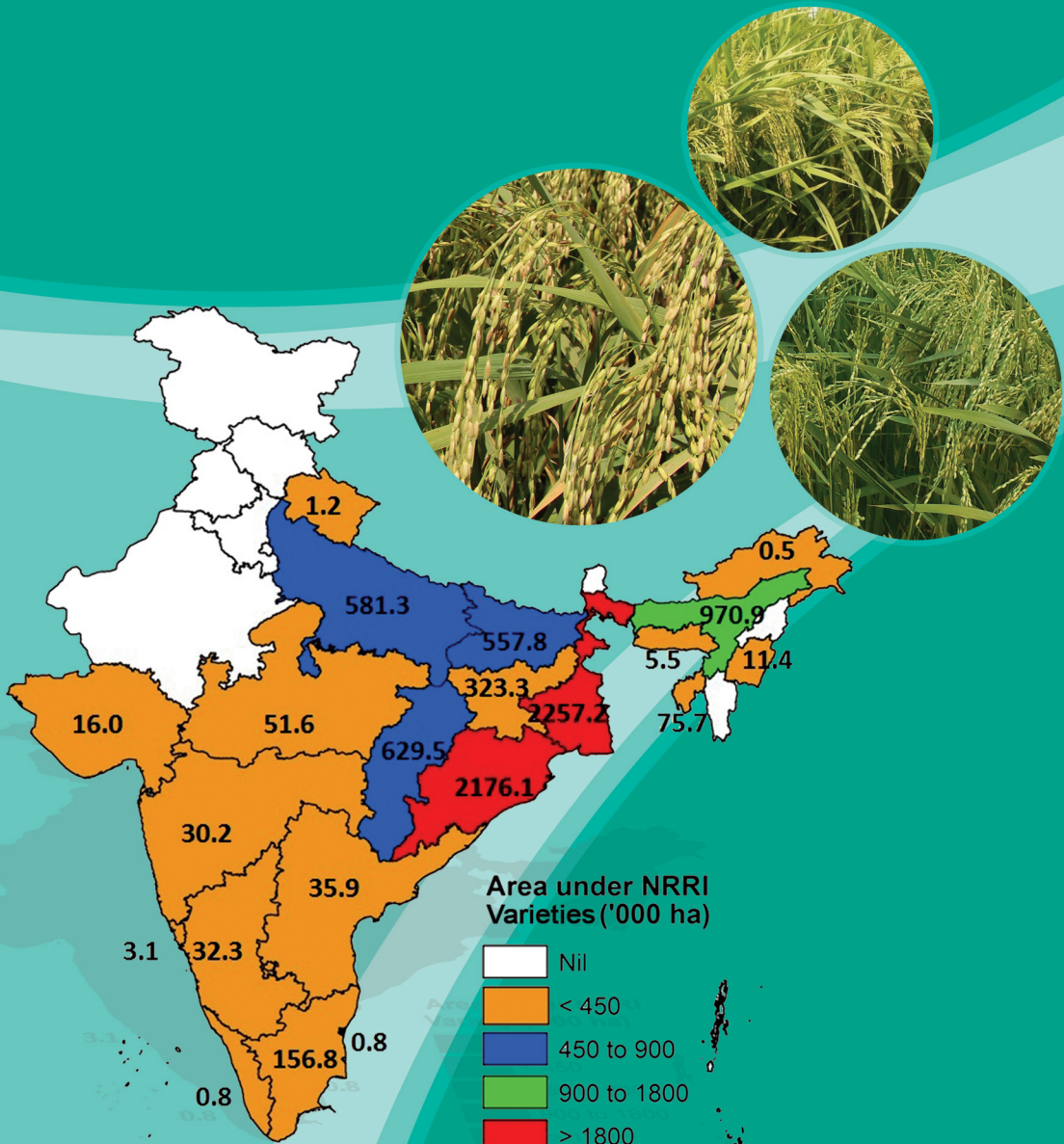


Contributions of NRRI Rice Varieties to National Food Security



ICAR-National Rice Research Institute
Cuttack 753 006, Odisha



NRRI Research Bulletin No.16

Contributions of NRRI Rice Varieties to National Food Security

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Correct Citation

Pathak H, Pradhan SK, Parameswaran C, Mondal B, Jambhulkar NN, Tripathi R, Chakraborti M, Kumar GAK, Samal P and Sahu RK (2018). Contributions of NRI Rice Varieties to National Food Security. NRI Research Bulletin No. 16, ICAR-National Rice Research Institute, Cuttack, Odisha, 753006, India. pp 26+vi.

Published by

Dr. H Pathak
Director
ICAR-National Rice Research Institute
Cuttack, Odisha, 753006, India

Cover page and layout design

Sunil Kumar Sinha

November, 2018

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Laser typeset at the ICAR-National Rice Research Institute, Cuttack-753006, Odisha, India, and printed in India by the Print-Tech Offset Pvt. Ltd., Bhubaneswar-751024, Odisha Published by the Director for ICAR-National Rice Research Institute, Cuttack-753006, Odisha.



त्रिलोचन महापात्र, पीएच.डी.
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सचिव एवं महानिदेशक

TRILOCHAN MOHAPATRA, Ph.D.
FNA, FNAsc, FNAAS
SECRETARY & DIRECTOR GENERAL

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FOREWORD

Rice varieties are unique combinations of genetic, aesthetic and economic innovation. Socio-economic revolution in a country with ensuring food and nutrition security can be brought about by the adoption of even a single variety, for example IR8, the miracle variety in rice. The development and promotional aspects of varieties involve great endeavor from scientists because only few breeding lines from a population of few hundred/thousands will be promoted as variety having combinations of suitable traits. ICAR-National Rice Research Institute (NRRI), Cuttack has released 132 varieties for different rice ecologies of the country. The familiar impacts of varieties released during 1960-70s were to increase in production, sustainability in rice production, food security, poverty reduction, etc. The varieties brought about Green Revolution and significant improvement occurred on food security of the country. After the Green Revolution, again several varieties were released and played an important role in increasing the rice production to at present about 113 million tons (Mt) of milled rice i.e., 170 Mt paddy annually.

Understanding the impacts of rice varieties released after the Green Revolution, especially during the last two to three decades is relatively difficult because gross increase in rice production might have been achieved by cumulative effects of many varieties and production technologies. Nevertheless, impact assessment of rice varieties is highly needed for stock-taking and identifying research areas to address the emerging challenges of rice farming. The present bulletin on impact of NRRI varieties on national food security is, thus very timely. For the analysis, area covered by varieties released from NRRI has been estimated to understand the impacts of NRRI varieties in different states of the country. The significant impact of NRRI varieties is the generation of gross returns of Rs. 48,643 crores annually with incremental income of around 2432 crores. In addition, NRRI varieties cover an area of about 7.9 Mha in India. The present estimate has provided a great opportunity to understand and reorient the research for the development of new varieties due to the threat of climate change.

I congratulate the authors for bringing out this publication and sincerely hope that the bulletin inspires and motivates scientists and all the stakeholders of rice community in transforming the life of the small and marginal farmers in our country.


(T. Mohapatra)



PREFACE

ICAR-National Rice Research Institute (NRRI) has released 132 rice varieties so far. Varieties namely Pooja, Shatabdi, Savitri, Sahabgadhan, Naveen, Maudamani are highly popular among the farmers. The breeder seed indent of NRRI varieties is also continuously increasing annually. These positive indicators explain greater adoption of NRRI varieties by the farmers in India. However, the area covered by and impacts of adoption of NRRI varieties in India is not known. In addition, 2018 happened to be 50 years of release of first NRRI rice variety PADMA. Thus, the present research bulletin on the impact of NRRI varieties aimed at estimating the area covered and the impact of NRRI varieties on rice production, income and national food security. The bulletin discusses the rice production in our country, breeder seed indents of NRRI varieties and the methodology used for estimation of area, production, gross returns, and incremental gain generated through cultivation of NRRI varieties in different states of India. The purpose of the bulletin is to inform the readers about the contribution of NRRI varieties in national food security and also highlights unique first of kind varieties namely high protein and super rice. The analysis started with collecting the information based on the breeder seed indents of NRRI varieties in different states of India. Once the preliminary information was obtained, several discussions were held to verify the methodologies used for the estimation because similar analysis were not been reported elsewhere in India. We have reevaluated the methodologies and validated the area covered by NRRI varieties especially in Odisha through directly getting the information from various departmental officers from different districts of Odisha. Also, detailed information of about all the 132 varieties released by NRRI is given in the annexure.

The significant contributions of all the scientists of NRRI need to be acknowledged for bringing out the research bulletin on the impacts of NRRI varieties on food security of the country. We sincerely hope that the bulletin will be useful for all the stakeholders of rice and would assist in further increasing the impacts of NRRI varieties.

Authors

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Summary

The ICAR-National Rice Research Institute (NRRI) was established in 1946 at Cuttack, Odisha to develop varieties and agro-technologies for enhancing and sustaining rice production in the country. The Institute so far has released 132 high-yielding varieties of rice for various ecosystems. Some of the NRRI varieties have been very popular among the farmers and even became ruling varieties in some states. However, there are no reports on the area covered by NRRI varieties and its impact on incremental gain in farm income in India. In the present study, six different methods were developed to estimate the area covered by NRRI varieties in India. The analysis showed currently the NRRI varieties cover about 8.0 million ha (Mha) i.e., 18.0% of rice area of the country. State-wise, West Bengal has the largest area of 2.26 Mha i.e., 41.1% of its rice area under the NRRI varieties followed by Odisha with 2.18 Mha (56.5%). Also, adoption of NRRI varieties is 39.3% in the Assam and 27.3% in Tripura. Moreover, total production of rice with NRRI varieties in the country is 27.80 million tons (Mt) with the value of Rs. 48,643 crores per annum. Further, incremental production and income with NRRI varieties considering 5% more than the high yielding local check is estimated to be 1.39 Mt and Rs. 2,432 crores per annum, respectively. Over the years, indents of breeder seed (BS) of NRRI varieties have increased considerably indicating that the varieties are getting more popular among the farmers in different states. The Institute has taken several pro-active steps to develop and popularize the varieties and other agro-technologies to address the emerging challenges such as climate change for enhancing and sustaining rice production.

