Research Bulletin No. 45

Translating Science for the Benefits of Society: THE DIRECT AND INDIRECT IMPACTS OF NRRI

JP Bisen, B Mondal, Swagatika Samal, S Paul, RP Sah, Anilkumar C, RL Verma, BC Marndi, NN Jambhulkar, B Gowda G, GP Pandi G, MK Kar, M Chakraborti, S Priyadarsani, SD Mohaptra, GAK Kumar, S Samantaray and AK Nayak

ICAR-National Rice Research Institute
Cuttack 753006, Odisha

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Published by

Director
ICAR-National Rice Research Institute,
Cuttack-753006, Odisha, India

Layout and design

Sunil Kumar Sinha

April 2024

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सत्यमेव जयते

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Foreword

This research bulletin celebrates the remarkable journey of the National Rice Research Institute (ICAR-NRRI), highlighting its pivotal role in revolutionizing rice farming through innovation and dedication. Over the years, ICAR-NRRI has been at the forefront of agricultural research, consistently striving to enhance rice crop productivity and quality. The institute has introduced a diverse portfolio of rice varieties, tailored to suit various agro-climatic conditions by meticulous breeding programs These varieties, bred for traits such as high yield, disease resistance, and stress tolerance, have not only empowered farmers but also bolstered national food security. NRRI's commitment to data-driven decision-making is evident in its pioneering work on varietal area estimation. By developing and implementing improved methods for estimating varietal areas, NRRI has provided policymakers and researchers with robust tools to monitor the distribution and adoption of improved rice varieties across the country.

The institute's innovative technologies and cultivation practices have led to a significant increase in rice yields, contributing to economic prosperity and food security on a national scale. Moreover, NRRI's extensive germplasm bank serves as a vital resource for researchers and breeders working to enhance the resilience and adaptability of rice crops in the face of emerging challenges such as climate change and evolving pest pressures. The institute's extensive germplasm bank serves as a genetic treasure trove for researchers and breeders engaged in enhancing the resilience and adaptability of rice crops to emerging challenges, including climate change and evolving pest pressures. NRRI's relentless pursuit of excellence and its invaluable contributions to rice research and development have left an indelible mark on the agricultural landscape of the nation. As we navigate the complexities of the future, NRRI's legacy of innovation and progress will continue to guide and inspire generations to come.

This research bulletin encapsulates the essence of NRRI's tireless pursuit of excellence, capturing the spirit of innovation, dedication, and impact I appreciate the efforts of authors for bringing out this publication and hope the bulletin will be useful for various stakeholders.

Yours sincerely,

(Himanshu Pathak)

Dated the 04th, April, 2024
New Delhi

PREFACE

It is with great pleasure that we present this research bulletin, shedding light on the profound and multifaceted impact of the ICAR-National Rice Research Institute (NRRI). As a premier institution dedicated to rice research, NRRI has been at the forefront of innovation, consistently contributing to the enhancement of rice varieties and the overall landscape of agricultural practices in India.

This comprehensive bulletin delves into the dual dimensions of NRRI's impact—direct and indirect. In the direct realm, the spotlight is on NRRI's flagship rice varieties, celebrated for their high yields, biofortification, and resilience to climatic challenges. Through meticulous breeding and research efforts, NRRI has not only addressed the immediate needs of farmers but has significantly elevated the standards of rice cultivation, aligning with contemporary agricultural demands.

The bulletin also intricately explores NRRI's indirect impact, a dimension often underestimated but equally pivotal. NRRI's commitment to strengthening rice crop improvement programs in the country is evident through its active role in supplying germplasm and breeding materials. By sharing its wealth of knowledge and resources, NRRI acts as a cornerstone in the collaborative efforts towards a more resilient and productive rice sector nationwide.

The research bulletin brings together contributions from eminent researchers, scientists, and experts, providing a holistic view of NRRI's journey and its transformative influence on rice cultivation. It is our hope that this compilation serves as both a testament to NRRI's achievements and an invaluable resource for scholars, policymakers, and practitioners engaged in the advancement of agriculture and food security.

We extend our gratitude to the researchers and institutions that have contributed to this endeavor, acknowledging the collaborative spirit that underscores the collective pursuit of excellence in rice research and crop improvement.

Authors

CONTENT

1. Introduction

Rice, one of the world's most essential crops, plays a pivotal role in ensuring global food security, fostering international trade, and sustaining livelihoods for millions of people. Its significance transcends mere sustenance, extending to economic, cultural, and social dimensions. It serves as a staple food for over half of the world's population, particularly in Asia where it is a dietary cornerstone. It provides a crucial source of carbohydrates, essential nutrients, and caloric intake. Its adaptability to diverse climates and cultivation methods makes it a reliable food source for various regions. Beyond being a primary energy source, rice is rich in essential nutrients such as vitamins, minerals, and fiber. As part of a balanced diet, it contributes to addressing malnutrition and promoting overall health. Rice cultivation spans a wide range of climatic conditions, from flooded paddies to rainfed fields. This adaptability ensures a stable food supply even in regions prone to climatic variability.

Rice is a major commodity in global trade, with numerous countries relying on its export and import for economic sustenance. Leading producers such as China, India, and Vietnam play pivotal roles in shaping the international rice market. For many nations, rice exports contribute significantly to their trade balances. Conversely, importing nations benefit from access to a stable and diverse global rice market, ensuring a steady food supply even in the face of local production challenges. Rice trade facilitates cultural exchanges, as different varieties and types of rice are shared and appreciated globally. This exchange not only promotes diversity in diets but also fosters mutual understanding and appreciation.

Moreover, the rice cultivation provides employment for millions of people, from farmers and laborers to those involved in processing, distribution, and marketing. This extensive network supports rural economies and contributes to poverty alleviation. Rice farming often forms the backbone of rural communities. Investments in rice cultivation, infrastructure, and education contribute to the overall development of these communities, enhancing living standards and reducing urban migration. Rice is deeply embedded in the cultural fabric of many societies. Its cultivation and associated practices contribute to the preservation of traditional knowledge, rituals, and heritage, passing down through generations.

India, a global powerhouse in rice production, boasts a rich tapestry of diverse rice-growing ecologies owing to its varied agro-climatic conditions. From the fertile plains of the Gangetic basin to the coastal regions in the east and the arid landscapes in the west, the nation's diverse topography and climates have given rise to a multitude of rice ecosystems. These ecologies include rainfed uplands, irrigated lowlands, deepwater areas, and saline-affected regions, each presenting unique challenges and opportunities for rice cultivation.

Established in 1946, the ICAR-NRRI in Cuttack, Odisha, stands as a pioneering institution dedicated to rice research and development. Recognizing the diverse ecologies prevalent in India, NRRI has been at the forefront of efforts to develop high-yielding, biofortified, and climate-resilient rice varieties tailored to suit the specific needs of different regions.

Currently at its varietal portfolio the institute has rice varieties for nutrition, climate resilience, high yield, diverse ecologies, different maturity duration, varied grain types and so on. Through its varietal technologies, ICAR-NRRI stands as a beacon of agricultural innovation, continually working towards the development of rice varieties tailored to diverse ecologies. Through its research and outreach programs, NRRI not only empowers farmers with knowledge and resources but also plays a crucial role in ensuring food security and sustainability in the dynamic landscape of India's rice cultivation. The institute's commitment to addressing the unique challenges of each rice-growing ecology underscores its role as a key contributor to the nation's agricultural resilience and prosperity.

In this backdrop, estimating the crop area under the varieties developed by research institutions, such as the ICAR-National Rice Research Institute (NRRI), is crucial for assessing the impact of varietal technologies and understanding the outreach of these varietal products. This information serves as a key indicator for policymakers, researchers, and farmers alike, providing insights into the adoption and success of new agricultural practices. However, the lack of reliable data, varietal mixing, informal seed system, limited resources for monitoring etc. prove to be a major huddle in estimating the impact and the outreach of a research institute in terms of its varieties. Despite these challenges, attempt has been made at ICAR-NRRI from time to time to estimate the coverage of its area and thereby its impacts. This research bulletin aims at discussing the varietal portfolio of ICAR-National Rice Research Institute and the methods for estimating the impact of its varieties in terms of their outreach and production. Additionally, this research bulletin reports the indirect impact of NRRI in strengthening the rice breeding programmes across the country.

2. NRRI's journey in rice crop improvement

ICAR-National Rice Research Institute (Earlier Central Rice Research Institute), Cuttack is the premier institute of rice research in the country, established in the backdrop of infamous Bengal famine way back to 1946. Initially, the institute was mandated for collection and conservation of germplasm which later on after introduction of semi dwarf genotypes during late 1960s shifted to varietal development for rainfed shallow lowland (RSL) ecosystem. At beginning, as leading centre of FAO funded International Cooperative Rice Breeding Project, CRRI has undertaken an intensive programme of hybridizing japonica with indica rice and shared F 2 seeds to the different cooperating centres and rice research stations to select the most suitable types for their conditions. Consequently, from the seeds of hybridized population, sent from CRRI to different countries of the world and Institutions within India, the Regional Research Station, Aduturai in Madras state identified a promising culture and released it as ADT-27. In addition, rice varieties viz. Mahsuri and Malinja in Malaysia and Circna in Australia were identified from this programme and were released for cultivation. Cytological explanation for the spikelet sterility/male sterility in indica x japonica hybrids (Sampath and Mohanty 1954) was also established at NRRI which later on capitalized by Chinese scientist in commercial realization of rice hybrids.

Subsequently, the All India Coordinated Rice Improvement Project (AICRIP) was commissioned at Hyderabad in 1965 to for multi-location evaluation of breeding materials (Fig 1.). The AICRIP initially functioned as a part of CRRI which later on renamed as Directorate of Rice Research (DRR) and operated directly under ICAR as an independent Institute. Taichung Native 1 was the first high-yielding semi-dwarf variety introduced in the country covered large rice area which however quickly replaced by IR 8 of IRRI. The scientists of CRRI had crossed TN 1 with a number of improved Indian varieties of tall type, a product of this cross was the semi-dwarf high-yielding variety Padma which was released by the Government of India in 1968. Padma (CR 28-25, IET 953) was of 120 days duration, short bold, medium resistance to blast and other major diseases and pests with yield of 3.5-4.0 t ha^{-1}. The Institute celebrated the Golden Jubilee of release of Padma in 2018 by releasing a golden plaque.

Since inception, the institute has steered groundbreaking research, adopted various cutting edge strategies/technologies in development of high yielding rice varieties that have contributed immensely to the achieve of self-sufficiency in rice production. Breeding strategies adopted for varietal development at ICAR-NRRI). Till date the institute has developed 179 rice varieties for different rice agro-ecologies in the country. ICAR-National Rice Research Institute, Cuttack has been pioneer in hybrid rice research, started hybrid rice breeding program during 1979, quite before the beginning of project mode programme in 1989 by ICAR. In the beginning, ICAR-NRRI has acquired all the prerequisite materials (CMS lines viz. V 20A, Yar Ai Zhao A, Wu10A, MS 577A, Pankhari 203A, V 41A, Er-Jiu nanA, respective maintainers, nine other maintainers and thirteen restorers) from the IRRI (NRRI annual report 1981-82) and has commercialized 06 popular hybrids, Ajay, Rajalaxmi, CR Dhan 701, 702, 703 and 704.

Indian sub-continent is well known for its native wealth of basmati and aromatic non-basmati rice, of which aromatic short grain (ASG) types remain important with respect to aroma, cooking and quality traits. These traits are responsible for greater consumer preference globally and fetching premium prices in domestic as well as in global markets. Institute has commercialized altogether eleven premium quality aromatic rice varieties for different ecologies.

Besides, Institute has developed climate smart rice varieties (Swarna Sub1, CR DHAN 801, CR DHAN 802, CR DHAN 803, CR Dhan 804, CR Dhan 806, CR Dhan 807 and CR Dhan 808) through MAS. Meantime, institute has also started breeding varieties suitable for low input condition, low P responsive varieties like Sahbhagidhan, Vandana, CR Dhan 103, 107 has been released for cultivation. Direct seeded rice (DSR) system encourage efficient water and nitrogen use and reduced greenhouse gas emissions and labor demand, thus, avoids all forfeits involved in transplanted rice system. Institute has commercialized altogether 06 rice varieties/hybrid, Sahbhagidhan, CR DHAN 103, 107, 807 (herbicide tolerant), 808, 704 suitable under DSR cultivation. Besides, institute has released a total of 13 water saving rice varieties suitable for cultivation under aerobic condition. To shift yield paradigm in rice, institute has adopted next generation rice breeding strategy and C4 type rice varieties, could release three super rice varieties, CR Dhan 307, 314 and 316 with > 8.0 t/ha yield potential. Through male sterility facilitated recurrent selection approach, institute could release a popular rice variety CR Dhan 312. For ensuring nutritional security the institute could release five nutridence rice varieties, CR Dhan 310 (high protein), CR Dhan 311 (High protein and moderate Zn), CR Dhan 315 (High Zn), CR Dhan 411 (High protein) and CR Dhan 324 (High protein, moderate Zn and Fe).

The global climate change and change in consumer's food habits have necessitated reorientation of breeding strategies. The changing climate and its unpredictability has compelled to breed for high performing climate resilient crop varieties on one side, whereas, the demand for high antioxidants, low GI, low phytate and pharmaceutically acceptable, high value rice is growing up to provide better nutrition, health benefits and higher income. Institute has adopted speed breeding (SB) based varietal development technologies which enables accelerative delivery of demand-led high performing, climate resilience and resistance crop varieties in 05-06 years by saving almost 50% time, 90% space and 50% inputs. Other cutting edge technologies like genomic selection and genome editing are also adopted to maximize substantial genetic gain in our rice breeding pipelines.

