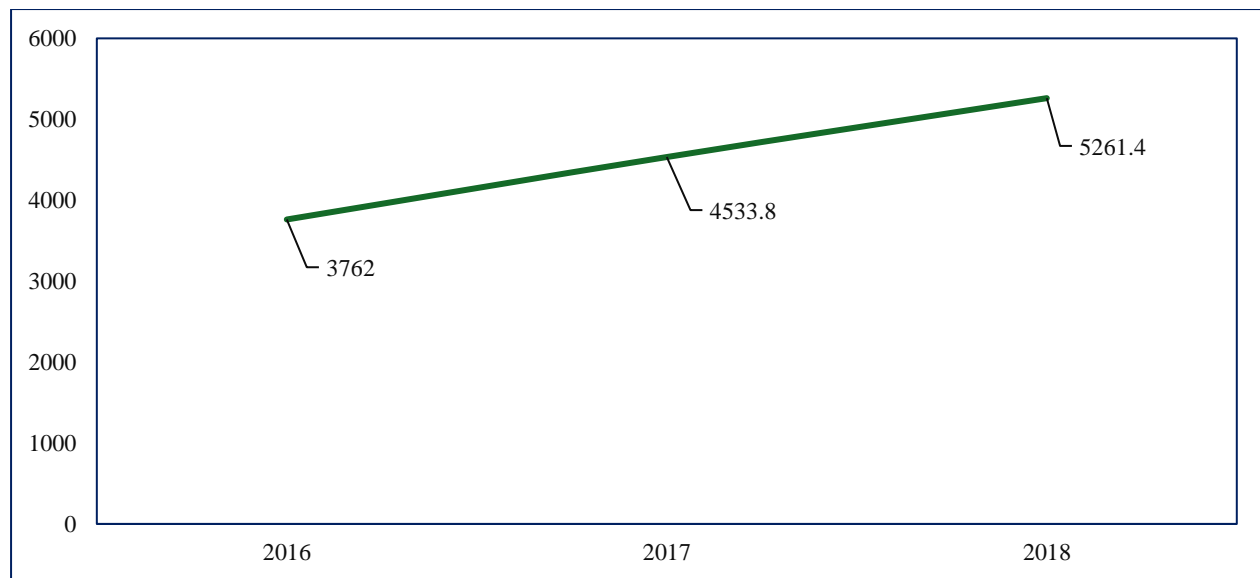


Figure 4: Seed sale trend of a new drought tolerant variety Sahbhagi (unit in quintal)

Source: State agriculture department

Pooja

Pooja is a 150-day popular variety suitable for low lying areas. Current yield potential of this variety is 5 tonnes per ha. As a substitute of this variety, farmers prefer a variety of same duration having yield potential of 5.83 ton with medium slender grain size. Therefore, any breeding program aims to bring a substitute of Pooja must focus, *inter alia*, on yield and grain size.

Kalachampa

Farmers in coastal belt of Odisha are growing Kalachampa (160 days) for quite a long time. Though the variety promises a yield of 6.5 ton per ha, but farmers reported an average yield of 5 ton from this variety. So, farmers expect this variety to be having minimum yield bearing ability of 6.15 ton per ha and it should come with medium slender grain size.

Lalat

Lalat is a short duration variety (120 days) grown in both the ecologies, but not preferred in areas where prolonged inundation is a problem. Farmers who cultivate this variety in lowland areas want to replace with a variety having a maturity in about 130 days. Lalat yields around 4.5 ton/ha. However, in a replacement variety, farmers want minimum yield of 5 tons per ha with a medium slender grain size. Like other varieties, height is not a factor for farmers if yield, duration and grain size choices are met.

Sarala

This is a long duration variety (160 days) widely grown in coastal areas of Odisha having an average yield of 4 tons per ha. Farmers in the region prefer to replace this variety if any variety with 150-days duration can give a yield of 6.22 ton per ha.

Upland and medium land ecology

Swarna

This is one of most popular and widely grown varieties in Odisha. This variety matures in 135 days and yields 5 tons per ha. In low lying coastal region, farmers will prefer a replacement with a variety maturing in 145 days and yielding 5.87 ton with medium slender grain quality. Crop height is not a matter of important

consideration for the farmers. Swarna sub-1 is relatively new in the seed chain and gaining increasing acceptance among farming community of coastal area, as 63% of sampled Swarna growers facing frequent flash floods think Swarna sub 1 is a perfect replacement.

MTU 1001

This mega variety is strongly preferred by farmers in medium high land districts. MTU 1001 has the duration of 130 days with average yield of 5 tons per ha. Farmers growing this variety now prefer a variety having slightly less duration (124 days) and giving a yield of 5.34 ton per ha.

MTU 1010

Farmers growing this variety in medium high land areas prefer a replacement of 116-days variety that can produce average yield of 5.7 ton per ha. Preferred grain size is medium slender and crop height is a redundant factor.

Khandagiri

This is a short duration (90 days) variety suitable for upland ecology. Duration wise, this is accepted by farmers; but its average yield is quite low (3 tons per ha). Farmers need a substitute variety with same duration but with higher yield (3.92 ton per ha) and medium slender grain quality.