1. Introduction

Rice is the staple food for more than 2/3rd of Indian population. The country has the world's largest rice area of 44 million ha (Mha) and second highest production of 164 million tons (Mt). The crop is cultivated in varying climatic and soil conditions round the year in one or the other parts of the country. The introduction of semi-dwarf, nitrogen responsive varieties during 1960-70 had resulted in phenomenal increase in the production of rice in India. Currently, about 75% of rice area is covered with high-yielding varieties. It contributes more than 40% to the total food grain production of the country occupying a pivotal role in the food and livelihood security of its people.

The ICAR-NRRI, Cuttack, Odisha established in 1946, is country's premier Institute for rice research. It has contributed immensely in country's Green Revolution and food security. The Institute so far has released 132 high-yielding varieties of rice for various ecosystems (Annexure I); collected and conserved about 35000 germplasm and developed resource management and crop protection technologies for cost-effective, environment-friendly and climate-smart rice production system. The first high yielding variety (HYV) of NRRI (the then CRRI) Padma was released in 1968. Subsequently, several HYVs with higher yield potential and resistance to biotic and abiotic stresses have been released. These varieties have contributed significantly in achieving sustainable food security of this nation. The Institute has also released varieties (CR Dhan 310 and CR Dhan 311) with high protein (10.3%) for nutritional security in 2016. Additionally, to address the emerging challenges of climate change, the Institute has recently (2018) released climate-smart varieties i.e., tolerant to both submergence and drought (CR Dhan 801 and CR Dhan 802). Most of the varieties of NRRI have been popular among the farmers and even became ruling or preferred varieties in some states i.e., Pooja in Odisha, Naveen in Assam, Shatabdi in West Bengal and Savitri in Tamil Nadu.

The seed quality is the prime factor for achieving sustainable food production and security in India (Ali, 2016). A vibrant seed supply system has been well established in India for the supply of quality rice seeds to the farmers (Chouhan et al., 2017). NRRI, Cuttack is one of the major institutes contributing significantly to the production of breeder seed and currently there are at least 55 NRRI varieties indented for breeder seed production through DAC in India out of 250 varieties. However, the coverage of NRRI varieties and its contribution to overall income gains in India are not reported so far. Thus, the objectives of the present study were to estimate the area covered by the NRRI varieties, to assess the production and income grains due to the spread of NRRI varieties in different states of the country, and to identify the strategies for popularization of NRRI varieties.

2. Area, production and productivity of rice in India

The rice production in India had increased at least five fold since 1950-51 (Figure 1). The phenomenal change in the production and productivity of rice is attributed to the green revolution and the increase in production occurred in spite of almost stagnant rice area in our country. Even though, few drought years witnessed during last few decades reduced the production of rice in India, it is certain that the impact of drought on rice production is very less during the drought years. Thus, India has achieved the self-sufficiency in rice production over the years and 113 Mt of milled rice was produced during the 2017-18. The major factors

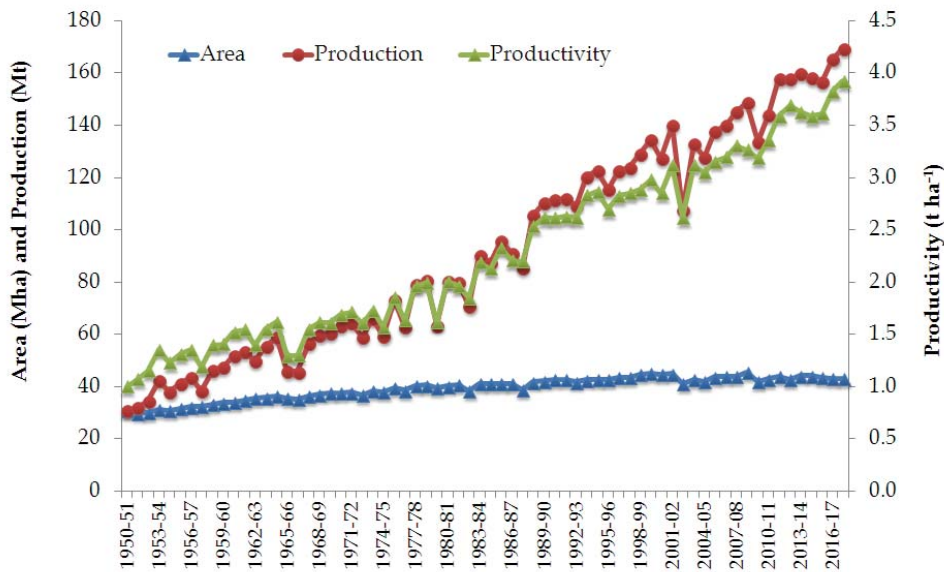


Figure 1. Area, production and productivity of rice during 1950-51 to 2016-17.

attributed to increase in the rice production are release of high yielding, nitrogen responsive rice varieties. The NRRI, Cuttack has so far released 132 rice varieties including three hybrids. The impact of green revolution in India is very well understood. But, understanding the impacts of NRRI varieties requires the prior information of area covered by NRRI varieties. Additionally, India cannot be complacent on the self-sufficiency of rice production because large variability exists in the productivity of rice in our country, especially in eastern states of our country. A thorough analysis of variety adoption by farmers could reveal the specific locational requirements of the farmers and research could be oriented accordingly to address the needs of the nation

3. NRRI varieties/hybrids released in India

Padma is the first variety released for cultivation throughout India by NRRI during 1968 for the irrigated ecology. Almost, 50 years of first variety released from our institute, NRRI has so far released 132 rice varieties including three hybrids for cultivation (Figure 3.1). The NRRI varieties are released for cultivation in almost most of the rice ecologies in India. There are totally 45 varieties has been released for irrigated ecology from NRRI. Apart from irrigated ecology, 9 varieties for aerobic, 19 varieties for upland conditions, 23 varieties for shallow lowlands has been released for cultivation. In addition, NRRI has also released varieties for specialized ecologies such as coastal salinity, semi-deep, and deep water ecologies, boro rice, varieties for bunded uplands and aromatic rice. Significantly, 25% of NRRI varieties (33 rice varieties) have been released during the last five years. Moreover, many varieties are very popular among the farmers in different states of our country. Also, specialized rice varieties such as high protein, super rice and varieties developed through molecular tools has been released for cultivation in India.

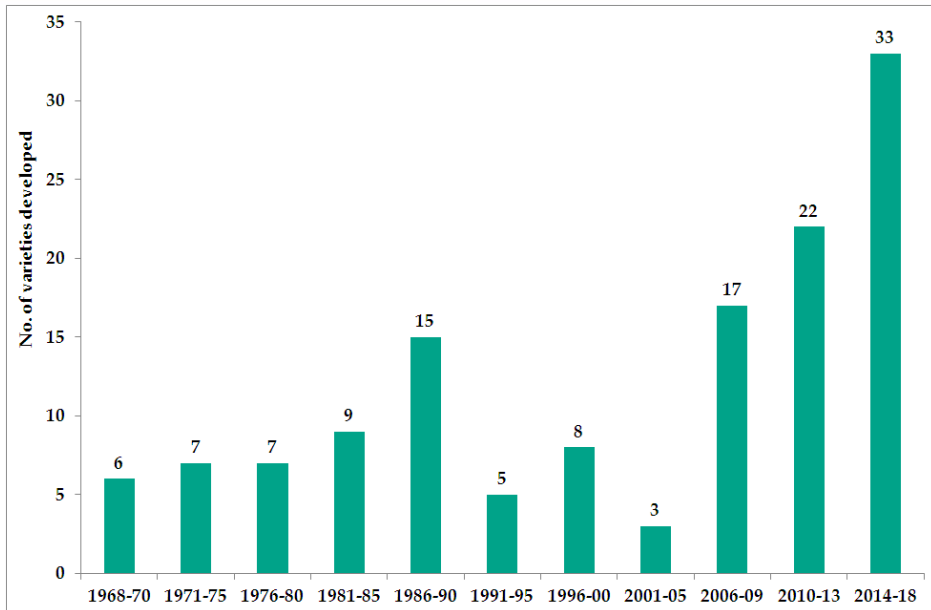


Figure 2. Varieties developed by ICAR-NRRI during 1968-2018.

4. NRRI varieties indented through Dept. of Agril. and Cooperation, Govt. of India

The NRRI plays a pivotal role in the supply of quality breeder seeds to the country. The demand of breeder seed indent for NRRI varieties has increased from 34 quintals in 2004-05 to 702 quintals in 2016-17 indicating an increase of about 20-folds in the demand for NRRI varieties (Figure 3). The major varieties indented through breeder seed indent include Shabagidhan, Swarna-Sub1, Abishek, Pooja, CR Dhan 500, CR Dhan 201, Sarla, and Annada. The most of the demand for breeder seed indent comes for varieties released during the last 10-15 years. In addition, old varieties such as Ratna, Khitish, Ponmani, Annada, Gayatri and Vandana are also very popular even today among the farmers. All together, 55 NRRI varieties are indented for breeder seed indent in India.

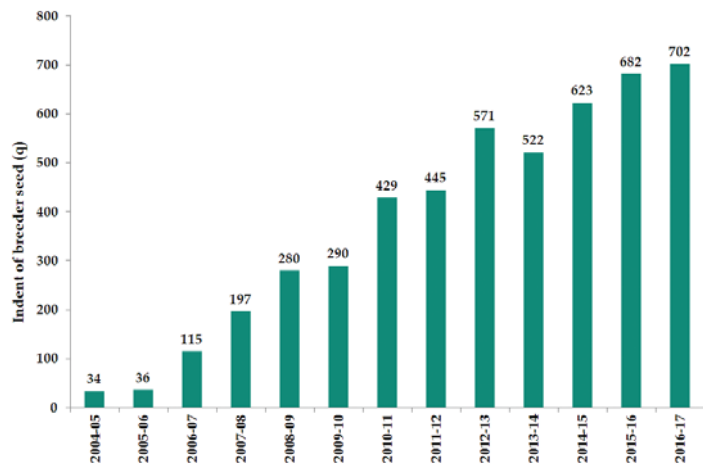


Figure 3. Breeder seed indent for NRRI varieties through Dept. of Agriculture and Cooperation, Ministry of Agriculture and Farmers Welfare, Govt. of India.