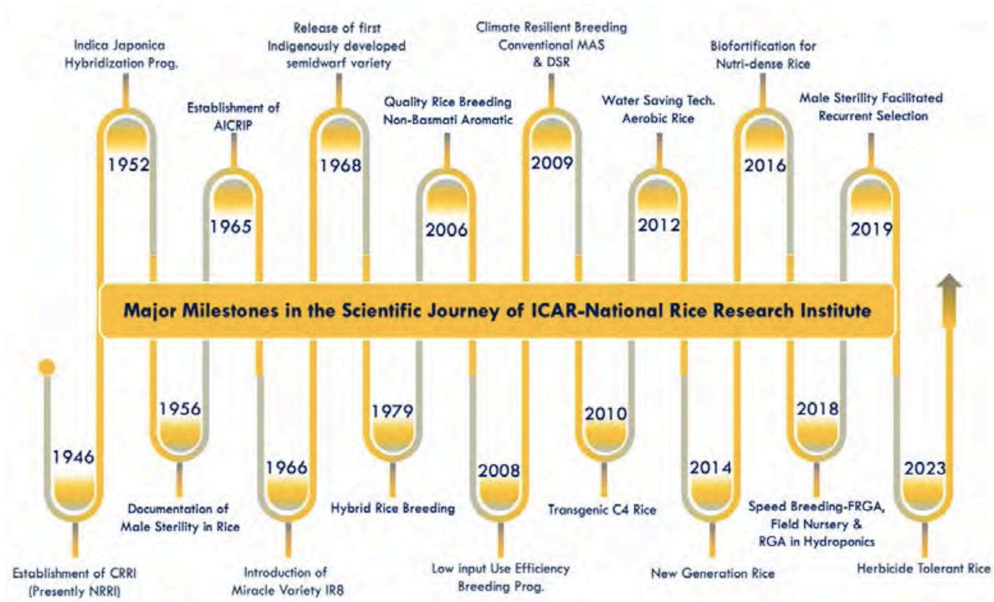

Fig.1: Major milestones in the journey of ICAR-National Rice Research Institute

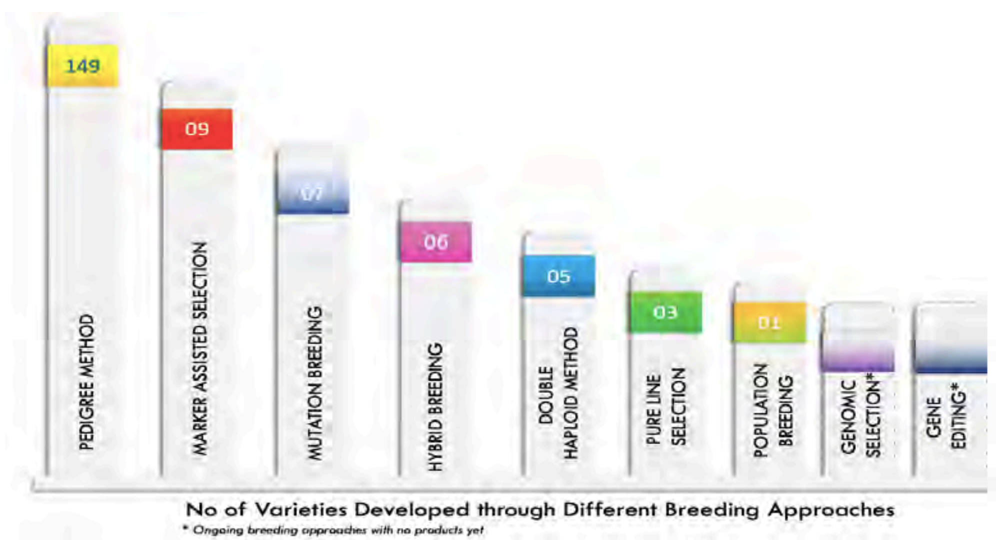

Fig. 2: Rice varieties developed by ICAR-NRRI using different breeding approaches

3. Varietal portfolio of NRRI

A varietal portfolio denotes the assortment of diverse variations of a specific crop that a research institution or organization creates, maintains, and promotes. In the context of NRRI Cuttack, which concentrates on rice research, the varietal portfolio would encompass a selection of rice varieties tailored to tackle diverse agricultural challenges. Presently, the essential components of the rice varietal portfolio at NRRI Cuttack encompass varieties designed for climate resilience (such as drought tolerance, submergence tolerance, combined drought and submergence tolerance, and salinity tolerance), aromatic varieties, nutrition-focused varieties (high protein and zinc), varieties addressing biotic stresses, those suitable for various rice-growing ecologies, and those catering to different grain types and durations. The accompanying infographics provide an overview of the number of varieties categorized within the different types of rice varieties developed by the institute (Fig 3).

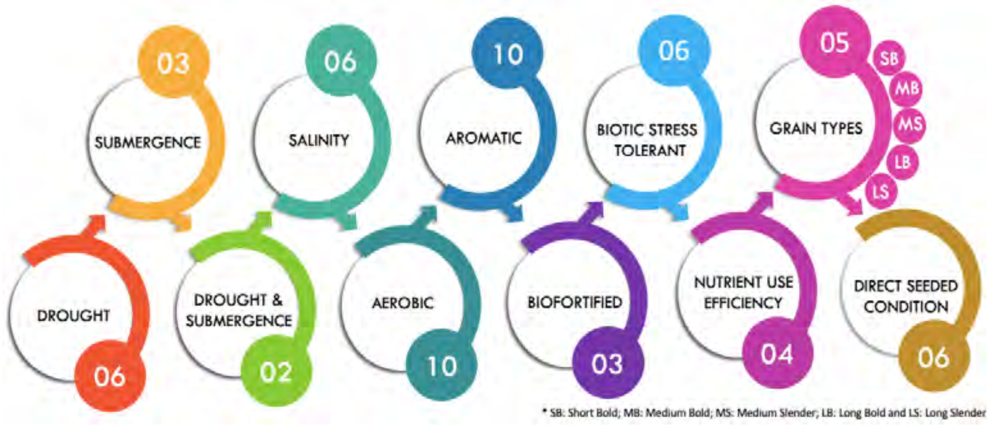

Fig.3: Varietal portfolio of NRRI for rice crop

These diverse varieties were specifically developed to exhibit various traits, catering to the distinct requirements of farmers in different regions across the country. Notably, within its range of varieties, those resilient to climate challenges and the biofortified ones are increasingly gaining favor among farmers. Additionally, the institute has varieties for different ecologies too. Out of 179 released rice varieties, the institute has maximum 71 varieties for irrigated ecology followed by 33 varieties for shallow lowland, 28 varieties for upland, 16 for semi-deep, 13 for aerobic, 8 for coastal saline, five for boro and fine for deep water ecologies of the country (Fig 4.).

Moreover, the grain type is one of the desirable attribute by the consumer for consuming rice grains. The grain type preference for consumption vary from a region to another; by the consumer income as it has been observed that the urban consumers with relatively higher income prefers fine and long grain type than their rural counterparts having relatively low per capita income. The grain type preference also vary based on the purpose of consumption. For example, for making rice floor based products any grain type may be used by the processors but for pulao, biryani and such dishes long and aromatic grain types are preferred by the processors and consumers. ICAR-NRRI, has considered the consumer preference of a diverse class and region in its rice breeding programme and consequently has its varieties displaying five distinct grain types namely short bold, medium bold, medium slender, long bold and long slender. Currently, the institute has one variety for short slender grain type followed by five for medium slender, 31 for long bold, 44 for long slender, 45 for short bold each and 53 for medium slender grain type which is catering to the diversified consumption needs of the society.

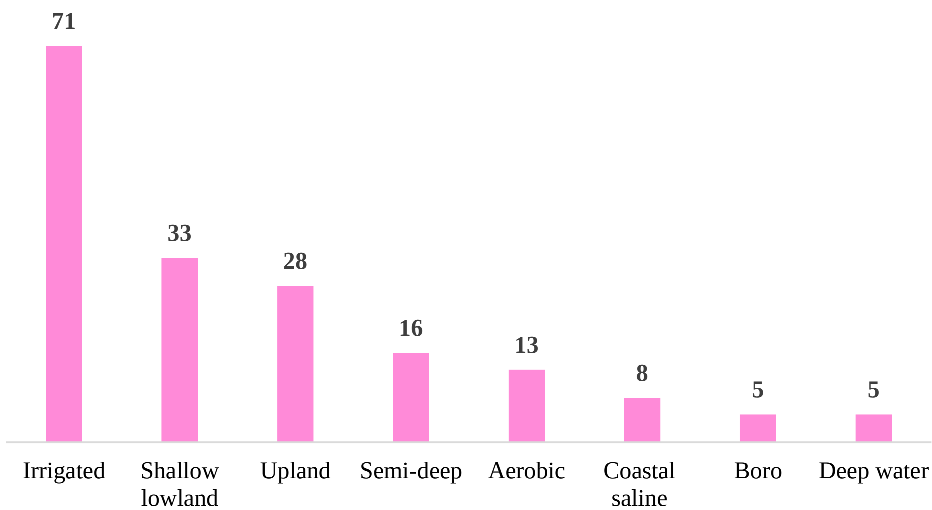

Fig. 4: Varietal technologies (in Nos) of ICAR-NRRI for different rice ecologies

Further, out of 179 varieties, 70 varieties have been released by the central varietal release committee (CVRC) while 109 varieties have been released by the state varietal release committee of the different states.

4. Methodology for the estimation of crop area

In practical terms, the entirety of land allocated to a specific crop comprises a combination of areas designated for various varieties, landraces, hybrids, and wild types. However, the areas assigned to specific varieties and hybrids primarily contribute to the estimation of the total crop area. While numerous methodologies exist for estimating crop area, methods specifically designed for estimating varietal areas are scarce. Craig and Atkinson (2013) have detailed the evolution of estimation methods from simple summations of localized area data and direct extrapolations of statistically sampled data to crop-specific pixel classifications, incorporating error-corrected regression and calibration estimations.

Prominent techniques for area estimation, such as farm censuses (Meyer-Roux, 1992 & Bosecker, 1988, as cited in Craig & Atkinson, 2013), administrative data on crops, area frameworks, point sampling, remote sensing, geographical information systems, land surveying, and farmers' assessments, can all be utilized to gauge the extent of area under a specific crop variety. However, considerable challenges related to time, cost, and manpower constraints might hinder the selection of any of these methods by technology developers. Given the intricacies associated with directly estimating varietal areas, Pathak et al. (2018) introduced indirect approaches for estimating varietal areas under specific crop varieties, with a focus on rice varieties developed by the ICAR-National Rice Research Institute (NRRI), Cuttack, India. They identified conventional methods for varietal area estimation, including seed supply, sample surveys, community assessments, and expert estimations, basing their approaches on the seed supply chain. The ensuing section delves into these methodologies in detail. However, it is important to note that understanding the proliferation of varietal technologies is essential as a precursor to estimating varietal spread.

The tangible manifestation of a crop's varietal technology lies in its seeds, encapsulating distinctive traits that define the technology. While a seed itself represents a natural product of a plant, the integration of biotechnological tools and breeding strategies gives rise to varietal technology. Such technologies constitute outcomes of research organizations focusing on crops, like the Indian Council of Agricultural Research (ICAR) and similar entities. These technology generators serve as exclusive sources of varietal technologies, promoting and disseminating their novel and advanced innovations through front-line demonstrations, seed mini-kits, agricultural exhibitions, and media channels.

However, unlike industrial systems where technology licensing facilitates widespread production to meet product demand across regions, agricultural systems involve the sharing of varietal technologies with other stakeholders for rapid multiplication to meet diverse regional demands. This holds particularly true in India's agricultural landscape where the public sector significantly influences many crops. Varied stakeholders, including state agricultural departments, private firms, agricultural cooperatives, and farmer groups in the form of farmer producer organizations (FPOs), receive varietal technologies in the form of breeder seeds (BS).

These primary recipients of varietal technology undertake seed multiplication activities to transform breeder seeds into foundation seeds (FS) in the first generation, certified seeds (CS) in the second generation, and truthfully labelled seeds (TLS) in the third generation. The technology dissemination network remains relatively straightforward until the breeder seed of a variety evolves into a truthfully labelled seed, with clear records of technology quantity and recipients. However, complexities within the seed supply chain emerge at this stage.

In such a multifaceted market environment, gauging the extent of varietal technology spread is equally intricate. However, prior researchers have endeavored to streamline this complexity through feasible and reliable approaches, relying on reasonable assumptions. The subsequent section is dedicated to these approaches, building on the work of Pathak et al. (2019), who applied them to rice varieties from ICAR-NRRI.

4.1 The existing methods of estimation

With an emphasis on rice varieties created by the ICAR-National Rice Research Institute (NRRI), Cuttack, India, Pathak et al. (2018) developed indirect methodologies for determining varietal areas under specific crop varieties due to the difficulties involved with directly measuring varietal areas. Based on the seed supply chain, they identified traditional techniques for varietal area estimation as comprising expert estimations, community assessments, sample surveys, and seed supply. These approaches are explored in detail in the following section. This section expands upon the work of Pathak et al. (2019), who used rice varieties from ICAR-NRRI to apply the five indirect area estimating methods that are presented below.