Bhuban

Bhuban is another variety grown in medium upland districts of Odisha. It attains maturity in 135 days with yield capacity of 4 ton per ha. But farmers are ready to replace this if a variety with less duration (115 days) with yield potential of 5.2 ton per ha is available.

Naveen

This 120-days variety is widely cultivated by farmers in upland and medium high land districts of Odisha. For its replacement, farmers will prefer a comparatively shorter duration variety (115 days) with yield capacity of 5.2 ton per ha and preferred medium slender grain size.

Pratikhya

This short duration (135 days) variety is currently yielding 4 ton per ha in upland districts. A modification in duration (125 days), medium slender grain size and a yield of 5.4 ton per ha will be strong replacement traits accepted by farmers.

Varietal replacement

The major rice varieties being grown by farmers in Odisha in the cropping seasons are older than 10 years indicating a sluggish varietal replacement rate in the state. Maturity duration, expected yield, grain quality, plant height, resistance to major diseases and pests are key considerations for a farmer in adopting a variety. However, a variation in respect of trait preferences is observed between two rice growing ecologies. While a longer duration variety is sought in lowlands, a relatively shorter maturity variety is preferred by farmers in medium lands. The farmers-preferred traits are critically important as it helps breeding strategy to be more contextual and in line with choices and preferences of rice growers. Below is the description of the result of different varieties in two different ecologies.

Grain size as a varietal trait

Farmers consider grain size as an important criterion for varietal replacement. It has been observed that medium slender grain is mostly favoured by farmers in both the ecologies. In lowland districts, 81% farmers want medium slender grain in new variety. Similarly, 75% farmers demand medium slender grain in new variety in upland and medium land region.

Prioritization of preferred traits

There are several traits that farmers contemplate before selecting or replacing a variety. It was evident that there was not substantial variation in ranking order between two ecologies. The first ranked trait is the yield followed by the duration, resistance of diseases and pests, grain quality and crop height. Interestingly, disease pest resistance trait was placed just after the yield and duration. The corresponding mean Garrett's scores in lowland ecology for duration, yield, grain quality, crop height, and resistance to diseases and pests are 61.46, 64.00, 34.13, 31.13 and 59.29, respectively (Table 2). In upland belt, the same scores are 60.49, 65.15, 34.74, 30.28, 59.36, respectively (Table 3).

This holds importance from plant breeding perspective. A well-designed breeding program should integrate this trait ranking order. This will satisfy tastes and preferences of rice growers of different varieties. Therefore, these traits in order will feed breeding strategy for developing and replacing varieties in different ecologies of Odisha.

Table 2: Garrett's ranking technique for trait preferences by the sample farmers for varietal replacement in lowland districts of Odisha

<i>Factor</i>	<i>Mean score</i>	<i>Rank</i>
Duration (days)	61.46	2
Yield (t/ha)	64.00	1
Grain Quality	34.13	4
Height	31.13	5
Resistance to diseases and pest	59.29	3

Table 3: Garrett's ranking technique for trait preferences by the sample farmers for varietal replacement in Upland districts of Odisha

<i>Factor</i>	<i>Mean Score</i>	<i>Rank</i>
Duration (days)	60.49	2
Yield (t/ha)	65.15	1
Grain Quality	34.74	4
Height	30.28	5
Resistance to diseases and pest	59.36	3

Conclusion and Recommendations

Varietal replacement dynamics from farmers' perspective is an integral part of the breeding program for development of improved varieties. The study aims at sketching a current varietal map in two main ecologies — lowland and upland in Odisha. This study also delves into comprehending farmers' preferences about varietal traits in order to replace currently grown major varieties and identify deciding factors that come into play while farmers contemplate varietal replacement. The major varieties grown in lowland region are Pooja, Swarna, Swarna sub-1, Kalachampa and Sarala. In upland and midland ecology, farmers mainly grow Swarna, MTU 1001, MTU 1010, Pratikshya, Lalat, DRR 44 and Sahabhazi dhan. In lowland ecology, for varietal replacement farmers would prefer a variety of 140-150 days with yield potential of 5-6.5 tonnes per hectare. In midland and upland, preference is given to the variety of 90 to 125 days' duration along with yield potential of 4-5.5 tons per hectare. Medium slender grain size is preferred in lowland and midland and upland by 81% and 75% farmers, respectively. Crop height has been proved a non-significant factor for variety selection in both the ecologies. In both the ecologies, the ranking order of factors were yield,

duration, resistance to disease and pest, grain size and crop height. These finding complements the efforts of ongoing plant breeding research and food security programs.

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Author's Declarations and Essential Ethical Compliances

Author's Contributions (in accordance with ICMJE criteria for authorship)

This article is 100% contributed by the sole author. He conceived and designed the research or analysis, collected the data, contributed to data analysis & interpretation, wrote the article, performed critical revision of the article/paper, edited the article, and supervised and administered the field work.

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Research involving human bodies (Helsinki Declaration)

Has this research used human subjects for experimentation? No

Research involving animals (ARRIVE Checklist)

Has this research involved animal subjects for experimentation? No

Research involving Plants

During the research, the author followed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

Research on Indigenous Peoples and/or Traditional Knowledge

Has this research involved Indigenous Peoples as participants or respondents? No

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

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