5. Methodology for estimation of area, production, gross returns and incremental gain with NRRI varieties

5.1 Estimation of area under NRRI varieties

Conventionally, the area under specific varieties of a crop is calculated using various methods such as (1) distribution of breeder seed (BS) as indented to Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers' Welfare, Govt. of India; (2) sale of certified seed (CS) by the agricultural departments of various states; (3) sample survey; (4) expert estimation and (5) community survey. Every method however, has its own advantages and disadvantages and also various levels of subjectivity. In the current analysis, efforts were made to quantify the amount of quality seeds of NRRI varieties provided to the farmers through various ways and estimated the area in different states under NRRI varieties. In the analysis, it was identified that the seeds of the released varieties of NRRI reaches to the farmers through the following ways: breeder seed indent (BSI) to the Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers' Welfare, Govt. of India; breeder seed and truthfully-labeled seed (TLS) sold by NRRI Farm; participatory seed production; seed distributed in various programmes and projects such as MGMT, BGREI, Farmers FIRST and Tribal Sub-Plan of the Institute; front-line demonstrations and on-farm testing; seed multiplied and supplied by private entrepreneurs and seed disseminated from farmers to farmers. Considering all the modes of distribution of seeds of NRRI varieties to the farmers, the following methods were used to estimate the area under NRRI varieties in different states of our country.

Method I: It was assumed that the area covered by NRRI varieties is proportional to the breeder seed indent (BSI) of NRRI varieties to the BSI of all the rice varieties submitted at DAC, Govt. of India. The following equation was used to calculate area under NRRI varieties.

$$\text{Area (Mha)} = \frac{\text{BSI for NRRI varieties (kg)} / \text{Total BSI of all varieties (kg)} * \text{Area under rice (Mha)} * \text{Area under HYVs (\%)} / 100}{\text{Eq. 1}}$$

Where BSI, breeder seed indent; HYVs, high yielding varieties; 100, conversion factor.

Method II: In this method, 1 kg of breeder seed (BS) was considered to produce 60 kg of foundation seed (FS), which in turn produces another 60 kg of certified seed (CS). It was also considered that 50 kg of certified seed or truthfully labeled seed (TLS) is required to plant 1 ha of area. Thus, area covered by NRRI varieties was calculated using the following equation.

$$\text{Area (Mha)} = \frac{[\{\text{BSI of NRRI varieties (kg)} * 60 * 60\} + \text{TLS (kg)}] / 50(\text{kg ha}^{-1}) / 10^6}{\text{Eq. 2}}$$

Where BSI, breeder seed indent; TLS, truthfully labeled seed; 50 and 10^6 , conversion factors.

Method III: It was assumed that the area covered by NRRI varieties is proportional to the sale of CS and TLS of NRRI varieties to the sale of CS and TLS of all the rice varieties in a state. The following equation was used to calculate area under NRRI varieties.

$$\text{Area (Mha)} = \frac{\text{Sale of CS and TLS of NRRI varieties (kg)} / \text{Total sale of CS and TLS (kg)} * \text{Area under rice (Mha)} * \text{Area under HYVs (\%)} / 100}{\text{Eq. 3}}$$

Where CS, certified seed; TLS, truthfully labeled seed; HYVs, high yielding varieties; 100, conversion factor.

Method IV: In this method, it was considered that 50 kg of CS or TLS is required to plant 1 ha of area. An adjustment was made to consider the adoption of the varieties from farmers to farmers taking the SRR of state as a proxy. Area covered by a variety was thus calculated using the following equation.

$$\text{Area (Mha)} = \text{Sale of CS and TLS of NRRI varieties (kg)} / 50 \text{ (kg ha}^{-1}\text{)} / 10^6 * 100 / \text{SRR}$$

Eq. 4

Where CS, certified seed; TLS, truthfully labeled seed; SRR, seed replacement ratio; 50, 100 and 10^6 , conversion factors.

Method V: As all the above methods have some assumptions and uncertainties, this method estimated the area under NRRI varieties taking the average area of all the above 4 methods.

Data on BSI for all rice varieties and NRRI varieties were collected from DAC (2018) and sales of CS data were obtained from various States. Data on supply of BS and TLS for NRRI varieties during 2017-18 were collected from the Farm section, ICAR-NRRI, Cuttack, Odisha.

5.2. Validation of the estimated area under NRRI varieties

A survey was conducted during July-August, 2018 to validate the estimated areas derived through different methods in our analysis. The District Agriculture Officers of Odisha (30 officers) and West Bengal were requested to provide the data on coverage of NRRI varieties in their respective districts. These two states showed the largest area covered by NRRI varieties of the country. Additionally, an expert consultation was also organized to validate the estimated area under NRRI varieties.

5.3. Estimation of increase in production and income with NRRI varieties

5.3.1. Production and gross return with NRRI rice varieties

Production of rice of NRRI varieties was calculated using the following equation.

$$\text{Production of NRRI rice (Mt)} = \text{Area of NRRI varieties (Mha)} / \text{Total area (Mha)} * \text{Total production (Mt)}$$

Eq. 5

Gross return with NRRI varieties was calculated using the following equation.

$$\text{Price of NRRI rice (Rs. crore)} = \text{Production of NRRI rice (Mt)} * \text{MSP (Rs. t}^{-1}\text{)} / 10$$

Eq. 6

Where MSP, minimum support price; 10, conversion factor.

5.3.2. Incremental gains in production and return with NRRI varieties

Incremental gain in production due to adoption of NRRI varieties were calculated considering 5% incremental gain because a new variety is released only when a minimum yield advantage is more than 5% than the local check variety. Thus, the incremental gain in production of NRRI varieties was calculated using the following equation.

$$\text{Gain in production of NRRI var. (Mt)} = \text{Area of NRRI varieties (Mha)} / \text{Total area (Mha)} * \text{Total production (Mt)} * 5/100$$

Eq. 7

The incremental production was multiplied with the minimum support price (Rs. 17500 t⁻¹) to get additional return over non-NRRI varieties. Incremental gain in return with NRRI varieties was calculated using the following equation.

$$\text{Gain in income of NRRI var. (Rs. crore)} = \text{Gain in production of NRRI var. (Mt)} * \text{MSP (Rs. t}^{-1}\text{)} / 10$$

Eq. 8

Where MSP, minimum support price; 10, conversion factor.

6. Area covered by NRRI varieties

Rice is cultivated in an area of about 43 Mha in India. NRRI varieties accounts for an area of about 7.9 Mha in India (Figure 4). The farmers from 20 states and a union territory Pondicherry cultivate NRRI varieties. The major states growing NRRI varieties are West Bengal and Odisha cultivating NRRI varieties around 2.25 and 2.17 Mha, respectively accounting to almost 56% of rice area for NRRI varieties. In addition, around 2.737 Mha of rice area are covered by NRRI varieties from four states namely Assam, Bihar, Chhattisgarh, and Uttar Pradesh. Apart from these states, 14 states also cultivate NRRI varieties in at least 800 hectares to 75 thousand hectares.

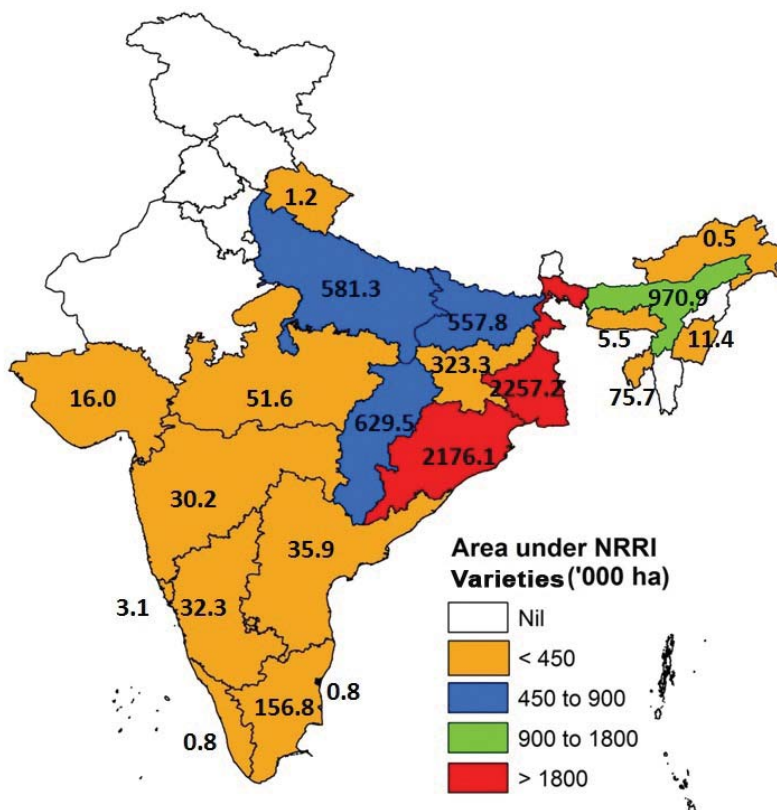


Figure 4. Area covered by NRRI varieties in India.

7. NRRI varieties contribution to rice production in India

The cultivation of NRRI varieties results in the production of about 27.8 MT of rice in India (Figure 5). The states such as West Bengal and Odisha accounts for the major share of 9.4 and 7.0 MT of rice, respectively. Apart from these two major states, Assam, Bihar, Jharkhand, Uttar Pradesh produces around 4.737 MT of rice from cultivating NRRI varieties. Thus, approximately 17% of rice production in our country comes from the cultivation of varieties released from NRRI. The total production of rice in India is about 168 MT.