A) Proportionate method - I: Based on the percentage of a variety's breeder seed demand in total, this strategy is used. The premise is that the diffusion of technology is directly correlated with the fraction of the technology generator's breeder seeds in the nation's total breeder seed inventory for that crop. The area under a technology generator's varietal technology can therefore be evaluated using the following equation:

$$\text{Area (Mha)} = \left[\frac{BS_n}{BS_N} \times \text{Area Under Rice (Mha)} \times \frac{\text{HYV Area (\%)}}{100}\right]$$

Where,

BS_n:	Breeder seeds indent of a crop varietal technology (kg)
BS_N:	Total breeder seeds indent of the crop (kg)
HYV:	High yielding varieties
100:	Conversion factor

B) Proportionate method - II: This method is based on the percentage of a variety's multiplied seeds (seeds that are truly labeled and certified) in the overall multiplied seed demand. According to this assumption, the dissemination of technology is equal to the proportion of the technology generator's multiplied seeds in the nation's overall multiplied seed demand for the crop. The area under a technology generator's varietal technology can therefore be evaluated using the following formula:

$$\text{Area (Mha)} = \left[\frac{(\text{Sale of CS} + \text{TL Seeds})}{\text{Total sale of CS \& } \mathit{TL\ Seeds}} \times \text{Area under rice (Mha)} \times \frac{\text{HYV Area (\%)}}{100}\right]$$

Where,

CS:	Sale of certified seeds (kg)
TL:	Sale of truthfully labelled seeds (kg)
HYV:	High yielding varieties
100:	Conversion factor

C) Seed multiplication method: This approach estimates the spread of a varietal technology by considering the seed indenting system procedure and its subsequent multiplication. The approach makes certain assumptions in order to perform estimation work. The major assumptions in this approach are-

a) Multiplication ratio for the seed
b) Seed rate per hectare

The varietal spread is estimated using the following equation-

$$\text{Area (Mha)} = \left[\frac{(\text{BS} * \text{ Seed multiplication factor}) + \text{TL Seed}}{\text{Seed Rate}}\right] \times \frac{1}{10^6}\right]$$

Where,

BS:	Breeder seeds indent of a crop varietal technology (kg)
TL:	Truthfully labelled seed (kg)
Seed rate:	in kg/ha
10^6:	Conversion factor

D) ***Technology adoption method:*** By using seed replacement rate (SRR) as a stand-in for technology transferred from farmer to farmer, this approach captures the spread of technology in the unofficial system. Using this approach, the following equation is used to estimate the varietal technology spread:

$$\left[\frac{(\text{Sale of CS} + \text{TL Seeds})}{\text{Seed Rate (kg / ha)}} \times \frac{100}{\text{SRR}} \times \frac{1}{10^6}\right]$$

Where,

CS	: Sale of certified seeds (kg)
TL	: Sale of truthfully labelled seeds (kg)
SRR	: Seed replacement rate (%)
10^6	: Conversion factor

E) ***Averaging method:*** The mean value of the area determined by the preceding four procedures serves as the foundation for this approach. Thus, the following equation is used to estimate the area under a crop varietal technology:

$$\textbf{Area (Mha)} = \left[\frac{\textbf{Sum of area by above methods}}{\textbf{4}}\right]$$

These approaches provide a simple way to handle the complex problems related to varietal area estimation in a technological setting. These methods are economical and need little data. However, since the seed multiplication process takes three seasons for short-duration rice varieties and three years for long-duration varieties, these techniques have not yet taken into consideration the losses that occur within the seed supply chain. Furthermore, the method of adopting technology ignores the discontinuance of technology and instead measures the diffusion of technology among farmers in the informal sector by utilizing the Seed Replacement Rate (SRR) as a stand-in for the measurement of technology dissemination.

Given these constraints, we have made an effort to improve the varietal area estimation approach by adding variables such supply chain losses and technical discontinuation. The very next part explores our improved varietal area estimation methodology.

4.2 Improved Method of Estimation

It is commonly acknowledged that formal and informal channels play a role in the spread of diverse technologies. Although it is quite simple to estimate the transmission of technological technology through formal channels using reasonable assumptions, it is far more difficult to estimate the diffusion through informal channels. One significant difference between the ways that varietal technology is disseminated through formal and informal channels is that non-breeder seeds are used in the informal sector to disseminate varietal technology, while breeder seeds are used in the formal sector. We propose that all seeds sent through informal channels are equal to truthfully labelled seeds (TLS) in order to streamline the process of evaluating varietal distribution across these channels.

An attempt was made to improve the current seed multiplication technique for area estimation with the goal of taking a more thorough approach. In order to explain the spread of varietal technology via unofficial channels, it was proposed that farmers set aside a percentage of their harvest for their own seed needs and that there is a subset of farmers who only get technology through unofficial channels. It was also anticipated that some of the previous year's technology adopters will stop using it this year and switch to a better varietal technology.

Although the previous method was predicated on an ideal seed supply chain network, our improved method recognizes that "not all produced foundation seeds are transformed into truthfully labelled seeds, and not all supplied breeder seeds are converted into foundation seeds." Thus, by adding a corrective element to the seed multiplication process, the improved approach incorporates supply chain losses into the varietal technology supply chain. Expert perspectives from plant breeders, extension workers, economists, and supply chain participants, such as farmers and seed multiplication specialists, were consulted in order to determine several assumptions. In addition, initial computations were performed for a number of assumptions in order to choose suitable values.

With these factors taken into account, the refined technique uses the following formula to calculate the diffusion of varietal technology:

Total Area (Million hectares) = Formal Area (Million hectares) + Informal Area (Million hectares)

A consensus was reached through a targeted and inclusive group discussion including plant breeders, crop production experts, post-harvest and processing specialists, extension workers, experts from research institutes' seed multiplication units, a few progressive farmers, and agricultural economists. This conclusion confirmed that the following factors influence the degree of varietal technology dissemination through formal channels, as evaluated by area coverage:

Formal Area = *f* (Breeder seed supply, seed multiplication coefficient, variety seed rate, and supply chain losses)

To estimate the coverage of varietal technology or the region under varietal technology, the previously mentioned elements might be articulated in the following functional structure:

$$\mathbf{Area}_{Formal}\ (\mathbf{Mha}) = \left[\left\{\frac{(\mathbf{BS} * \mathbf{Seed\ multiplication\ factor}) \times \mathbf{Correction\ Factor}}{\mathbf{Seed\ Rate}}\right\} \times \frac{\mathbf{1}}{\mathbf{Conversion\ factor}}\right]$$

Where,

BS: Breeder seed supplied in quintals
Seed multiplication factor: Multiplication factor for producing one kg of TL seed from the breeder seed
Seed rate: Seed required for planting one hectare of land
Correction factor = (1-supply chain loss); supply chain loss range between 0-1.

Furthermore, it was proposed that early adopters of new varietal technologies would continue to use them for durations of one year for hybrids and three to five years for open-pollinated varieties, falling under the informal framework of varietal technology dissemination or spread, which deals with the farmer-to-farmer diffusion of technology. To give an example, open-pollinated crop varieties have their seeds replaced by farmers every three to five years, whereas hybrids have their seeds replaced annually because of a phenomena known as inbreeding depression. Thus, the spread of varietal technology among farmers occurs not via breeder seeds but from seeds with no seed multiplicity, i.e., seeds that are authenticated or accurately labelled.

In addition, observations made during a closed-group conversation with the same group of specialists revealed that farmers keep part of their current production for their personal use as seed and also distribute part of it to their peers. In contrast to the lateral spread of technology through the unofficial channel, some farmers within the same network may decide to stop using the current varietal technology. This could be because they have grown weary of it or because it hasn't performed well enough under various conditions, such as unfavorable farming conditions or abiotic and biotic stresses. Additionally, varietal technology seeds are usually used following a period of storage because to the unique climatic and seasonal requirements for crop growth. It was also anticipated that, between storage and use, some seeds would become lost or lose their viability for various causes. These losses were included under the category of supply chain losses for the sake of analytical ease. As such, these variables have an impact on the unofficial channels via which technology is distributed. Accordingly, it was believed that the following factors would influence the spread of diverse technologies via unofficial channels:

Informal Area = *f* (Individual seed utilization, shared seed exchange among fellow farmers, supply chain losses, and technological discontinuation)

The following functional form provides a mathematical expression for the aforementioned determinants, which can be used to determine the region covered by varietal technology or the extent of its proliferation –

$$\mathbf{Area}_{Informal}\ (\mathbf{Mha}) = \frac{\left[\left\{\frac{(\mathbf{1^{st}\ generation\ output\ of\ technology}) \times \mathbf{Output\ kept\ as\ seed}\ (\%) \times \mathbf{Correction\ Factor}}{\mathbf{Seed\ Rate}}\right\} \times \{\mathbf{100 - SRR - technology\ discontinuance}\ (\%)\}\right]}{\mathbf{Conversion\ factor}}$$

Where,

SRR: Seed replacement rate (%)

In the aforementioned formula used to calculate the area covered by the unofficial channel, "first-generation output of technology" refers to the total yield that a farmer would receive as a result of adopting the improved varietal technology. This cumulative production is equal to the product of the yield due to the varietal technology and the area over which it has been adopted.

We determined the output kept as seed by dividing the hectare-per-year productivity by the amount of seed required to sow the same amount of land. However, it is crucial to recognize that this ratio can vary among different crops, depending on the per-hectare productivity and the seed rate required for cultivating one hectare under a specific crop. The improved methodology is based on the following assumptions:

1. The technology generator is the sole source of technology transfer in the form of breeder seed supply.
2. The Seed Replacement Rate (SRR) serves as a proxy for the varietal replacement rate in the indirect estimation of technology spread.
3. The informal channel of technology spread is assumed to be in its simplest form.
4. Not all breeder seeds supplied culminate in certified or truthfully labelled seed.
5. All breeder seeds supplied by a technology generator are exclusively used for their intended purpose.
6. Competitive technologies replace the adopted technology on farms, making technology spread a non-additive process.

5. Validation of the Methodology

To validate the improved methodology, a small sample survey was drawn from 50 respondents including the progressive farmers, block level agricultural officers and district agricultural officers in the Odisha state. Further, the farmers who bought NRRI rice varieties from the formal channel were identified through the village level survey. For the survey, we took expert consultation from the breeders who have the knowledge of ecological suitability of the varieties in the formal seed chain along with the possible agro-ecological regions in Odisha for their adoption. Based on this information, it became relatively easier to trace the farmers in the region were NRRI varieties were grown.

The estimated area from the improved method was compared with the actual area of NRRI rice varieties cultivated by the farmers. This approach led us to evaluate the improved method's validity and led us to know if it overestimates or underestimates the area under the crop. Further, using the same approach the improved methodology was tested in another ecology in the coastal belts of the state and subsequently through the focused group discussion involving the social scientists and extension personals it was found that the improved method keeps room for error in the range of ±10 per cent from the actual values.

6. NRRI Rice Varieties in Formal Seed Chain

Through the breeder seeds of the improved rice varies, NRRI continue to assume a prominence in the national rice seed supply chain. The recent trends in the breeder seed indent receipt of NRRI rice varieties indicate a significant role of the institute in feeding the formal seed system of rice in the country. Between 2004-05 to 2022-23, the breeder seed indent of NRRI rice varieties have increased about eight folds from mere 34 quintal to 264 quintals (Fig. 5) which indirectly highlights the popularization of NRRI rice varieties among the farmers.

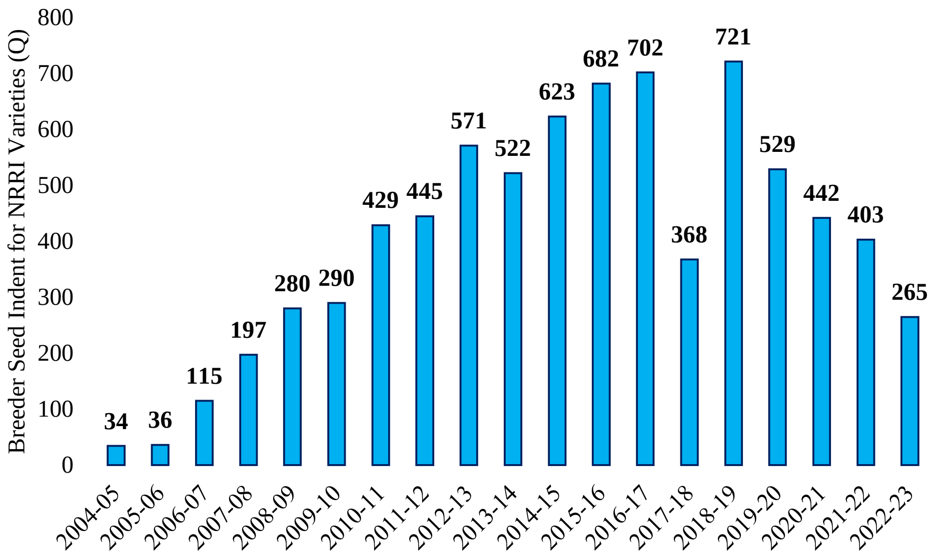

Fig. 5: Breeder Seed Indent of Rice varieties of NRRI

Further, the in the last five years, the number of varieties in the formal seed system has increased from 34 in 2018-19 to 41 in 2022-23. Further, the last five year indent of NRRI varieties suggest that, during 2018-19, Swarna *sub 1*, Pooja, Satabdi, CR Dhan 500, Sarala, Gayatri, CR Dhan 1009 *sub 1*, Anadda, Varshadhan, Savitri, CR Dhan 307 and CR Dhan 310 were top ten varieties indented through the breeder seed indent of Department of Agriculture and Cooperation (DAC), Government of India. However, the indent of the year 2022-23 suggests that, Swarna *Sub 1*, CR Dhan 1009 *Sub 1*, CR Dhan 310, CR Dhan 311, CR Dhan 800, CR Dhan 203, Pooja, CR Dhan 101, Improved Lalat, CR Dhan 409 and CR Dhan 810 were top ten varieties indented by DAC. The closer insight of the indented varieties suggests that, over the period the indent of climate resilient and biofortified varieties of the institute is increasing. Moreover, the declining trends in the breeder seed indent of NRRI rice varieties post 2018-19 is mainly due to decline in the indent of Swarna *sub 1* variety.