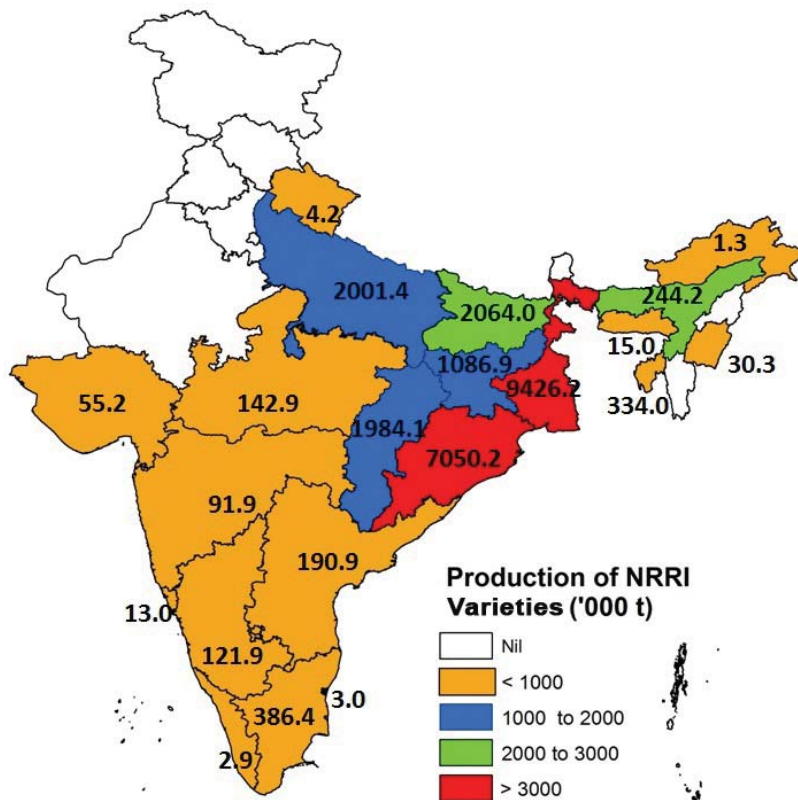


Figure 5. Production of rice in India with NRRI varieties.

8. Gross returns and incremental gains with NRRI varieties

Gross returns from cultivation of NRRI varieties in India were estimated to be around Rs. 48,643 crores annually. Incremental gain with NRRI varieties over conventional varieties

was Rs. 2432 crores annually. Farmers of West Bengal, Odisha, Assam received the major benefit in terms of incremental gain through cultivation of NRRI varieties (Figure 6).

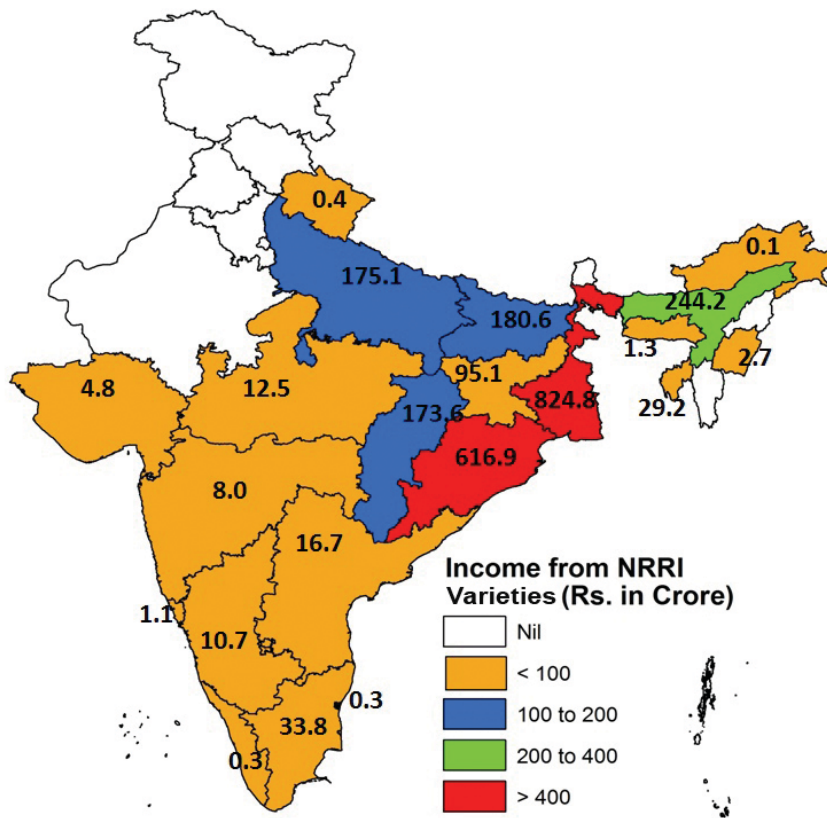


Figure 6. Incremental gains with NRRI varieties compared to conventional varieties.

9. High protein and super rice NRRI varieties

Rice consists of relatively low protein compared to another staple crop wheat. However, there is greater diversity in the protein content present in rice identified in several germplasms. Utilizing a germplasm line having higher protein content of more than 10%, NRRI have developed two protein rich rice varieties namely CR Dhan 310, CR Dhan 311 each having protein content of at least 10%. The successful marketing of these varieties will assist in reducing the protein energy malnutrition among the children in the places where rice is being solely consumed as major energy requirements. NRRI also has an effective breeding program for the development of super rice varieties, which could yield 10 t ha^{-1} . The variety namely Maudamani and other breeding lines are producing yield of 10 t ha^{-1} in research farms and in the farmers fields. The stability of yield of these varieties has the potential to break the yield ceiling barrier of rice crop in future.

10. Strategies for the popularization of NRRI varieties

The phenomenal increase in the DAC indents for the breeder seed of NRRI varieties can be attributed to several pro-active steps developed for the popularization of the varieties and other agro-technologies to address the emerging challenges such as climate change for enhancing and sustaining rice production. The strategies followed by NRRI for the popularization of recently released rice varieties are discussed below.

- **NRRI-Farmers-Seed Entrepreneurs:** In this strategy, truthfully labeled seeds are given to the farmers in the BGREI and other programmes. Farmers are then connected to the private companies i.e., seed entrepreneurs. This model has been very successful and well supported by the farmers. For example, 50 q seeds of NRRI variety Maudamani were initially provided to Sriram Seed Company in Dugripali, Bargarh during dry season of 2016-17. Due to the spread of Maudamani, coverage during the kharif season, 2017 was around 50,000 ha in Sonepur and Bargarh districts alone.
- **Promotion of NRRI Super rice:** The Institute has developed a super rice culture CR 3856-44-22-2-1-11 with medium slender grains. Through farmer's participatory yield evaluation trial, this variety yielded more than 10.0 t ha⁻¹ under favorable irrigated system. Also, on-farm testing of this culture is conducted in 10 districts of coastal, western and interior districts of Odisha with the help of Agriculture Department of the State.
- **NRRI-State Govt.-Farmers:** In this strategy, seeds are given to the farmers through State Govt. This model is followed for newly released varieties in all the BGREI states including Odisha. For kharif 2017, seeds of CR Dhan-202 (100 kg) and CR Dhan 305 (200 kg) have been given to Jharkhand and CR Dhan 201 (100 kg), CR Dhan 203 (100 kg) and CR Dhan 304 (20 kg) were given to West Bengal.
- **Farmer FIRST Programme:** In Farmer FIRST programme, seeds of 21 varieties have been distributed to the lead farmers in some village clusters in Cuttack district of Odisha.
- **MGMG Programme:** In this strategy, seeds are given to all the village-clusters covered under the Mera Gaon Mera Gaurav (MGMG) programme of the Institute to promote the varieties in the NRRI-Progressive Farmers-Farmers model. Seeds of high yielding newly released varieties including hybrid seed and high protein and high zinc rice are distributed to innovative and lead farmers in adopted villages through MGMG programme.
- **Frontline Demonstrations:** In the frontline demonstration of recently released varieties, four districts of Odisha (Dhenkanal, Kendrapada, Boudh and Phulbani) are being covered with more than 10 new varieties covering at least 10 ha/district..
- **Farmers Participatory Seed Programme:** In this strategy, seeds are being produced in some selected blocks (eg. Mahanga) in farmers participatory mode and sold to other farmers.
- **NRRI-Leading farmer-farmer:** Seeds of newly released high yielding varieties are distributed to lead farmers for on-farm demonstration and these varieties are supposed to spread further through personal contacts.
- **Seeds sold to farmers:** The NRRI farm in this season (2017-18) has sold 147.0 tons of truthfully labeled seeds have been sold to farmers.
- **Field days:** In NRRI, field days will be observed at different sites of demonstrations under various programmes involving officials of state department of agriculture, seed corporation, KVKs, SAU, research institutes, private seed firms, farmer interest groups, etc. This will help in generating breeder seed indents.



- **Seed increase:** In this strategy, seeds of recent variety have been multiplied and the seeds were supplied to various functionaries to reach to the farmers for popularization.
- **Increase minikits and demonstration trials:** For popularization of recent varieties, large number of minikits and demonstration programme has been taken up. In collaboration with State Govt., around 25 q seeds of 22 recently released varieties have been supplied to 22 DDAs covering 22 districts of Odisha state and 6 DDAs of other states. The varieties have been given to the BGREI implemented districts for proper monitoring by the NRRI scientists. Besides, 20 q seeds of recent varieties have been made available through the Farm Section, NRRI to the Social Science Division for Front-line Demonstration in various districts of the state.
- **Seed supply to adopted village:** Seeds of the recent varieties have been supplied to the NRRI adopted villages. Seed of the recent varieties have also been supplied to the innovative farmers of the state as per recommendation of extension functionaries.
- **Requesting the state Agril. Dept. for seed indent:** During this year, seven states have been requested to place indent for recent varieties recommended for their state. Odisha, West Bengal, Chhattisgarh, Jharkhand, Madhya Pradesh, Gujarat and Bihar Agriculture Dept. have been requested to place indent for breeder seed production.

11. Climate change and re-orientation of variety development program at NRRI

The recent IPCC report has predicted 1.5° C increase in the average temperature of earth which will definitely be detrimental to developing countries like India. The intensity and occurrence of flood, drought, and high temperature are predicted to be highly variable and expected to be mostly on the higher side of scale. The alterations in weather due to climate change are likely to interfere with the biology of disease and insects pests and sudden large scale occurrence of pest and disease outbreaks may become routine in future. In anticipation of these threats, NRRI has developed an effective breeding program well-supported by crop production and protection scientist to characterize and introgress the resistant/tolerant genes identified through screening of hundreds of germplasm. Further, marker assisted introgression have been used to develop varieties namely CR Dhan 801 and CR Dhan 802 consisting of genes/QTLs tolerant to submergence and drought.

12. Future prospects

The impact assessment of NRRI varieties has given sufficient information of success of NRRI varieties among the framers and also provided a glimpse of future direction of research. However, the analysis also revealed that a synergistic relationship is definitely required for the farmer's preference and traits of modern rice varieties. Especially, the quality of grains and its associated milling percentage requires greater emphasis in future research. In addition, the variety evaluation for grain quality requires participation of framers, consumers, and various stakeholders to assist in the selection of breeding lines suited to their specific needs. The passive promotion of variety may no longer suits the needs of the developing India having specialized requirements for yield, quality, and milling percentage etc. Thus, an active varietal promotional program can greatly assist not only in the rapid adoption of rice varieties developed in NRRI but also could greatly increase the incremental gain achieved through cultivation of NRRI varieties over other varieties.