7. Direct Impacts of NRRI

7.1 Area and Production of NRRI Rice varieties

In its 75 years of service to the nation, NRRI has developed varieties suitable for different ecologies of the country. The breeder seed indent data suggest that, in the year 2022-23, NRRI rice varieties have been cultivated on 9.92 million hectare of land which was about 1/5th of the rice growing area of the country contributing about 30 million tonnes of paddy (23% of national production) (Fig. 6).

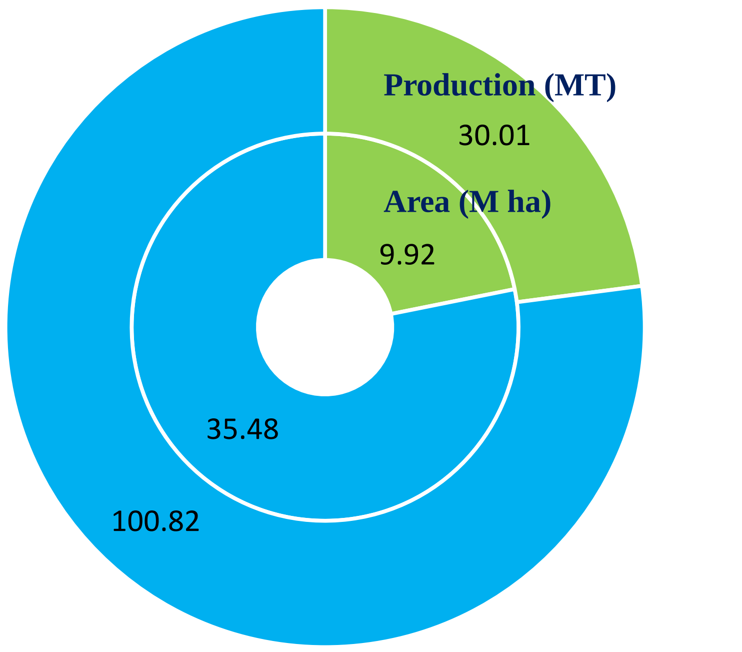

Fig. 6: Area (in M Ha) and production (in Million tone) due to NRRI rice varieties

Further, the estimates of the ecology wise coverage of rice varieties of NRRI rice varieties suggest that, climate resilient varieties of NRRI (like Swarna *Sub 1* and CR Dhan 1009 *Sub 1* for flood prone areas and Sahbhagi Dhan for drought prone areas) are preferred by the farmers who are mostly cultivating rice in the climatic vulnerable zones. However, the varieties cultivated in the flood prone and drought prone regions along with shallow low land and irrigated ecologies account for more than 90 per cent area covered by NRRI rice varieties (Fig. 7).

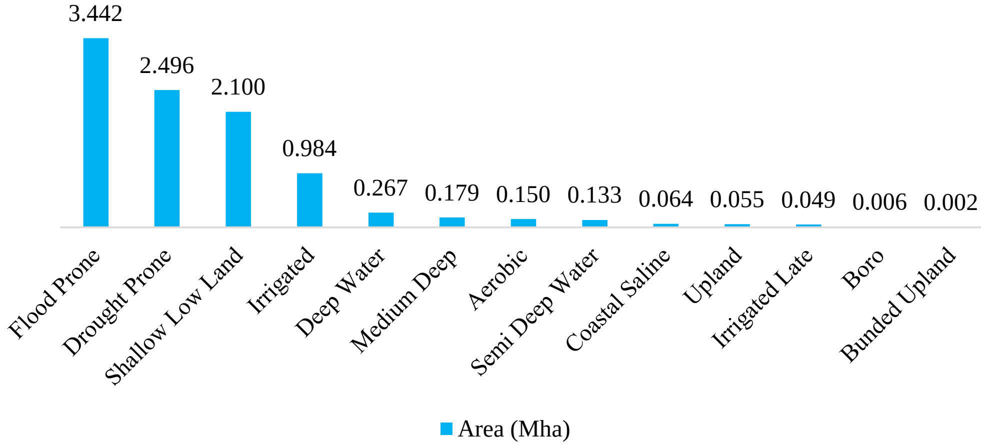

Fig. 7: Area (in million hectare) of NRRI rice varieties in different rice growing ecologies

7.2 Area and Production of Climate Resilient Rice Varieties of NRRI

Due to climatic diversity, varied topography and soil types and rainfall, rice crop is cultivated under ecologies in India. In terms of ecologies rice is grown on 13 million hectare of flood prone area, 7.5 million hectare of drought prone area and 1.2 million hectare of salinity affected areas. Among these, NRRI rice varieties are cultivated on 1/3rd of the drought prone area, 1/4th of the flood affected area and on about five percent of the salinity affected areas in the coastal regions (Fig. 8).

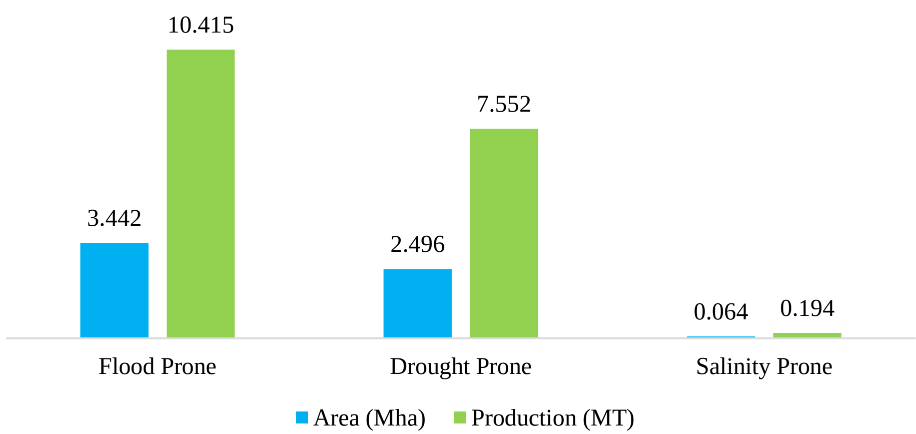

Fig. 8: Area (in Mha) and Production (in MT) due to climate resilient rice varieties of NRRI

The current breeder seed indent of NRRI rice varieties suggests that, during the year 2022-23, one variety for the drought tolerance, two varieties for the flood tolerance and three varieties for the salinity tolerance are in the farmers field through the formal seed system which are providing the yield advantage of 1 t/ha against drought, 1.35 t/ha against flood and 1.5 t/ha against salinity conditions. Consequently, the climate resilient varieties of NRRI is providing a cumulative production resilience of 4.46, 2.50 and 0.10 million tonnes under flood, drought and salinity conditions.

7.3 Area and Production of Biotic Stress Tolerant Rice Varieties of NRRI

NRRI has developed eight rice varieties through the targeted breeding for resistance against different biotic stresses. They are CR Dhna 107, CR Dhan 317, CR Dhan 326, CR Dhan 800, CR Dhan 805, Samlei, Improved Lalat and Improved Tapaswini (Fig. 9)

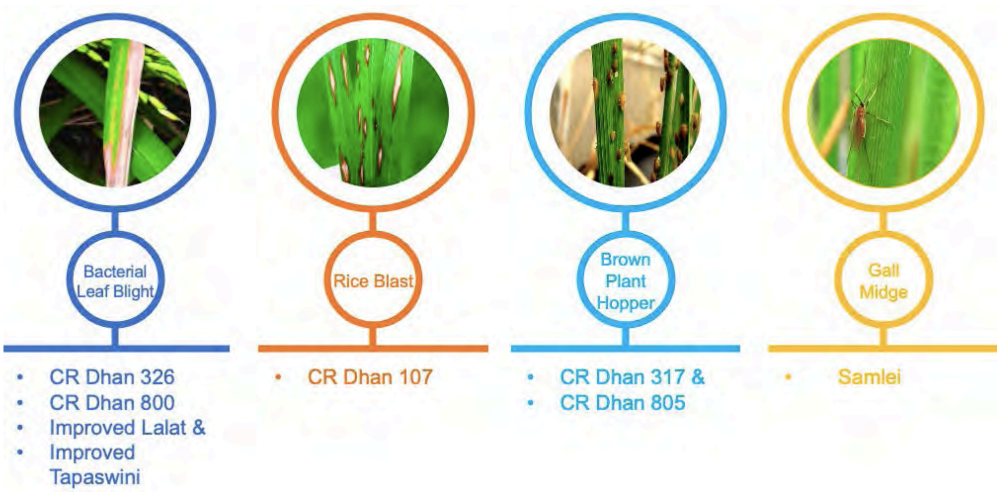

Fig. 9: Stress tolerant rice varieties of NRRI against different diseases and pests

However, currently only two of these varieties are in the seed chain and are cultivated on about 0.5 million hectare of rice cultivation area which yields about 2.51million tonnes of cumulative production resilience to the farmer under the stress conditions. Further, the current demand of breeder seed from DAC's breeder seed indent indicates that, by the year 2026-27, NRRI's BPH resistant variety CR Dhan 317 would cover about 11000 hectare of rice cultivation area in the country.

7.4 Area and Production of Biofortified Rice Varieties of NRRI

On the nutritional front, NRRI has developed four nutritionally rich biofortified rice varieties namely CR Dhan 310 (High Protein 10.5%), CR Dhan 311 (High Protein 10.1% & Moderately High Zinc 20 ppm), CR Dhan 315 (High Zinc 25 ppm) and CR Dhan 411 (High Protein 10%). Among these biofortified rice varieties, CR Dhan 310 and CR Dhan 311 are in formal seed chain covering about 0.102 and 0.017 million hectare area which cumulatively yields about 0.363 million tonnes of biofortified grains. Moreover, the breeder seed supply of these biofortified rice varieties of the institute has witnessed a sharp growth from 3.9 quintals in 2018-19 to 121.60 quintals in 2021-22 indicating that by the year 2024-24, these varieties will be cultivated on about 3.5 million hectare area.

7.5 Area and Production of rice varieties commercialized through MoUs

A research institute has different means of disseminating its technologies. From 2010 onwards ICAR-National Rice Research Institute has signed more than 100 memorandum of understanding (MoU) with different agencies for commercialization of its technologies and product. The major categories in which the technology commercialised by the institute falls under hybrids (30), inbreed varieties (62), commercialization of parental lines (03), microbial formulations (01), farm machineries and equipment (03), commercialization of light trap (02), commercialization of customised leaf colour chart (03), method for albino free shoot regeneration in rice through anther culture (01) and marketing and exports of rice varieties (01) (Fig. 10).

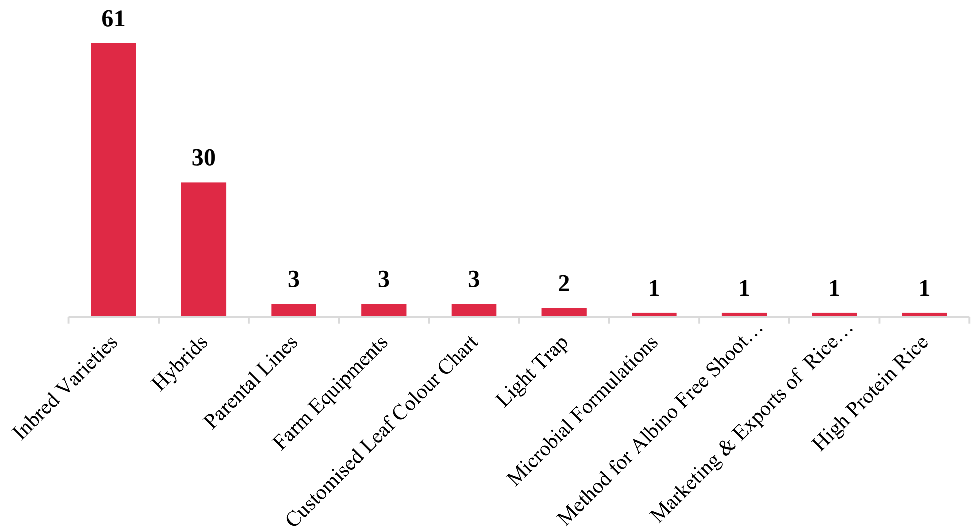

Fig. 10: MoUs (in Nos.) signed by ICAR-NRRI for commercialization of its products and processes

In the year 2019-20, about 30 quintals of breeder seeds of different rice varieties of NRRI have been supplied by the Institute through the same channel. Consequently, around 0.59 million hectare rice area has been brought under NRRI rice varieties which translates into the production of 0.170 million tonnes of rice grain. The details of MoUs and their impacts in terms of area coverage, production at the national yield and gross returns accrued to the economy (2021-22) are given below:

Table 1: Area and production due to NRRI rice varieties commercialised through MoUs (2021-22)

MoU Signing Firms for Breeder seeds of NRRI rice varieties	BS supplied (Q)	Area (Mha)	Production (MT)
Seed Association of Bengal, Kolkata, WB	5.560	0.107	0.031
Seed Association of Bengal, Kolkata, WB	21.500	0.413	0.119
Anima Seeds, Sambalpur	1.200	0.023	0.007
Agrigenetics Pvt Ltd., Hyderabad	0.200	0.004	0.001
Delta Seed Pvt Ltd, Hyderabad	0.150	0.003	0.001
Badamba 4S4R, FPC Ltd, Badamba, Cuttack	0.300	0.006	0.002
Niali 4S4R, FPC Ltd. Cuttack	1.800	0.035	0.010
Total	**30.710**	**0.590**	**0.170**

However, the major share of breeder seed supplied by an Institute is through the DAC indent and volume of varietal technology transfer through MoUs is subjected to wide variations and are dependent on the number of MoUs signed by the institute and the quantity for which the MoU has been signed. Hence, the breeder seed supply and consequently the area is subjected to variation.