Annexure I

Varieties/hybrids developed by ICAR-National Rice Research Institute, Cuttack, Odisha.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	Released for State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
1	Padma	Irrigated	CR 28-25 (IET 953)	T 141/TN 1	1968	All India	120	Short Bold	3.5-4.0	Moderately resistant to major diseases and pest.
2	Bala	Upland	CR 42-38-173 (IET 1916)	N 22/TN 1	1970	Assam, Bihar, Odisha, Uttar Pradesh, West Bengal	105	Short Bold	3-3.5	Moderately resistant to bacterial leaf blight, stem borer, and hard to thresh.
3	Kiron	Irrigated	CR 141-2-192 (IET 3226)	CR 42/CR 10	1970	West Bengal	110	Medium Slender	4.0	Field tolerance to all major diseases and pest.
4	Krishna	Irrigated	CR 1-6 (IET 1417)	GEB 24/IR 8	1970	Odisha	125	Medium Slender	3.5-4.0	Resistant to bacterial leaf blight and moderately resistant to stem borer, susceptible to gall midge.
5	Ratna	Irrigated	CR 44-11 (IET 1411)	TMK 6/IR 8	1970	Odisha, Punjab, Haryana	125	Long Slender	5.0	Moderately resistant to bacterial leaf blight and stem borer.
6	Vijaya	Irrigated	CR 10-5437 (IET 1879)	T 90/IR 8	1970	Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, West Bengal	135	Medium Slender	3.5-4.0	Resistant to bacterial leaf blight and moderately resistant to stem borer, susceptible to gall midge.
7	Saket-4	Irrigated	CR 44-35 (IET 1410)	TKM 6/IR 8	1971	Uttar Pradesh	115	Long Slender	4.0	Moderately resistant to bacterial blight, green leaf hopper and stem borer.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	State for release	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
8	Jayanti	Irrigated	CR 10-4103 (IET 1039)	T 90/IR 8	1973	Assam, Bihar, Odisha, Uttar Pradesh, West Bengal	135	Long Slender	4.0	Tolerant to blast.
9	Kalinga-I	Irrigated	CR 126-33-11 (IET 2969)	Dunghansali/IR 8	1973	Odisha	105	Long Bold	4.0	Susceptible to diseases
10	Kalinga-II	Irrigated	CR 126-42-2 (IET 3279)	Dunghansali/IR 8	1973	Odisha	100	Long Bold	4.0	Susceptible to diseases.
11	Shakti	Irrigated	CR 93-4-2 (IET 3232)	CR 55-13/IR 8	1973	Odisha	135	Short Bold	5.0	Resistant to rice tungro virus, moderately resistant to sheath blight, green leaf hopper and gall midge.
12	Supriya	Irrigated	CR 36-148 (IET 1530)	IR 8/CR 1	1973	Odisha	125	Medium Slender	4.0	Moderately resistant to bacterial blight and stem borer
13	Vani	Irrigated	CR 12-178 (IET 2255)	IR 8/CR 1014	1975	Odisha	125	Long Slender	4.0	Moderately resistant to bacterial blight, blast and resistant to rice tungro virus.
14	Naikichilli	Irrigated	CR 146-7027-274 (IET 7848)	CR 10-114/CR 115	1977	Tamil Nadu	120	Long Slender	4.0	Resistance to blast.
15	Anamika	Shallow lowlands	CR 149-3244-198 (IET 3257)	MNP 36/CR 12/ Pankaj	1979	West Bengal, Bihar, Odisha and Assam	145-150	Long Bold;	4.25	Moderately resistant to bacterial blight, blast, stem borer, and rice leaf hopper.
16	Indira	Irrigated	CR MUT 587-4 (IET 2412)	Tainan 3 mutant	1980	Odisha	125	Medium Slender	4.0	Moderately resistant to bacterial blight, blast and stem borer.
17	Pallavi	Irrigated	CR 214-52-102 (IET 11708)	Jikkoku/ Serup kichel	1980	Odisha	125	Medium Slender	4.0	Resistant to bacterial blight.
18	Ramakrishna	Shallow lowlands	CR 44-122-1 (IET 4155)	TKM 6/IR 8	1980	Odisha	130	Medium Slender	4.0	Resistant to bacterial blight and tolerance to gall midge.
19	Samalei	Shallow lowlands	CR 95-ORS-952-1 (IET 3350)	Leaung 152/IR 8	1980	Odisha	150	Long Slender	4.0-5.0	Resistant to gall midge and blast.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	for State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
20	Sattari	Upland	CRM 23-3241 (IET 5750)	NSJ 200/Padma-Gamma irradiate	1980	Odisha and West Bengal	70	Short Bold	3.0	Dwarf, escapes diseases and pest.
21	Narendra-1	Irrigated	CR 110-173 (IET 2233)	Belle Patna/ IR 8	1981	Uttar Pradesh	110	Long Bold	4.0	Tolerance to bacterial blight.
22	Savitri/Ponmani	Shallow lowlands	CR 210-1009 (IET 5897)	Pankej/Jagamath	1982	Odisha and Tamil Nadu	150-155	Short Bold	3.8	Semi-dwarf, moderately resistant to bacterial blight and sheath blight.
23	Khitish	Irrigated	CR 156-5021-207 (IET 4094)	Bulk 1/CR 115	1982	West Bengal	120	Long Slender	5.5	Suitable for dry season.
24	CR 138-928	Irrigated	CR 138-928 (IET 4078)	Jaya/TKM 6	1983	Gujarat	120	Medium Slender	4.0	Semi dwarf, moderately resistant to bacterial blight, stem borer and gall midge.
25	Kalinga-III	Upland	CR 237-1 (IET 6802)	AC-540/Ratna	1983	Odisha	80	Long Slender	3.5	Cold tolerance and resistant to brown spot.
26	Utkalprabha	Medium Deep	CR 221-1030 (IET 11184)	Waikyaku/CR 1014	1983	Odisha	155	Medium Slender	4.0	Field tolerance to major pest and diseases.
27	Neela	Upland	CR 404-56-1 (IET 7317)	CR 94-1512-6/ Ratna	1985	Odisha	90	Medium Bold	4.0	Dwarf, resistant to rice tungro virus, gall midge, moderately resistant to brown plant hopper, white back plant hopper.
28	Sarasa	Irrigated	CR 407-19 (IET 7315)	CR 94-1512-6/ Ratna	1985	Odisha	120	Long Slender	5.0	Resistant to gall midge, virus, and white back plant hopper.
29	Udaya	Irrigated	CR 190-103 (IET 6703)	CR 129-118/ CR 57-49-2	1985	Odisha	135	Long Bold;	5.5	Semi dwarf, resistant to bacterial blight, brown plant hopper, white back plant hopper, gall midge, green leaf hopper, and moderately resistant to rice tungro virus.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
30	Annada	Upland	CR 222-MW 10 (IET 6223)	MTU 15/Waikyaku	1987	Odisha, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Goa	110-112	Short Bold	5.0	Moderately resistant to blast and stem borer.
31	CR 1014	Medium Deep	CR 563-1014	T 90/Urang Urangan	1988	Odisha	155	Medium Slender	4.0	Tall, moderately resistant to sheath blight, field tolerance to all other est. and diseases.
32	Dharitri	Shallow lowlands	CR 210-1017-607 (IET 6272)	Pankaj/ Jagannath	1988	West Bengal, Odisha, Assam, Tripura and Madhya Pradesh	145-160	Short Bold	3.75-4.5	Semi dwarf, moderately resistant to blast, bacterial blight, stem borer and gall midge.
33	Gayatri	Medium Deep	CR 210-1018 (IET 8022)	Pankaj/ Jagannath	1988	Odisha	155	Short Bold	4.0-6.0	Semi dwarf, moderately resistant to bacterial blight, blast, and gall midge.
34	Heera	Upland	CR 544-1-2 (IET 10973)	CR 408-48/ CR 289-1208	1988 / 1991	Odisha	68	Long Bold	3.0	Dwarf, resistant to gall midge.
35	Kalashree	Medium Deep	CR 260-292 (IET 9043)	CR 151-79/ CR 1014	1988	Odisha	160	Medium Slender	4.0	Moderately tolerant to blast and gall midge.
36	Kalyani-I	Upland	CR 66-36-4 (IET 10970)	TN 1/CH 45/ Rikku 132/N 22	1988	Odisha	62	Medium Slender	2.5-3	Resistant to blast.
37	Kshira	Irrigated	CR 401-7 (IET 7328)	Vijaya/CR 94-1512-6	1988	Odisha	135	Medium Bold	4.5	Dwarf, resistant to blast, rice tungro virus, brown plant hopper, gall midge and white back plant hopper.
38	Moti	Shallow lowlands	CR 260-136-321 (IET 9170)	CR 151-79/ CR 1014	1988	Odisha	145	Long Slender	4.0-4.5	Tall, resistant to blast, rice tungro virus, green leaf hopper
39	Padmini	Shallow lowlands	CRM 25 (IET 10561)	CR 1014 mutant	1988	Odisha	145	Medium Slender	3.5-4.0	Moderately tolerant to lodging, resistant to bacterial blight.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
40	Panidhan	Medium Deep	CR 260-30 (IET 10222)	CR 151-79/ CR 1014	1988	Odisha	170	Medium Slender	3.5-4.0	Field tolerance to major pests and diseases
41	Tara	Upland	CR 404-48 (IET 9215)	CR 94-1512-6/ CR 1014	1988	Odisha	100	Medium Bold	4.5	Dwarf, resistant to blast, rice tungro virus, green leaf hopper, and gall midge.
42	Tulasi	Medium Deep	CR 260-171 (IET 8548)	CR 151-79/ CR 1014	1988	Odisha	170	Medium Slender	3.5-4.0	Submergence tolerance and field tolerance to major pest and diseases.
43	Vanaprabha	Upland	CR 289-1045-16 (IET 9804)	ARC 12422/ ARC 12751	1988	Odisha	90	Long Slender	3.5	Resistant to blast and rice tungro virus.
44	Shaktiman	Irrigated	CR 404-24 (IET 7316)	CR 94-1512-6/ Pusa-2-21	1990	Odisha	120	Short Bold	4.0	Resistant to bacterial leaf blight, green leaf hopper and gall midge.
45	CR 1002	Shallow lowlands	CR 213-1002 (IET 5890)	CR 70-80-2/ Pankaj	1992	Odisha, Madhya Pradesh, West Benagl, Bihar	145	Short Bold	4.75	Moderately resistant to sheath blight and green leaf hopper
46	Lunishree	Coastal Saline	CRM 30 (IET 10678)	Nonasali Gamma irradiated mutant	1992	Odisha	145	Long Slender	4.75	Field tolerance to major pests and diseases and tolerance to salinity.
47	Seema	Shallow lowlands	CR 211-1016 (IET 8036)	Jagannath Natural Crops	1992	Odisha	150	Medium Slender	4.5	Resistance to blast.
48	Sneha	Upland	RR 19-2 (IET 1148)	Amada/ CR-143-2-2	1992	Odisha	70	Long Slender	3.5	Resistance to blast and gundhi bug.
49	Vandana	Upland	CR 357/RR167-982 (IET 12304)	C 22/Kalakeri	1992/2000	Bihar, Odisha	95	Long Bold;	3.5	Moderately resistant to blast.
50	Dhala Heera	Upland	CR 544-1-3-4 (IET 11411)	CR 404-48/ CR 289-1208	1996	Odisha	85	Long Bold;	3.5	Resistance to rice tungro virus, gall midge, green leaf hopper, white back plant hopper and blast
51	Radhi	Irrigated	CRM 40 (IET 12413)	Swarnaprabha mutant	1996	Odisha	120	Long Bold;	4.5	Field tolerance to major pest and diseases.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
52	Sonamani	Coastal saline	CR 644 (IET 11365)	Velki mutant/ Mahsuri	1996	Odisha	155	Long Bold;	4.5	Susceptible to yellow stemborer.
53	Tapaswini	Irrigated	CR 333-6-1 (IET 12168)	Jagannath/ Mahsuri	1996	Odisha	135	Medium Slender	5.0	Moderately resistant to bacterial leaf blight and white back plant hopper.
54	Pooja	Shallow lowlands	CR 629-256 (IET 12241)	Vijaya/T 141	1999	Odisha, Madhya Pradesh, Assam, Tripura, West Bengal	150	Medium Slender	4.5	Resistant to blast and field tolerance to major pest and diseases.
55	Sarala	Medium Deep	CR 260-77 (IET-10279)	CR 151/CR 104	2000	Odisha	150	Medium Slender	4.75	Non-lodging and photosensitive.
56	Durga	Medium Deep	CR 683-123 (IET 112383)	Pankaj/CR 1014	2000	Odisha	155	Medium Bold	4.3	Resistant to rice tungro virus, and suitable for late planting
57	Shatabdi	Irrigated	CR 146-7027-224 (IET 4786)	CR 10-114/ CR 10-115	2000	West Bengal	110	Long Slender	3.7	Moderately resistant to bacterial blight, sheath blight, sheath rot and suitable for dry season.
58	Anjali	Upland	RR 347-166 (IET 16430)	Sneha/ RR 149-1129	2002	Uttar Pradesh, Bihar, Jharkhand, Assam, Tripura	95	Short Bold	3.5	Moderately resistant to blast, white back plant hopper, gall midge and leaf folder.
59	Hazaridhan	Irrigated	CR 314-5-10 (IET 8707)	IR-42/ IR 5853-118-5	2004	Jharkhand	120	Long Slender	3.7	Resistant to blast and moderately resistant to bacterial leaf blight.
60	Sadabaha	Upland	CR 306-37-13 (IET 10919)	BRRI SAIL/ IR 10181-58-3-1	2004	Jharkhand	105	Long Bold;	3.5	Moderately resistant to sheath blight.
61	Abhishek	Irrigated	RR 272-89 (IET 17868)	CR 314-5-10 Natural Cross	2006	Uttar Pradesh, Bihar, Jharkhand, Assam	125	Short Bold	4.5-5.0	Semi dwarf, resistant to blast and moderately resistant to brown spot and gall midge.
62	Chandrama	Irrigated Boro	CR 386-2-10 (IET 10419)	ARC 6650/ CR 94-721	2006	Assam	130 (Irrig) 170 (Boro)	Short Bold	4.5	Resistant to blast, moderately resistant to bacterial leaf blight, rice tungro virus, sheath blight, brown plant hopper, white back plant hopper, gall midge and 15 days of dormancy.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
63	Virender	Upland	RR 347-2 (IET 17901)	Shehal/RR 149-1129	2006	Odisha, Gujarat	95	Short Bold	2.75	Resistant to brown spot, gall midge and moderately resistant to blast.
64	Geetanjali	Irrigated	CRM 2007-1 (IET 18987)	Basmati 370 Mutant	2006	Odisha	130	Long Slender (aromatic)	4.5	Semi-dwarf, resistance to gall midge.
65	Ketekijoha	Shallow lowlands	IET 18669	Savitri/Badshabhog	2006	Odisha	145	Medium Slender (aromatic)	3.5	Moderately resistant to bacterial leaf blight, sheath blight, stem borer and gall midge.
66	Naveen	Irrigated	CR 749-20-2 (IET 1446)	Sattari/Jaya	2006	Odisha, Tripura, West Bengal	120	Medium Bold	5-5.5	Resistance to blast
67	Rajalaxmi (Hybrid)	Irrigated	CRHR-5 (IET 19600)	CRMS 32A/IR 42266-29-3R	2006	Odisha, Assam	135	Long Slender	5.85	Moderately resistant to sheath blight.
68	Ajay (Hybrid)	Irrigated	CRHR-7 (IET 18166)	CRMS 31A/IR 42266-29-3 R	2006	Odisha	130	Long Slender	6.07	Moderately resistant to blast, bacterial leaf blight, sheath blight, brown plant hopper, white back plant hopper and gall midge.
69	Varshadhan	Semi-deep	CRLC-899 (IET 16481)	IR 31432-8-3-2/ IR 31406-3-3-3-1// IR 26940-3-3-3-1	2006	Odisha	160	Long Bold	3.5-4.0	Stiff straw for water logging situation, moderately resistance to neck blast bacterial leaf blight and sheath rot.
70	Satya Krishna (CR Dhan 10)	Irrigated	CRAC 2221-43 (IET 18312)	D H from PHB 71	2008	Odisha	135	Long Slender	5.2	Resistant to neck blast, sheath rot and moderately resistant to sheath blight, gall midge.
71	Nua kalajeera	Shallow lowlands	Kalajeera (IET 18393)	Pureline selection for Kalajeera	2008	Odisha	150	Short Bold (aromatic)	2.8	Black husk, aromatic; photosensitive, resistant to yellow stem borer and moderately resistant to blast and sheath rot.
72	Nua Dhusara (CR Sugandh Dhan 3)	Shallow lowlands	CR2579-1Dhusara (IET 18395)	Pureline selection for Dhusara	2008	Odisha	150	Medium Slender (aromatic)	3.0	Aromatic, resistant to neck blast, sheath rot, rice tungro virus and moderately resistant to gall midge and photosensitive.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	for State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
73	Chandan (CR Boro dhan 2)	Boro	CRM 898 (IET 17612)	Gamma ray mutant from China 45	2008	Odisha, Assam	125 Irrig, 145 Boro	Medium Slender	6.1	Moderately resistant to sheath blight, brown plant hopper, blast and bacterial leaf blight.
74	Hanseswari (CR Dhan 70)	Semideep	MTC4 (IET 11904)	Pure line selection in composite cross	2008	Odisha	150	Short Bold	3.0	Moderately resistant to blast.
75	Swama Sub1	Flood prone shallow lowlands	CR 2539-1 (IET 20266)	Swama 3/ IR 49830-7-1-2-3	2009	Odisha	145	Medium Slender	5.2	Tolerant to complete submergence up to 15 days.
76	CR Dhan 40	Bunded Upland	CRR 383-22 (IET 19253)	N 22/RR 20-5	2008	Jharkhand, Maharashtra	110	Short Bold	3.5	Drought tolerant, moderately resistant to blast, brown spot, white back plant hopper, sheath blight, leaf folder and resistant to gall midge.
77	Sahbhagidhan	Rained upland	IR 74371-70-1-1-CRR-1 (ET 19576)	IR 55419-04*2/ Way Rarem	2009	Odisha and Jharkhand	105	Long Bold;	3.5-4.0	Tolerant to drought, resistance to leaf blast, moderately resistance to brown spot, sheath rot, sheath blight and leaf folder.
78	Phalguni	Bunded uplands and irrigated	CRAC 2224-1041 (IET 18720)	DH of KRR 2	2010	Odisha	117	Long Slender	4.0-4.5	Resistance to blast, moderately resistant to sheath rot, rice tungro virus, brown spot, sheath blight, yellow stem borer, white back plant hopper, brown plant hopper, green leaf hopper and resistant to gall midge.
79	Reeta (CR Dhan 401)	Shallow lowland	CR 780-1937-1-3 (IET 19969)	Savitri/IR44	2010	Odisha	150	Medium Slender	5.5	Resistant to leaf blast, moderately resistant to neck blast, brown spot, sheath blight, leaf blast and leaf folder
80	Luna Suvama (CR Dhan 403)	Coastal Saline	CR 2096-71-2 (IET 18697)	Mahsuri/ Ourmundakan	2010	Odisha	150	Medium Slender	3.5-4.0	Resistant to blast, sheath blight, brown plant hopper and leaf folder.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	for State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
81	Luna Sampad (CR Dhan 402)	Coastal Saline	CR 2095-181-1 (IET 19470)	Mansuri/Chakrakanda	2010	Odisha	140	Short Bold	3.6-4.2	Resistant to blast, tolerant to sheath blight, brown plant hopper, and leaf folder.
82	Nua Chhikamini	Shallow lowland	CR 2580 (IET 18394)	Chhikamini	2010	Odisha	145-150	Short Bold (aromatic)	3.5	Resistant to sheath rot, rice tungro virus, neck blast, gall midge, and moderately resistant to sheath blight.
83	CR Dhan 501	Semi-deep	CR 2008-111 (IET 19189)	Savitri/Padmuni	2010	Uttar Pradesh, Assam	152	Long Bold;	3.4	Resistant to neck blast.
84	CR Dhan 701	Shallow lowland	CRHR 32 (IET 20852)	CRMS 31A/CRL-22R	2010, 2014	Bihar, Gujarat, Odisha	142	Medium Slender	6.0	Moderately resistant to rice tungro virus, sheath blight and brown spot.
85	CR Dhan 601	Boro	CRG 1190-1 (IET 18558)	Jaya/IR64	2010	Odisha, West Bengal and Assam	160	Medium Slender	5.6	Resistant to blast, rice tungro virus, moderately resistant to brown spot, sheath rot, sheath blight, green leaf hopper, leaf folder and cold tolerance.
86	CR Dhan 500	Deep Water	CR 2285-6-6-31 (IET 20220)	Ravana/Mahsuri	2011	Odisha, Uttar Pradesh	160	Medium Slender	3.5	Moderately resistant to blast, neck blast, brown spot, gall midge and sheath blight and resistant to leaf folder.
87	Satyabhama (CR Dhan 100)	Upland	CR 2340-11 (IET 20148)	IR 31238-350-3-2-1/IR 41054-102-2-3-2	2012	Odisha	110	Medium Slender	2.3-4.7	Resistant to leaf blight, rice tungro virus, sheath blight, leaf folder, moderately resistant to white back plant hopper and gall midge.
88	Pyari (CR Dhan 200)	Aerobic	CR 2624-IR 55423-01 (IET 21214)	UPL RI5/IR 12979-24-1 (Brown)	2012	Odisha	115-120	Short Bold	4.5	Moderately resistant to blast, neck blast, brown spot, sheath blight, leaf folder and gall midge