8. Incremental Income Due to NRRI Rice Varieties

Estimation of incremental income accrued to farmers due to cultivation of NRRI rice varieties was based on the assumption that that yield gain due to the release of new varieties over the popular check is 5 per cent. Thus, we delineated out the incremental production from the total production due to NRRI rice varieties using the 5 per cent yield gain due to release of new varieties. Thus, the incremental production so obtained was multiplied with the current minimum support price of paddy to obtain the monetary value due to incremental production. The incremental production due to cultivation of NRRI rice varieties was 1.502 million tonnes during the year 2022-23 which when multiplied with MSP of Rs. 2040 per quintal yields an incremental income of Rs. 3064.08 Crore. Further, the cumulative farmers profit estimated based on average all India cost of cultivation of rice suggests that, all the farmers who have cultivated NRRI rice varieties have cumulatively earned a net profit of Rs. 3268 crores in the year 2022-23.

9. Indirect Impact of NRRI

Based on the recommendations of the International Rice Commission that was founded in 1949, FAO launched a japonica/indica hybridization program at the Central Rice Research Institute (presently National Rice Research Institute), Cuttack in 1950. The aim was to develop high-yielding nitrogen-responsive rice varieties for different agro-climatic regions in Southeast Asian countries. The major objective of the program was to hybridize indica rice genotypes with introduced japonica types and grow F1 generation at CRRI, Cuttack (Parthasarathy, 1954). Thousands of crosses were effected at CRRI, Cuttack under this scheme and F2 seeds harvested were supplied to participating states/countries for selecting desirable segregants for their locations. Most tropical Asian countries participated in the project, sending seeds of their best varieties for crossing with japonicas at the Central Rice Research Institute (CRRI), Cuttack, India. A parallel scheme of hybridization, with similar objectives, was initiated by the Indian Council of Agricultural Research (ICAR). These two projects used 192 improved indica varieties selected by the participating Asian countries and Indian states and produced 710 japonica-indica hybrids. F 1 seeds were distributed to the participating countries or states, who then grew the F 2 and subsequent generations and crossed them to breed varieties better suited to local conditions. This project resulted in the release of only four commercial varieties namely **Malinja** and **Mahsuri** in Malaysia; **ADT27** in Madras, India; and **Circna** in Australia. In India ADT27, which is suitable for the early monsoon season, replaced the earlier varieties ADT3 and ADT4. Similarly, Malinja and Mahsuri were the first two varieties suitable for double cropping in Malaysia. These two varieties occupied a major area in Malaysia.

Many rice genotypes developed and identified better for many traits were used as parents in developing improved rice varieties across the country (Annexure-I). Similarly, several genotypes were used in breeding pedigrees during the development of many major varieties and some were contributed as grandparents of major varieties (Annexure-II).

The pedigree analysis of the popular rice varieties in India in different period led us to believe that, about 25 and 29 of the NRRI varieties or lines were directly involved in the development of 157 varieties as a female and male parent respectively. Further in the nine varieties, both the parent used by the breeding programmes on rice crop improvement came from NRRI varieties/lines. Additionally, in the rice crop improvement programmes undertaken across the country after 1975 onwards, NRRI's rice varieties or lines were used as a grand-parent in 78 varieties. Cumulatively, NRRI varieties and lines have contributed as either parent or grand-parent in 244 rice varieties developed in the country. Figure 11 depicts the number of NRRI varieties/lines which have served as parent and grand-parent in the rice crop improvement programmes in the country.

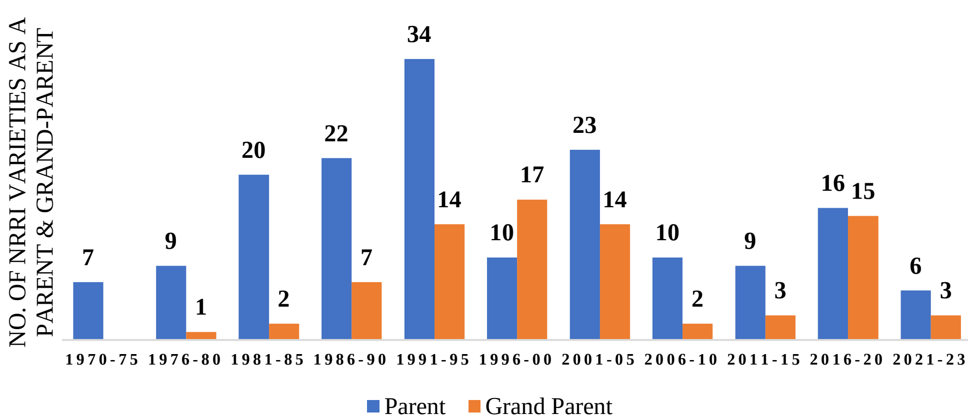

Fig. 11: Indirect contribution of NRRI rice varieties as parent or grand-parent in rice crop improvement programme in India

Furthermore, the institute also screened rice genotypes over the years and identified stable-performing germplasm accessions to be utilized in breeding programs. Identified stable-performing genotypes are registered with ICAR-National Bureau of Plant Genetic Resources (NBPGR) as unique germplasm accessions (Annexure-III). Some of those germplasm accessions have been and are being utilized as parents or grandparents in the development of modern-day rice varieties resistant to either biotic or abiotic stresses (Annexure-IV). Some of them also served as good donors for improving the nutritional quality of modern rice varieties.

10. Other Ways through which NRRI is bringing differences

The ICAR-National Rice Research Institute (NRRI) extends its impact beyond varietal technologies, significantly influencing the lives of people through various initiatives. Firstly, NRRI plays a pivotal role in agricultural extension services, providing farmers with cutting-edge knowledge and best practices. Through workshops, training programs, and field demonstrations, NRRI contributes to the capacity building of farmers, empowering them with the latest advancements in rice cultivation.

Secondly, NRRI actively engages in research and development beyond crop varieties, focusing on sustainable agricultural practices. Its efforts include soil health management, water-use efficiency, and integrated pest management, addressing broader environmental and resource conservation concerns. This multifaceted approach enhances the overall resilience of farming communities.

Moreover, NRRI is instrumental in socioeconomic development by promoting entrepreneurship among farmers. Initiatives such as seed production units, farmer producer organizations (FPOs), and market linkages foster economic empowerment, transforming agriculture into a more sustainable and profitable venture.

Furthermore, NRRI's outreach extends to rural communities through education and skill development programs. By imparting knowledge on modern farming techniques and encouraging the adoption of agro-processing technologies, NRRI contributes to elevating the livelihoods of individuals in rural areas.

In brief, NRRI's impact transcends the realm of varietal technologies, encompassing agricultural education, sustainable practices, economic empowerment, and community development. By addressing holistic aspects of rural life, NRRI serves as a catalyst for positive change, fostering prosperity and sustainability in the lives of people associated with rice farming.

11. Limitations of the study

a. Not all the indirectly developed varieties that uses NRRI varieties/genes/unique germplasms have find place here due to complexity of the methods for information acquisition and traceability,

b. We have not been able to trace all the varieties developed in the other countries or by the international agencies by the germplasm exchange mechanisms through INGER facility of IRRI,

c. Pre-INGER several materials should might have led to varietal development in the other countries that has not been covered because of the complexities in the traceability,

d. Indirect impact due to commercialization of NRRI technologies through the private firms is not taken into account due to poor maintenance of variety specific record by the private agencies.

12. Way Forward

The manuscript focusing on the methodology of estimating crop area using the breeder seed indent and the impact of NRRI on farmers' lives provides valuable insights into agricultural practices and the broader socioeconomic influence of the research institute. To enhance the manuscript's comprehensiveness and impact, several areas can be considered for further exploration and development:

1. Validation and Robustness of Methodology: Conduct further validation studies to assess the accuracy and reliability of the breeder seed indent methodology across different agro-climatic regions. Explore variations in results under diverse crop management practices, soil types, and farming systems to enhance the robustness of the proposed methodology.

2. In-Depth Analysis of NRRI's Socioeconomic Impact: Expand on the qualitative aspects of NRRI's impact on farmers' lives, including case studies, interviews, and testimonials to provide a richer understanding of the institute's role in rural development. Investigate the long-term effects of NRRI's interventions, such as changes in income levels, livelihood diversification, and improvements in overall living standards.

3. Comparison with Other Methodologies: Compare the breeder seed indent methodology with existing approaches for estimating crop area to assess its relative advantages, limitations, and applicability in different contexts. Discuss the potential integration of modern technologies such as remote sensing and GIS in conjunction with breeder seed indent for a more comprehensive and accurate estimation.

4. Policy Implications and Recommendations: Explore the policy implications of the research findings, suggesting recommendations for policymakers to enhance the adoption of breeder seed indent methodology in crop area estimation. Provide policy recommendations for scaling up successful NRRI interventions, emphasizing collaboration with governmental agencies, NGOs, and private stakeholders to amplify their impact.

5. Extension Services and Farmer Training: Elaborate on NRRI's role in extending agricultural knowledge to farmers through capacity-building programs, workshops, and extension services. Propose strategies to enhance the effectiveness of training programs, ensuring widespread adoption of best practices among farmers.

6. Future Research Directions: Suggest avenues for future research, such as exploring innovative technologies for crop area estimation, assessing the socio-economic impact of emerging agricultural trends, and identifying novel approaches for enhancing farmers' adaptive capacity.

By delving deeper into these aspects, the manuscript can provide a more comprehensive and nuanced understanding of the breeder seed indent methodology and NRRI's transformative impact on farmers' lives. This expansion will contribute to the scholarly literature and offer valuable insights for researchers, policymakers, and practitioners in the field of agriculture and rural development.

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Annexure-I

Rice Varieties Developed by ICAR-National Rice Research Institute

S. No.	Variety	Ecology	Year of release	Duration	Grain Type
1	Padma	Irrigated	1968	120	SB
2	Bala	Upland	1970	105	SB
3	Kiron	Irrigated	1970	110	MS
4	Krishna	Irrigated	1970	125	MS
5	Ratna	Irrigated	1970	125	LS
6	Vijaya	Irrigated	1970	135	MS
7	Saket-4	Irrigated	1971	115	LS
8	Jayanti	Irrigated	1973	135	LS
9	Kalinga-I	Irrigated	1973	105	LB
10	Kalinga-II	Irrigated	1973	100	LB
11	Shakti	Irrigated	1973	135	SB
12	Supriya	Irrigated	1973	125	MS
13	Vani	Irrigated	1975	125	LS
14	Naikichili	Irrigated	1977	120	LS
15	Anamika	Shallow lowlands	1979	145-150	LB;
16	Indira	Irrigated	1980	125	MS
17	Pallavi	Irrigated	1980	125	MS
18	Ramakrishna	Shallow lowlands	1980	130	MS
19	Samalei	Shallow lowlands	1980	150	LS
20	Sattari	Upland	1980	70	SB
21	Narendra-1	Irrigated	1981	110	LB
22	Savitri/ Ponmani	Shallow lowlands	1982	150-155	SB
23	Khitish	Irrigated	1982	120	LS
24	CR 138-928	Irrigated	1983	120	MS

S. No.	Variety	Ecology	Year of release	Duration	Grain Type
25	Kalinga-III	Upland	1983	80	LS
26	Utkalprabha	Medium Deep	1983	155	MS
27	Neela	Upland	1985	90	MB
28	Sarasa	Irrigated	1985	120	LS
29	Udaya	Irrigated	1985	135	LB;
30	Annada	Upland	1987	110-112	SB
31	CR 1014	Medium Deep	1988	155	MS
32	Dharitri	Shallow lowlands	1988	145-160	SB
33	Gayatri	Medium Deep	1988	155	SB
34	Heera	Upland	1988 / 1991	68	LB;
35	Kalashree	Medium Deep	1988	160	MS
36	Kalyani-II	Upland	1988	62	MS
37	Kshira	Irrigated	1988	135	MB
38	Moti	Shallow lowlands	1988	145	LS
39	Padmini	Shallow lowlands	1988	145	MS
40	Panidhan	Medium Deep	1988	170	MS
41	Tara	Upland	1988	100	MB
42	Tulasi	Medium Deep	1988	170	MS
43	Vanaprabha	Upland	1988	90	LS
44	Shaktiman	Irrigated	1990	120	SB
45	CR 1002	Shallow lowlands	1992	145	BB
46	Lunishree	Coastal Saline	1992	145	LS
47	Seema	Shallow lowlands	1992	150	MS
48	Sneha	Upland	1992	70	LS
49	Vandana	Upland	1992/ 2000	95	LB;
50	Dhala Heera	Upland	1996	85	LB;
51	Radhi	Irrigated	1996	120	LB;
52	Sonamani	Coastal saline	1996	155	LB;

S. No.	Variety	Ecology	Year of release	Duration	Grain Type
53	Tapaswini	Irrigated	1996	135	MS
54	Pooja	Shallow lowlands	1999	150	MS
55	Sarala	Medium Deep	2000	150	MS
56	Durga	Medium Deep	2000	155	MB
57	Shatabdi	Irrigated	2000	110	LS
58	Anjali	Upland	2002	95	SB
59	Hazaridhan	Irrigated	2004	120	LS
60	Sadabahar	Upland	2004	105	LB;
61	Abhishek	Irrigated	2006	125	SB
62	Chandrama	IrrigatedBoro	2006	130 (Irrig) 170 (Boro)	SB
63	Virender	Upland	2006	95	SB
64	Geetanjali	Irrigated	2006	130	LS (Aromatic)
65	Ketekijoha	Shallow lowlands	2006	145	MS (Aromatic)
66	Naveen	Irrigated	2006	120	MB
67	Rajalaxmi (Hybrid)	Irrigated	2006	135	LS
68	Ajay (Hybrid)	Irrigated	2006	130	LS
69	Varshadhan	Semi-deep	2006	160	LB
70	Satya Krishna (CR Dhan 10)	Irrigated	2008	135	LS
71	Nua kalajeera	Shallow lowlands	2008	150	SB (Aromatic)
72	Nua Dhusara (CR Sugandh Dhan 3)	Shallow lowlands	2008	150	MS (Aromatic)
73	Chandan (CR Boro dhan 2)	Boro	2008	125 Irrig, 145 Boro	MS
74	CR Dhan 40	Bunded Upland	2008	100	SB
75	Hanseswari(CR Dhan 70)	Semideep	2008	150	SB

S. No.	Variety	Ecology	Year of release	Duration	Grain Type
76	Swarna Sub1	Flood prone shallow lowlands	2009	145	MS
77	Sahbhagidhan	Rainfed upland Drought-prone areas	2009	105	LB;
78	Phalguni	Bunded uplands and irrigated	2010	117	LS
79	Reeta (CR Dhan 401)	Shallow low land	2010	150	MS
80	Luna Suvarna (CR Dhan 403)	Coastal Saline	2010	150	MS
81	Luna Sampad (CR Dhan 402)	Coastal Saline	2010	140	SB
82	Nua Chinikamini	Shallow low land	2010	145-150	SB (Aromatic)
83	CR Dhan 501	Semi-deep	2010	152	LB;
84	CR Dhan 701	Shallow low land	2010, 2014	142	MS
85	CR Dhan 601	Boro	2010	160	MS
86	CR Dhan 500	Deep Water	2011	160	MS
87	Satyabhama (CR Dhan 100)	Upland	2012	110	MS
88	Pyari (CR Dhan 200)	Aerobic	2012	115-120	SB
89	Hue (CR Dhan 301)	Irrigated	2012	135	LS
90	Improved Lalat	Irrigated	2012	130	LS
91	Improved Tapaswini	Irrigated	2012	130	SB
92	Sumit (CR Dhan 404)	Shallow lowlands	2012	145	LB
93	Poorna Bhog (CR Basna Dhan 902)	Shallow lowlands	2012	140	LS
94	Jalamani (CR Dhan 503)	Deep Water	2012	160	MS
95	Jayanti Dhan (CR Dhan 502)	Deep Water	2012	160	MS
96	Luna Barial (CR Dhan 406)	Coastal Saline	2012	150	SB

S. No.	Variety	Ecology	Year of release	Duration	Grain Type
97	Luna Sankhi (CR Dhan 405)	Coastal Saline	2012	110	MS
98	CR Sgandh Dhan 907	Irrigated Late (Aromatic)	2013	150	MS (Aromatic)
99	CR Dhan 300	Irrigated	2013	140	LS
100	CR Dhan 303	Irrigated	2014	125	SB
101	CR Dhan 305	Irrigated	2014	125	SB
102	CR Dhan 304	Irrigated	2014	130	SB
103	CR Dhan 201	Aerobic	2014	118	LS
104	CR Dhan 202	Aerobic	2014	115	LB
105	CR Dhan 407	Rainfed shallow lowland	2014	150	LB
106	CR Dhan 505	Deep water	2014	162	MS
107	CR Dhan 204	Aerobic	2014	120	LB
108	CR Dhan 306 (IET 22084)	Irrigated	2014	120-125	SB
109	CR Dhan 205 (IET 22737)	Aerobic	2014	110	SB
110	CR Dhan 101 (Ankit)	Upland	2014	110	MS
111	CR Dhan 203 (Sachala)	Aerobic	2014	110	LS
112	CR Dhan 206 (Gopinath)	Aerobic	2014	115	SB
113	CR Dhan 307 (Maudamani)	Irrigated	2014 & 2022	135	SB
114	IR64 Drt1	Rainfed drought-prone ecology/ irrigated ecology	2014	120-125	LS
115	CR Dhan 310 (IET 24780)	Irrigated	2016 & 2022	125	MS
116	CR Dhan 508	Deep Water	2017	160	LB
117	CR Dhan 506	Semi-deep	2017	165	LB
118	CR Sugandh Dhan 908	Irrigated Late	2017	145	MS (Aromatic)

S. No.	Variety	Ecology	Year of release	Duration	Grain Type
119	Gangavati Ageti	Upland	2017	85	LS (Aromatic)
120	Purna	Upland	2017	90	SB
121	CR Dhan 207 (Srimati)	Aerobic	2018	110-115	MS
122	CR Dhan 209 (Priya)	Aerobic	2018	112-115	LS
123	CR Dhan 409 (Pradhan Dhan)	Shallow lowland	2018	160-165	LS
124	CR Dhan 507 (Prasant)	Deep Water	2018	160	MS
125	CR Dhan 800	Shallow lowland	2018	140	MS
126	CR Sugandh Dhan 910	Shallow favorable lowlands and Irrigated Late	2018	142-145	MS (Aromatic)
127	CR Dhan 408 (Chaka Akhi)	Shallow lowland	2018	165 PS	LB
128	CR Sugandh Dhan 909	Irrigated Late	2018	140	MS (Aromatic)
129	CR Dhan 309	Irrigated	2019	115	LS
130	CR Dhan 801	Rainfed shallow lowland	2019 & 2022	140	SB
131	CR Dhan 802 (Subhas)	Shallow lowland	2019 & 2022	142	SB
132	CR Dhan 510	Semi deep	2019	160	SB
133	CR Dhan 511	Semi-deep	2019	160	SB
134	CR Dhan 311 (Mukul)	Irrigated	2019 & 2022	120-126	LB
135	CR Dhan 312	Irrigated	2020	135-140	MS
136	CR Dhan 313	Irrigated	2020	130-135	MS
137	CR Dhan 602	Boro	2020	155 (Boro) 125 (Non-boro)	LS
138	Santha Bhima (CR Dhan 102)	Upland	2020	105-110	SB
139	Sarumina (CR Dhan 210)	Aerobic	2020	110-115	LS

S. No.	Variety	Ecology	Year of release	Duration	Grain Type
140	CR Dhan 410 (Mahamani)	Shallow low land	2020	155	LS
141	CR Dhan 308	Irrigated	2020	135	MS
142	CR Dhan 315	Irrigated	2021	130	MS
143	CR Dhan 318	Irrigated	2021	118-120	LS
144	CR Dhan 319	Irrigated	2021	130 -135	SB
145	CR Dhan 320	Irrigated	2021	115	LS
146	CR Dhan 316	Irrigated	2021	130-135	LB
147	CR Dhan 317	Irrigated	2021	135-140	SB
148	CR Dhan 411 (Swarnanjali)	Shallow low land	2021	140	SB
149	CR Dhan 412 (NICRA Dhan : Luna Ambiki)	Coastal ecology	2021	140	MS
150	CR Dhan 413	Rainfed shallow lowland	2021	145	SB
151	CR Dhan 512	Semi deep water	2021	150	SB
152	CR Dhan 702	Irrigated & Shallow lowland	2021	140-145	LS
153	CR Dhan 703	Boro & Irrigated shallowlowland	2021	165 (Boro) & 140-145	LS
154	CR Dhan 803	Rainfed shallow lowland	2021	150	SB
155	CR Dhan 314	Irrigated	2022	130-135	LB
156	CR Dhan 414	Coastal saline ecology	2022	145-150	MS
157	CR Dhan 321	Irrigated ecology	2022	118-120	MS
158	CR Dhan 103	Rainfed uplands	2022	95-100	LS
159	CR Dhan 107	Rainfed early direct seeded condition	2022	90-95	LB
160	CR Dhan 415	Rainfed shallow lowland	2022	120-125	SB
161	CR Dhan 323 (Jyotsna)	Irrigated & Rainfed Shallow Lowland	2023	135-140	SB

S. No.	Variety	Ecology	Year of release	Duration	Grain Type
162	CR Dhan 324 (AbhayaPaushtik)	Irrigated	2023	115-120	LS
163	CR Dhan 326 (Panchatatva)	Irrigated	2023	135-140	MS
164	CR Dhan 327 (Madhumita)	Irrigated	2023	135	MS
165	CR Dhan 328	Irrigated Late	2023	140-145	LB
166	CR Dhan704 (Shyamdev)	Irrigated & DSR	2023	130-135	SS
167	CR Dhan 805 (Naveen Shakti)	Irrigated	2023	125-130	MS
168	CR Dhan 806 (Varsadhan Sub1)	Deep Water	2023	160-165	LB
169	CR Dhan 911(Basudev)	Irrigated	2023	120-125	LS
170	CR Dhan 329	Irrigated	2023	130	SB
171	CR Dhan 322	Irrigated Late	2023	140	LS
172	CR Dhan 331	Irrigated Late	2023	140	MS
173	CR Dhan 332	Irrigated Late	2023	145	LS
174	CR Dhan 214	Aerobic	2023	110-115	LB
175	CR Dhan 211	Aerobic	2023	115-120	LB
176	CR Dhan 212	Aerobic	2023	110-115	LB
177	CRR Dhan 807	Rainfed early direct seeded condition	2023	110-115	LB
178	CR Dhan 808	Direct Seeded Drought Prone Areas	2023	90-95	SB
179	CR Dhan 804	Rainfed shallow lowlands/ irrigated conditions	2023	115-120	LS

Annexure-II

Trait Specific NRRI Rice varieties

Traits	Varietal Technology	Year of release	Suitable ecology	Duration (in Days)
Submergence Tolerance	Swarna sub1	2009	Flood prone shallow lowland	145
	CR Shan 505	2014	Deep water	162
	Varshadhan	2006	Semi Deep	160
Salinity Tolerance	Lunishree	1992	Coastal saline	145
	Luna Suvarna	2010	Coastal saline	150
	Luna Sampad	2010	Coastal saline	140
	Luna Barial	2012	Coastal saline	150
	CR Dhan 414	2022	Coastal saline	145-150
	Luna Ambiki	2021	Coastal saline	140
Drought Tolerance	CR Dhan 40	2008	Bunded upland	100
	CR Dhan 107	2022	Rainfed early direct seeded cond.	90-95
	CR Dhan 415	2022	Rainfed shallow lowland	120-125
	CR Dhan 804	2023	Rainfed shallow lowland	115-120
	Sahabhagi Dhan	2009	Rainfed upland/drought prone areas	105
	Purna	2017	Upland	90
Drought & Submergence Tolerance	CR Dhan 801	2019	Rainfed shallow lowland	140
	CR Dhan 802	2019	Shallow lowland	142
Aerobic	CR Dhan 101	2014	Upland	110
	CR Dhan 201	2014	Aerobic	118
	CR Dhan 202	2014	Aerobic	115
	CR Dhan 203	2014	Aerobic	110
	CR Dhan 204	2014	Aerobic	120
	CR Dhan 205	2014	Aerobic	110
	CR Dhan 206	2014	Aerobic	115

Traits	Varietal Technology	Year of release	Suitable ecology	Duration (in Days)
	CR Dhan 207	2018	Aerobic	110-115
	CR Dhan 209	2018	Aerobic	112-115
	CR Dhan 210	2020	Aerobic	110-115
Biotic Stress Tolerance	CR Dhan 800	2006	Irrigated/ Boro	130 (Irrigated)
				170 (Boro)
	CR Dhan 805	2019	Irrigated	120-126
	Improved Lalat			
	Improved Tapaswini	2004	Upland	105
	CR Dhan 317	2013	Irrigated	140
	CR Dhan 326	2021	Irrigated	135-140
Biofortified	CR Dhan 310	2016	Irrigated	125
	CR Dhan 311	2019	Irrigated	120-126
	CR Dhan 411	2021	Shallow lowland	140
Aromatic	Geetanjali	2005	Irrigated	120
	Keteki Joha	2005	Rainfed lowland	140-145
	Nua Dhusara	2008	Rainfed lowland	145-150
	Nua Kalajeera	2008	Shallow lowland	145-150
	Nua Chinikamini	2010	Rainfed lowland	145-150
	Poornabhog	2012	Shallow lowland	140-145
	CR Sugandh Dhan 907	2013	Fav. Lowland & Irrigated Late	152
	CR Sugandh Dhan 908	2017	Irrigated	143-148
	CR Sugandh Dhan 909	2018	Irrigated	140
	CR Sugandh Dhan 910	2016	Fav. Lowland & Irrigated Late	142-145