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
89	Hue (CR Dhan 301)	Irrigated	CRK 26-1-2-1 (IET 19351)	IR 42/Rahaspanjar	2012	Odisha	135	Long Slender	4.5-5.5	Resistant to gall midge and moderately resistant to sheath rot.
90	Improved Lalat	Irrigated	CRMAS 2621-7-1 (IET 21066)	Lalat and IRBB 60	2012	Odisha	130	Long Slender	4.5-5.0	Resistant to bacterial leaf blight, gall midge and moderately resistant to stem borer.
91	Improved Tapaswini	Irrigated	CRMAS 2622-7-6 (IET 21070)	Tapaswini with IRBB 60	2012	Odisha	130	Short Bold	4.0-5.0	Resistant to bacterial leaf blight, brown plant hopper, yellow stem borer, white back plant hopper.
92	Sumit (CR Dhan 404)	Shallow lowlands	CR 662-22-1-1-1-1 (IET 19913)	IR-32/IR 13246	2012	Odisha	145	Long Bold	5.2	Resistant to leaf folder and sheath blight.
93	Poorna Bhog (CR Basna Dhan 902)	Shallow lowlands	CRM 2203-4 (IET 18008)	Pusa Basmati-1 mutant	2012	Odisha	140	Long Slender	4.5-5	Resistant to neck blast, gall midge and moderately resistant to sheath rot and sheath blight.
94	Jalamani (CR Dhan 503)	Deep Water	CR 2080-169-3-2-5-2 (IET 20706)	Paniketka/Ambika	2012	Odisha	160	Medium Slender	4.6	Moderately resistant to leaf folder, green leaf hopper, blast, neck blast, brown spot, gall midge and sheath blight.
95	Jayanti Dhan (CR Dhan 502)	Deep Water	CR 2282-1-2-5-1 (IET 20214)	Samson Polo/Jalandhi	2012	Odisha	160	Medium Slender	4.6	Moderately resistant to blast, neck blast, sheath blight, sheath rot, rice tungro virus and resistant to leaf folder.
96	Luna Barial (CR Dhan 406)	Coastal Saline	CR 2092-158-3 (IET 19472)	Jaya/Lunishree	2012	Odisha	150	Short Bold	4.1	Moderately resistant to blast, leaf folder and sheath blight.
97	Luna Sankhi (CR Dhan 405)	Coastal Saline	CR 2577-1 (IET 21237)	IR 31142-14-1-1-3-2/IR 71350	2012	Odisha	110	Medium Slender	4.6	Moderately resistant to blast and sheath blight.
98	CR Sgandh Dhan 907	Irrigated Late (Aromatic)	CR 2616-3-3-3-1 (IET 21044)	Dubraj/Pusa 44	2013	Chhattisgarh, Odisha, Andhra Pradesh, Gujarat	150	Medium Slender (aromatic)	4.0-4.5	Resistant to neck blast, gall midge and moderately resistant to sheath rot and sheath blight.
99	CR Dhan 300	Irrigated	CR 2301-5 (IET 19816)	NDR 9370018/ KDM 105/PSBRC 60	2013	Maharashtra, Gujarat, Odisha, Bihar	140	Long Slender	5.0-5.5	Resistant to leaf folder, leaf blast, neck blast, sheath rot and sheath blight.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	for State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
100	CR Dhan 303	Irrigated	CR 2649-7 (IET 21589)	Udaya/ET 16611	2014	Madhya Pradesh, Uttar Pradesh, Odisha	125	Short Bold	5.0	Moderately resistant to blast, neck blast, sheath rot and rice tungro virus
101	CR Dhan 305	Irrigated	CR 2706 (IET 21287)	IR 77080-B-34-3/IRRI 123	2014	Jharkhand, Maharashtra, Andhra Pradesh	125	Short Bold	4.8	Moderately resistant to leaf blast, brown plant hopper, and white back plant hopper.
102	CR Dhan 304	Irrigated	CR 2644-2-6-4-3-2 (IET 22117)	Tapaswini/ IET 16611	2014	Odisha, West Bengal	130	Short Bold	5.0	Resistant to gall midge.
103	CR Dhan 201	Aerobic	CR 2721-81-3 (IET 21924)	IR 72022-46-2-3-2/IRRI 105	2014	Chhattisgarh, Bihar	118	Long Slender	3.8-4.0	Moderately resistant to blast, sheath rot, sheath blight, and leaf folder.
104	CR Dhan 202	Aerobic	CR 2715-13 (IET 21917)	IRRI 148/IR 78877-208-B-1-1	2014	Jharkhand, Odisha	115	Long Bold	3.7-4.5	Moderately resistant to brown spot, sheath rot, sheath blight, leaf folder and pigmented base
105	CR Dhan 407	Rainfed shallow lowland	CR 2459-12-8 (IET 21974)	Swarna/IR 64	2014	Odisha, West Bengal	150	Long Bold	5.0	Moderately resistant to neck blast
106	CR Dhan 505	Deep water	CR 2682-4-2-2-1 (IET 21719)	CRLC 899/ Ac. 38606	2014	Odisha, Assam	162	Medium Slender	4.5	Moderately resistant to blast, neck blast, sheath rot, sheath blight, rice tungro virus, stem borer (both dead heart and white ear heads), leaf folder, whorl maggot, submergence tolerance, and elongation ability.
107	CR Dhan 204	Aerobic	CR 2696-IR 83920	IRRI 76569-259-1-2-1/CT 6510-24-1-2	2014	Jharkhand, Tamil Nadu	120	Long Bold	4.8-5.6	Moderately resistant to neck blast, brown spot, sheath rot, leaf folder, leaf blast and good grain quality
108	CR Dhan 306 (IET 22084)	Irrigated	CRK 27	CRK 27 FR 42 B Pankaj	2014	Madhya Pradesh, Bihar, Puducherry	120-125	Short Bold	6.0-6.4	Moderately resistant to brown spot, stem borer, leaf folder, and white back plant hopper.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
109	CR Dhan 205 (IET 22737)	Aerobic	CR 3001-IR-86931-B-578-CR-5-5-2	N22/Swarna	2014	Tamil Nadu, Gujarat, Odisha, Madhya Pradesh, Punjab	110	Short Bold	3.7-4.5	Moderately resistant to leaf blast, brown spot, sheath rot, stem borer, and leaf folder.
110	CR Dhan 101 (Ankiti)	Upland	CR 2702 (IET 21627)	IR 78875/IR 78877	2014	Odisha	110	Medium Slender	3.98	Moderately resistant to leaf blast, neck blast, brown spot, sheath rot, sheath blight, leaf folder, and green leaf hopper
111	CR Dhan 203 (Sachala)	Aerobic	CR 2717-10-IR84899-B-185	IR 78877/IRRI 132	2014	Odisha	110	Long Slender	4.05	Moderately resistant to leaf blight, brown spot, sheath rot, sheath blight and leaf folder.
112	CR Dhan 206 (Gopinath)	Aerobic	CR 2996-1-14-29-3-1	Brahmanakhi/ NDR 9930077	2014	Odisha	115	Short Bold	3.95	Moderately resistant to leaf blight, brown spot, sheath rot, sheath blight, and leaf folder.
105	CR Dhan 307 (Maudamani)	Irrigated	CR 2599 (IET 20925)	Dandi/ Naveen/ Dandi	2014	Odisha	135	Short Bold	7.0	Moderately resistant to blast, neck blast, brown spot, sheath blight, leaf folder, gall midge, white back plant hopper, hispa and thrips.
114	CR Dhan 408 (Chaka Akhi)	Shallow lowland	CR 491-1590-330-2-1	CR 149-5010-228/T1242	2014	Odisha	165 PS	Long Bold	4.8	Moderately resistant to neck blast, bacterial leaf blight, sheath rot, sheath blight, leaf folder and white back plant hopper.
115	CR Dhan 310 (IET 24780)	Irrigated	CR 2829-PLN-37	ARC 10075/ Naveen	2016	Odisha, Madhya Pradesh, Uttar Pradesh	125	Medium Slender	5.0	High grain protein (10.5%),
116	CR Dhan 207 (Srimati)	Aerobic	CR 3629-1-5 (IET 23448)	IR 71700-247-1-1-1-2/IR 57514-5-B-1-2	2016	Odisha	110-115	Medium Slender	3.7	Moderately resistant to blast, neck blast, brown spot, sheath rot, sheath blight, leaf folder, green leaf hopper, and gall midge.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	for State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
117	CR Dhan 209 (Priya)	Aerobic	CR 3695-1-1 (IET 23467)	IR 72022-46-2-3-2/IRRI 105	2016	Odisha	112-115	Long Slender	4.0	Moderately resistant to blast, neck blast, brown spot, rice tungro virus, sheath blight, rice tungro virus, leaf folder and white back plant hopper.
118	CR Dhan 409 (Pradhan Dhan)	Shallow lowland	CR2690-2-2-1-1-1 (IET 23110)	Chakaakhih/ AC-38687	2016	Odisha	160-165	Long Slender	4.7	Moderately resistant to blast, neck blast, sheath blight, sheath rot, sheath blight and leaf folder
119	CR Dhan 507 (Prasant)	Deep Water	CR 3836-1-7-4-1-1 (IET 22986)	Gayatri/Sudhir// Varshadhan	2016	Odisha	160	Medium Slender	4.75	Moderately resistant to neck blast, brown spot, sheath blight, sheath rot, and leaf folder.
120	CR Dhan 800	Shallow lowland	CRMAS 2232-85 (IET 20672)	Swarna*4/ IRBB-60	2016	Odisha	140	Medium Slender	5.75	Moderately resistant to bacterial leaf blight and sheath rot.
121	CR Sugandh Dhan 910	Shallow favorable lowlands and Irrigated Late	CR 2713-180 (IET 22649)	Swarna/Geetanjali	2016	Odisha	142-145	Medium Slender (aromatic)	4.38	Moderately tolerant to blast, neck blast, sheath rot, rice tungro virus, sheath blight, leaf folder, white back plant hopper.
122	CR Dhan 311 (Mukul)	Irrigated	CR 2829-PLN-100 (IET 24772)	HP-2/Naveen	2016	Odisha	120-126	Long Bold	5.54	Tolerant to blast, brown spot, rice tungro virus, bacterial leaf blight, moderately resistant to gall midge, sheath blight and high protein (10.1%), high Zn (20ppm)
123	CR Dhan 508	Deep Water	CR 3835-1-7-2-1-1 (IET 23601)	CRLC 899/ 2 Warda	2017	Odisha, West Bengal, Assam	160	Long Bold	4.4	Moderately resistant to sheath blight, brown spot and sheath rot.
124	CR Dhan 506	Semi-deep	CR 2687-2-3-1-1-1 (IET 23053)	CRLC 899/ Warda 2	2017	Assam, Andhra Pradesh, Karnataka	165	Long Bold	4.2	Moderately resistant to leaf blast, neck blast, brown spot, sheath blight, sheath rot, tungro virus, stem borer (both dead heart and white ear heads), leaf folder and whorl maggot.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
125	CR Sugandh Dhan 908	Irrigated Late	CR 2713-35 (IET 23189)	Swarna/ Geetanjali	2017	Odisha, West Bengal, Uttar Pradesh	145	Medium Slender (aromatic)	5.0	Moderately resistant to leaf blast, neck blast, bacterial leaf blight, brown spot, stem borer, leaf folder and WBPH.
126	CR Sugandh Dhan 909	Irrigated Late	CRL 74-89-2-4-1 (IET 23193)	Pankaj/Podumoni	2017	Assam, Bihar, Uttar Pradesh, Maharashtra	140	Medium Slender (aromatic)	5.0	Moderately tolerant to leaf blast, neck blast, bacterial leaf blight, brown spot, stem borer, leaf folder and white back plant hopper
127	Gangavati Agei	Upland	CRR 363-36 (IET 19251)	Gaurav x Kalinga III	2017	Karnataka	85	Long Slender (aromatic)	6.5	Resistant to brown spot, gall midge (biotype-1), stem borer and moderately resistant to leaf blast, moderately resistant to gall midge (biotype-4,5) and leaf folder.
128	Puma	Upland	CRR 356-29 (IET 18654)	Amada x RR 151-3	2017	Gujarat	90	Short Bold	6.0	Moderately resistant to leaf blast, brown spot, stem borer and leaf folder. Tolerant to drought.
129	CR Dhan 308	Irrigated	CR 3505-7-1-1-1-2-1 (IET 25523)	IR 36/Vijetha	2018	Chhattisgarh, Maharashtra	132	Medium Slender	6.5	Resistant to false smut, glume discolouration, rice tungro virus, stem borer. Moderately resistant to brown spot, bacterial blight, neck blast, gall midge. Tolerant to leaf folder, whorl maggot and rice hispa insect pests.
130	CR Dhan 309	Irrigated	IR95797-CR3847-2-1-1-1-1, IET 25345	IR77080-B-34-3/ IRR1 132	2018	Assam, Chhattisgarh, Uttar Pradesh	115	Long Slender	6.5	Resistant to stem borer (dead heart and white ear head), leaf folder and whorl maggot.