Annexure-III

Varieties with NRRI identified genotypes as parents

S. No.	Variety	Parents	Designation	Released year	Released state
1	Abha	Saket 4 × JR 2-331	R 155-355	1980	MP
2	Abhaya	CR 157-392 × OR 57-21	R 296- 418-1	1989	AP
3	Abhilash	CR 63-5218 × Pankaj	KMDP 2	1985	KA
4	AD 99039	CR 1009 × GEB 24		2005	TN
5	ADT 35	Bhavani × Jaya	AD 5231	1979	TN
6	Ajaya	IET 4141 × CR 98-7216	RP 2151-1	1992	CVRC
7	Akash	Jaya × Mahsuri		1994	KA
8	Anamika	(MNP 36 × CR 12) × Pankaj	CR 149-3244-198	1980	CVRC
9	Anamica	(IR 8 × CR 1014) × (Pankaj × MNP 36)		1977	TN
10	Ananga	Kumar × CR 57-49	OR 131-5-8	1989	OD
11	Aruna	Jaya × PTB 33	KAU 93	1989	KE
12	ASD 17	(ADT 31 × Ratna) × (ASD 8 × IR 8)	AS 688	1988	TN
13	Badava Mahsuri	(Mahsuri × Vijaya)	PLA 1100	1982	AP
14	Bahadur	(Pankaj × Mahsuri)	TTB 101-5	1991	AS
15	Bhagya	(Tadukan × Jaya)	Kayamkulam 2	1986	AP
16	Birsa Vikas Dhan 109	(Kalinga III × IR 64)	Asoka F 200	2003	JH
17	Birsa Vikas Dhan 110	(Kalinga III × IR 64)	Asoka 228	2003	JH
18	Birsadhan 202	(Jaya × BR 34)	RAU 40093	1985	JH
19	Chilarai	(IR 24 × CR 44-118-1)	TTB 15-1	1987	AS
20	Satabdi	(CR 10-114 × CR 10-115)	CR 146-7027-224	1977	TN
21	CR 138-928	(Jaya × TKM 6)		1982	GU
22	CSR 10	(M 40-431-24-114 × Jaya)	81-H 21-2-4	1989	CVRC
23	Daya	(Kumar × CR 57-49)	OR 131-13-13	1984	OD
24	Gautam	Rasi mutant	PSRM 16	1995	BI
25	Godavari	MTU 2077 × CR 316-639	MTU 1032	2001	AP

S. No.	Variety	Parents	Designation	Released year	Released state
26	GR 103	GR 11 × Mahsuri	1-30-1-1	1991	GU
27	GR 5	Local selection from CR 319-344	NVS 18	1991	GU
28	GR-9	Sathi 34-36 × CR 544-1-2	NWGR 31	2002	GU
29	Himalaya 2	Imp. Sabarmati × Ratna	Pusa 33-30-3-3-19	1982	HP
30	Himalaya 741	CR 126-42-5 × IR 2061-213	IR 3941-45-plp- 2B	1986	HP
31	IR 36	(IR1561-228-1-2 × IR1737) × CR 94-13	IR 2071-625-1-252	1981	CVRC
32	Jagabandhu	(Savithri × IR 4819 sel.) × IR 27301 sel.	OR 1206-25-1	2002	OD
33	Jal Lahari	Pankaj × (Mahsuri × TKM 6)		1993	UP
34	Jayamati	(Jaya × Mahsuri)	TTB 103-2	1998	AS
35	Jayashri	(Jaya × Mahsuri)	BIET 1107	1981	BI
36	Jogesh	(CR 544-1-3-4 × NDR 1008)	OR 1519-2	2005	OD
37	Kanak	(Jaya × BR 34)	BIET-2004-RAU 6-69-2-13	1987	BI
38	Kanchan	(Jajati × Mahsuri)	OR 609-15	1992	OD
39	Kapilee	(Heera × Annada)		1993	AS
40	Karjat 6	(Heera × Karjat 184)	KJT-12-6-25-9-13-50-13	2005	MH
41	Karna	(Jaya × W1263)	KMP 39	1986	KA
42	Kasturi	Basmati 370 × CRR 88-17-1-5	RP 2144-108-5-3-2	1989	CVRC
43	Kavya	(WGL 27120 × WGL 17672) × (Mahsuri × Surekha)	WGL 48684	1991	AP
44	Ketekijoha	(Savithri × Bhadshabhog)	TTB 105-11-2	2005	OD
45	Khanika	Jaya × CR 237-1	CN 776-U6-B1	1996	WB
46	Kisan	Jaya × Soka	SJ 14	1982	WB
47	Krishna Hamsa	Rasi × Fine Gora	RP 1451-92-21-9	2001	CVRC
48	Kushal	Pankaj × Mahsuri	TTB 101-11	1991	AS
49	Lachit	CRM 13-3241 × Kalinga II	TTB 14-1	1987	AS
50	Lam Pnah 1	Bala Selection	RCPL 1-87-4	2002	ME
51	Luit	Heera × Annada	TTB 127-216-2	1998	AS
52	Madhuri	Jaya × R 11	R 36-2486	1980	MP

S. No.	Variety	Parents	Designation	Released year	Released state
53	Madhuri	Sabarmati × Ratna	Pusa 33-30-1-1	1983	UP
54	Mahalaxmi	Pankaj × Mahsuri	OR 621-6	1992	OD
55	Mahanandi	IR 19661-131-1-3-1 × Savitri	OR 1301-13	1999	OD
56	Makom	ARC 6650 × Jaya	KAU 170	1989	KE
57	Malviya dhan 36	Mutant of Mahsuri	HUR 38	2002	UP
58	Mandya Vijaya	Sona × Mahsuri	RP 1017-169-1-1	1986	KA
59	Mangala	Jaya × S 317	MR 272	1975	KA
60	Mangla Mahsuri	Reselection from Mahsuri	KAU-RM-1	1998	KE
61	Moniram	Pankaj × Mahsuri	TTB 101-14	1991	AS
62	MTU 9993	Rasi × Fine Gora	RP 1451-1196-1562-4218	1993	AP
63	Nandyal Sannalu	BPT 3291 × CR 1-57-8-212	NDLR 8	2001	AP
64	Narendra 97	N 22 × Ratna	Narendra 97	1992	CVRC
65	Pant Dhan 10	(IR 32 × Mahsuri) × IR 28	IR 9763-11-2-2-3	1992	UT
66	Pariphou	Phougak × Neela	WR 3-2-1	2006	MN
67	Piolee	Pankaj × Mahsuri	TTB 101-11	1991	AS
68	PR 108	Vijaya × PTB 21	RP 825-71-4-11-A	1986	PU
69	Pragathi	Jaya × S 317	MR 292-2	1975	KA
70	Pratap	Kumar × CR 57-49	OR 131-3-1	1983	OD
71	Purva	CR 44-35 × JR 2-331	JR 16-15-1-1	1977	CH
72	Pusa 33	Sabarmati × Ratna	PUSA 33-30-3-3	1982	TN
73	Pushpa	Jaya × Bangaru Teegalu	MR 301	1976	KA
74	Rajendra Mahsuri 1	BR 51-46 × Mahsuri	RAU 83-500	2002	BI
75	Ranjeet	Pankaj × Mahsuri	TTB 101-17	1994	AS
76	Ratnagiri 3	(CR 57-MR 1523 × IR 36) × RTN 68	RTN 121-1-1-1-1-1	1994	MH
77	RC Maniphou 1	Kalinga 2 × Palman		1992	MN
78	RC Maniphou 2	Kalinga 2 × Palman		1992	MN
79	RC Maniphou 4	Kalinga 2 × Palman		1992	MN
80	Remya	Jaya × PTB 33	MO 10	1989	KE
81	Renu	Jaya × Basmati 370	PNR 162	1993	UP

S. No.	Variety	Parents	Designation	Released year	Released state
82	Richa	Mahsuri × Basmati 370	JR 503	2004	CVRC
83	Samanta	(T 90 × IR 8) × Vikram × (S 120 × Mahsuri)	OR 487-30-3	1992	MP
84	Samba Mahsuri	(GEB 24 × TN1) × Mahsuri	BPT 5204	1986	AP
85	Satya	Tella Hamsa × Rasi	RNR 1446	1987	AP
86	Shanti	Ratna × IR 36	RP 2633-15-2-5	2001	AP
87	Shrabani	Mahsuri × IR 30	OR 367-SP-11	1988	OD
88	SLR 51214	Vijaya × PTB 21	RP 825-82-14-1-6	1984	GU
89	Sona Mahsuri	Sona × Mahsuri	BPT 3291	1982	AP
90	Sowbhagya	Mahsuri × Vijaya	MTU 4569	1982	AP
91	Srikakulam Sannalu	CR 104 × T 147	RGL 2537	1997	AP
92	Sriranga	RP 5-32 × Mahsuri	NLR 28523	1991	AP
93	Subramanya Bharathi	IR 19661 × CR 1009	PY 6	2000	PY
94	Sumati	Chandan × Pak. Basmati	RNR 18833	2001	AP
95	Surendra	OR 158-5 × Rasi	OR 447-20-P	1998	OD
96	Swarna	Vasistha × Mahsuri	MTU 7029	1979	AP
97	Tholakari	MTU 2077 × CR 316-639	MTU 1031	2001	AP
98	Tulasi	Rasi × Fine Gora	RP 1451-1712-4319	1988	CVRC
99	Turant Dhan	Sattari × Rasi	ES 18-5-2	1995	BI
100	Usar 1	Jaya × Getu		1984	UP
101	Vani	IR 8 × CR 104	CR 12-178	1975	KA
102	Varalu	WGL 20471 × CR 544-1-2	WGL 14377	2001	AP
103	Vibhava	CR 44-35 × W 12708	RP 894-15-2-1-1	1989	AP
104	Vijaya Mahsuri	Mahsuri × Vijaya	MTU 4407	1982	AP
105	VL Dhan 61	Jaya × Ta-poo-cho-Ze	VR 89-1179	1998	CVRC
106	VL Dhan 97	N 22 × Ratna	NDR 97	1991	UT
107	VL Dhan 207	VL Dhan 206 × Annada	VL 97-9729	2005	UT
108	Vyttila 5	Mutant of Mahsuri	KAU 655	1995	KE
109	Vyttila 6	(Chiriviruppu × IR 5) × Jaya		2005	KE

S. No.	Variety	Parents	Designation	Released year	Released state
110	Krishna	Chandan × Samba Mahsuri	RNR 2458	2013	AP
111	Kanaka Lata	Jaya × Mahsuri	TTB103-3-1	2013	AS
112	Karjat-8	(Ratna × Heera) × KJT-4	KJT 13-4-53-19-12	2013	MH
113	Sabour Shree	Haryana Basmati × Mahsuri	RAU 724-48-33	2014	BI
114	Chhattisgarh Zinc Rice 1 (CGZR 1)	Poornima × Annada (Pedigree selection)	R- RHZ-2 (R 1033-968-2-1)	2014	CH
115	Tripura Jala Dhan-1	TRC 229-F-41× Jaya	TRC 2008-1	2014	TR
116	Sampriti	Vikramarya × Mahsuri	CN 1317-557-56-BNKR- 42-2-3 (BKNR 3)	2014	WB
117	KRH 4	CRMS 32 A × MSN 36		2016	KA
118	EZHOME - 4	Jaya × Orkayama	KAU JO 532-1	2016	KE
119	JAIVA	Mahsuri × Kuthiru	Culture KAU MK 157	2016	KE
120	Chhattisgarh Zinc Rice-1	Poornima × Annada	R- RHZ-2	2017	CH
121	Bauna Kalanamak 101	Kalanamak KN3 × Swarna Sub1	Bauna Kalanamak- 101	2017	UP
122	Rice CR1009 Sub1	CR1009 × FR 13 A	CR 1009 Sub1	2017	TN
123	Kanaklata (TTB 103-3-1)	Jaya × Mahsuri	TTB103-3-1	2017	AS
124	GNR-5	Jaya × GR-6	NVSR-6137	2017	GU
125	Gangavati Emergency	Gaurav × Kalinga III	RR 363	2017	KA
126	Kanak	(Swarna × IR 36) × (Mohan × Khitish)	CN 1272-55-105	2018	CVRC
127	Nandyala Sona	BPT 3291 × CR 157-212	NDLR 7	2018	AP
128	Purna	Annada × RR 151-3	CRR356-29	2017	GU
129	ADT 52	CR 1009 × ADT 49		2019	CVRC
130	Khowai (TRC	Jagannath × Jaya		2018	TR