Sl. No.	Variety	Ecology	Designation	Parentage	Year of release	for State	Duration (days)	Grain type ^b	Yield (t ha ⁻¹)	Reaction to diseases and pest and special characters
131	CR Dhan 802 (Subhas)	Shallow lowland	CR3925-22-7 (IET 25673)	Swarna-Sub1*4/ IR81896-B-B-195	2018	Bihar, Madhya Pradesh	142	Short Bold	5.5	Submergence and drought tolerant. Resistant to stem borer (both dead heart and white ear heads), leaf folder, plant hopper and case worm, moderately resistant to bacterial blight, sheath rot and rice tungro virus.
132	CR Dhan 511	Semi-deep	CR 2789-9-2 (IET 213906)	Gayatri / Mahsuri / CR 997	2018	West Bengal, Andhra Pradesh	160	Short Bold	5.0	Moderately resistant to leaf blast, neck blast and bacterial blight diseases, stem borer (both dead heart and white ear heads), white backed plant hopper and leaf folder.

Annexure II

Area under NRI varieties in different states of India and resultant increase in production and income

State	Area under NRI var. ('000 ha)	Production of NRI var. ('000 t)	Incremental gain in production with NRI var. ('000 t)*	Price of NRI rice (Rs. Crore)	Incremental gain in income with NRI var. (Rs. Crore)*
Andhra Pradesh	35.94	190.86	9.54	334.00	16.70
Arunachal Pradesh	0.50	1.25	0.06	2.19	0.11
Assam	970.93	2790.64	139.53	4883.62	244.18
Bihar	557.76	2064.01	103.20	3612.02	180.60
Chhattisgarh	629.46	1984.13	99.21	3472.22	173.61
Goa	3.12	12.97	0.65	22.69	1.13
Gujarat	15.96	55.19	2.76	96.59	4.83
Haryana	0.00	0.00	0.00	0.00	0.00
Himachal Pradesh	0.00	0.00	0.00	0.00	0.00
J&K	0.00	0.00	0.00	0.00	0.00
Jharkhand	323.35	1086.93	54.35	1902.13	95.11
Karnataka	32.27	121.94	6.10	213.39	10.67
Kerala	0.77	2.94	0.15	5.14	0.26
Madhya Pradesh	51.59	142.89	7.14	250.06	12.50
Maharashtra	30.24	91.86	4.59	160.75	8.04
Manipur	11.45	30.29	1.51	53.01	2.65
Meghalaya	5.49	15.04	0.75	26.32	1.32
Mizoram	0.00	0.00	0.00	0.00	0.00
Nagaland	0.00	0.00	0.00	0.00	0.00
Odisha	2176.10	7050.24	352.51	12337.93	616.90
Punjab	0.00	0.00	0.00	0.00	0.00
Rajasthan	0.00	0.00	0.00	0.00	0.00
Sikkim	0.00	0.00	0.00	0.00	0.00
Tamil Nadu	156.85	386.36	19.32	676.12	33.81
Telangana	0.00	0.00	0.00	0.00	0.00
Tripura	75.74	333.99	16.70	584.48	29.22
Uttar Pradesh	581.29	2001.42	100.07	3502.49	175.12
Uttarakhand	1.16	4.18	0.21	7.32	0.37
West Bengal	2257.20	9426.24	471.31	16495.92	824.80
Puducherry	0.78	3.04	0.15	5.32	0.27
India	7917.92	27796.41	1389.82	48643.72	2432.19

*Incremental gain of 5% has been considered



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