S. No.	Variety	Parents	Designation	Released year	Released state
	2005-3)				
131	Tripura Jala 1	TRC 229-F-41 × Jaya		2019	TR
132	Uttar Lakshmi	MTU 7029 × Annada		2020	CVRC
133	Warangal Vari-2	(BPT 5204 × GEB 24) × (BPT 5204× Shatabdi)		2021	TS
134	Aerobic Dhan-1 (26178)	Naveen × Kataktara		2021	CVRC
135	Uttar Samir	Annada × Gontra Bidhan-1	PUR-B-36	2022	WB
136	AAU-TTB-Dhan 40 (Dholi)	(Ranjit × Swarna Sub-1) × Ranjit	TTB-AAUTTB-DHAN-40	2022	AS
137	KKL (R) 2 28791	ADT 46*3 × Swarna Sub 1		2022	CVRC
138	MTU Rice 1310	MTU 1075 × CR 3598-1-4-2-1		2022	CVRC
139	KMP-1	CR-1014 × IR-8		1984	KA
140	USAR-1	Jaya × Gatu		1985	UP
141	SLR-51214	Vijaya × PTB-21		1985	GU
142	Sravani	Mahsuri × IR-30		1989	CVRC
143	GR-103	GR-11 × Mahsuri		1992	GU
144	Chelarai	IR-24 × CR-44-118-1	TTB-15-1	1992	AS
145	MDU-4	AC-2836 (CR-194-523) × Jagannath	ACM-15	1993	TN
146	TKM-10	CO-31 × C-22	IET-12270	1993	TN
147	Kanchana	Jajati × Mehsuri	IET-10016	1993	OD
148	Sudhir	FR 13A × CNM 539	IET-10543	1999	CVRC
149	Shanti	Ratna × IR 36	RP 2633-15-2-5	2001	AP
150	VTL-6	(Cheruvirittu × IR 4630-22-2-17) × Jaya		2005	KE
151	Tunga	(Pankaj × Mahsuri) × TKM 6	IET- 13901	2006	KA
152	Barani Deep	(C 1064-5 × IR 9129-320-3-3-3)×IR 54	NDR 1025-2	2006	UP
153	Shusk Samrat	(C 1064-5×Kalakeri)× IR 54	NDR 1045-2	2006	CVRC
154	Shivam	CR 314-5-10 (Open Florat mutant) natural cross	RR-272- 829	2006	CVRC
155	Dhanya	Jaya × Ptb - 4		2006	KE

S. No.	Variety	Parents	Designation	Released year	Released state
156	Karma Mahsuri	Mahsuri × R 296-260		2008	CH
157	KKL (R)-1	CR 1009 × ADT 39		2008	TN
158	Chinsurah Rice	Pankaj × CR 146-7027-224	CNI 383-511	2010	CVRC
159	Bhavapuri Sannalu	BPT 5204 × CR 15 MR 1523		2010	AP
160	NDR 2065	(Pant Dhan-4 × Saket 4) × NDR 2018	IET 17476	2011	UP
161	ADT 49	BPT 5204 × CR 1009		2012	TN
162	ADT 30	IR 262 × ADT 27		1974	TN
163	Birupa	(ADT 27 × IR 8) × Annapurna	OR 253-2	1992	OD
164	Karikalan	TN(1) × ADT 27	C 5652	1972	TN
165	Karuna	IR 8 × ADT 27	CO 33	1971	TN
166	Pennai	TN 1 × ADT 27	ASD 14	1970	TN

Annexure-IV

Varieties with NRRI identified genotypes as grandparents

Sl. No.	Variety	Designation	Parents	Grandparents (NRRI genotype)	Released year	Released state
1	Chandrahasini	R979-1528-2-1	Abhaya / Phalguna	CR 157-392 / OR 57-21	2006	CH
2	CNRH 3		IR 62869 A / Ajaya R	IET 4141 / CR 98-7216	1995	WB
3	Bahadur Sub1	IET 25265		Pankaj / Mahsuri	2018	AS
4	Diyung (AAUDPU Dhan 06)	TTBDR 103-4-4	Malbhog/Bahadur	Pankaj / Mahsuri	2022	AS
5	CSR 56	IET 24537	CSR 21/ CSR 10	M 40-431-24-114 / Jaya	2019	UP & HA
6	Kharveli	OR 815-3	Daya / IR 13240-108-2-2-3	Kumar / CR 57-49	1998	OR
7	PKV Ganesh	SKL 3-11-25-30-36	Daya / SKL 6	Kumar / CR 57-49	2003	MH
8	Sebati	OR 776-SSD-26	Daya / IR 36	Kumar / CR 57-49	1998	OR
9	VL Dhan 65	VL 95-3400	Himalaya 2 / VL Dhan 16	Imp. Sabarmati / Ratna	2006	UT
10	Bhadrakali	WGL 3962	Phalguna / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1994	AP
11	Bhanja	OR 443-80-4	IR 36 // Hema / Vikram	IR1561-228-1-2 / IR1737 // CR 94-13	1992	OR
12	Bharani	NLR 30491	IR 36 / Sasyasree	IR1561-228-1-2 / IR1737 // CR 94-13	1997	AP
13	Bharathidasan	IR 13427-45-2 (PY 3)	IR 3403-267 / PTB 33 // IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1984	PY
14	Birsamati	BAU 320-95	IR 36 / BR 9	IR1561-228-1-2 / IR1737 // CR 94-13	2003	JH
15	Dhan Laxmi	RAU 1344-3-2	ES 1-2-3 / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	2000	BI
16	Giri	CN 846-30-3-1	IR 36 / Bhasmanik	IR1561-228-1-2 / IR1737 // CR 94-13	2002	WB
17	Gopinath	TTB 156-149-4-1	Pusa 2-21 / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1997	AS
18	Jawahar Rice 3-45	Rewa 3-45	IR 36 / Lohandi	IR1561-228-1-2 / IR1737 // CR 94-13	1997	CVRC
19	Kairaly	PTB 49	IR 36 / Jyothi	IR1561-228-1-2 / IR1737 // CR 94-13	1993	KE

Sl. No.	Variety	Designation	Parents	Grandparents (NRRI genotype)	Released year	Released state
20	Kanchana	PTB 50	IR 36 / Pavizham	IR1561-228-1-2 / IR1737 // CR 94-13	1992	KE
21	Karjat 1		Holamaldiga / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1985	MH
22	Karjat 3	KJT 72-1-173-44	IR 36 / Karjat 35-3	IR1561-228-1-2 / IR1737 // CR 94-13	1994	MH
23	Mahananda	CN 845-40-5	IR 36 / Patnai 23	IR1561-228-1-2 / IR1737 // CR 94-13	2000	WB
24	Malaviya dhan 2	HUR 3022	IR 36 / HR 137	IR1561-228-1-2 / IR1737 // CR 94-13	2004	UP
25	Naina	CSR 36	CSR 13 / Panvel 2 // IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	2005	CVRC
26	Narendra dhan 118		IR 36 / Hansraj A	IR1561-228-1-2 / IR1737 // CR 94-13	1987	UP
27	Narendra dhan 80		N 22 / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1986	UP
28	Penna	NLR 33365	NLR 9672 / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1997	AP
29	Prabhat	IR 9201-30-1-3-1-3	IR 2053-521-1-1-1 / IR2061-464-2-4-5 // IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1994	BI
30	Radhe	R 243-32231	IR 36 / IR 2053-521	IR1561-228-1-2 / IR1737 // CR 94-13	1990	MP
31	Raja Vadlu	RNR 99377	Rajendra / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1993	AP
32	Ratnagiri 3	RTN 121-1-1-1-1-1	CR 57-MR 1523 / IR 36 // RTN 68	IR1561-228-1-2 / IR1737 // CR 94-13	1994	MH
33	RP 2421	RP 2421-100-23-2	IR 36 / Kathawar	IR1561-228-1-2 / IR1737 // CR 94-13	1994	HP
34	Sebati	OR 776-SSD-26	Daya / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	1998	OD
35	Shanti	RP 2633-15-2-5	Ratna / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	2001	AP
36	SYE 4	SYE 499-32-8-11-8	IR 36 / SYE 75	IR1561-228-1-2 / IR1737 // CR 94-13	1996	MH
37	TRY (R) 2	RP 2597-14-250	IET 6238 / IR 36	IR1561-228-1-2 / IR1737 // CR 94-13	2001	TN
38	Kanak	CN 1272-55-105	Swarna/IR 36 // Mohan/Khitish	IR1561-228-1-2 / IR1737 // CR 94-13	2018	WB, BI, OD, MH, AP, KA

Sl. No.	Variety	Designation	Parents	Grandparents (NRRI genotype)	Released year	Released state
39	Rajendra Saraswati	RAU 1397-18-3-7-9-4-7	IR 36/ Type-3	IR1561-228-1-2 / IR1737 // CR 94-13	2020	BI
40	Malaviya Dhan 1	HUBR 2-1	HBR 92 / Pusa Basmati / Kasturi	Basmati 370 / CRR 88-17-1-5	2005	UP
41	Rajendra Kasturi		Kasturi / Sugandha	Basmati 370 / CRR 88-17-1-5	2004	BI
42	Karjat 9		Kasturi / IR 50	Basmati 370 / CRR 88-17-1-5	2016	MH
43	Jagtial Sannalu	JGL 1798	BPT 5204 / Kavya	WGL 27120 / WGL 17672 // Mahsuri / Surekha	2001	AP
44	Polasa prabha-Mahsuri	JGL 384	Samba Mahsuri / Kavya	WGL 27120 / WGL 17672 // Mahsuri / Surekha	1998	AP
45	Siddhi	WGL-44	BPT 5204 / ARC 5984 // Kavya /// Kavya / BPT 5204	WGL 27120 / WGL 17672 // Mahsuri / Surekha	2013	AP
46	Somanath	WGL-347	NLR-145/ Kavya	WGL 27120 / WGL 17672 // Mahsuri / Surekha	2016	MN
47	Telangana Vari 1		RP 4516-3-6/Kavya	WGL 27120 / WGL 17672 // Mahsuri / Surekha	2020	OD, WB, TN
48	Gitesh	TTB 283-1-26	Akisali x Kushal	Pankaj / Mahsuri	2018	AS
49	IET 15376	Madhuri Sel-9	Sel. From Madhuri	Jaya / R 11	2002	MP
50	Indira Sugandhit Dhan 1	IR 636-405	Madhuri / Surekha	Jaya / R 11	2003	CH
51	Uphar	OR 1234-12-1	Mahalaxmi / IR 62	Pankaj / Mahsuri	2005	OD
52	Numali	Numali	APMS 6B/Piolee	Pankaj / Mahsuri	2020	AS
53	PR 116	PAU 2020-10-3-1	PR 108 / PAU 1628 // PR 108	Vijaya / PTB 21	2000	PU
54	ADT 32		IR 20 / Pusa 33	Sabarmati / Ratna	1978	TN
55	GR 6	NGM 1-26-1	GR 3 / Pusa 33	Sabarmati / Ratna	1991	GU
56	HKR 46	HKR 46	RP 6-516-316 / Pusa 33	Sabarmati / Ratna	1999	HA
57	NEH Megha Rice 1	NEH 116-45-1	Pusa 33 / Khonorulu	Sabarmati / Ratna	1992	ME
58	NEH Megha Rice 2	NEH 116-55-1	Khonorulu / Pusa 33	Sabarmati / Ratna	1992	ME
59	Pawana	Pawana	Pusa 33 / IR 8	Sabarmati / Ratna	1988	MH

Sl. No.	Variety	Designation	Parents	Grandparents (NRRI genotype)	Released year	Released state
60	Richharia	PSR 1345-1	IET 7564 / Pusa 33	Sabarmati / Ratna	2000	BI
61	Polasa prabha-Mahsuri	JGL 384	Samba Mahsuri / Kavya	GEB 24 / TN1 // Mahsuri	1998	AP
62	Sri druthi	MTU 1121	Samba Mahsuri/ MTU BB 8-24-1	GEB 24 / TN1 // Mahsuri	2016	AP
63	Sasya	BPT 2411	Samba Mahsuri/Surya	GEB 24 / TN1 // Mahsuri	2020	AP
64	Surya	BPT 4358	Sona Mahsuri / ARC 6650	Sona / Mahsuri	2000	AP
65	Chaitanya	MTU 2067	Sowbhagya / ARC 5984	Mahsuri / Vijaya	1988	AP
66	Deepti	MTU 4870	Sowbhagya / ARC 6650	Mahsuri / Vijaya	2000	AP
67	Krishnaveni	MTU 2077	Sowbhagya / ARC 5984	Mahsuri / Vijaya	1989	AP
68	Nandi	MTU 5182	Sowbhagya / ARC 6650	Mahsuri / Vijaya	1991	AP
69	Pratibha	MTU 5293	Sowbhagya / ARC 6650	Mahsuri / Vijaya	1986	AP
70	CR Dhan 313	CR 3511-3-2-2-5-1-1	IR 36/Surendra	OR 158-5 / Rasi	2020	MH & CH
71	Pratikshya	OR S 201-5	Swarna / IR 64	Vasistha / Mahsuri	2005	OD
72	Indira Aerobic -1:	R 1570-2649-1-1546-1	Swarna/ IR 42253	Vasistha / Mahsuri	2014	CVRC
73	TKM 13	TM 07275	WGL 32100/ Swarna	Vasistha / Mahsuri	2015	TN
74	TM 07278	TM07278	WGL 32100/Swarna	Vasistha / Mahsuri	2017	BI & OD
75	Kanak	CN 1272-55-105	Swarna/IR 36 // Mohan/Khitish	Vasistha / Mahsuri	2018	WB, BI, OD, MH, AP, KA
76	Telangana Vari 8 (WGL-1487)	RP 6317-S35-BC_2F_4-49-25-6-21	MTU 1121*1/Swarna	Vasistha / Mahsuri	2022	AP & TS
77	DRR Dhan 66	RP 5973-13-1-6-67-01-12-1957	MTU 1010*2/Swarna	Vasistha / Mahsuri	2022	AP & TS
78	ADT 52		CR 1009/ ADT 49	BPT 5204/ CR 1009	2019	CH & MH

Annexure-V

Genotypes registered with NBPGR as unique genotype accessions

Sl. No.	Name of Germplasm	Year of Registration	Registration No.	Important Trait	Name of Contributors
1.	Khoda (PD -27)	2004	INGR No.04001	Tolerance to complete submergence	B C Patra & Ramani Kumar Sankar
2.	T-1471 (Kodiyan)	2005	INGR No.05001	Tolerance to anaerobic seeding	B C Patra & Ramani Kumar Sankar
3.	Khadara (PD33)	2008	INGR No.08108	Tolerance to complete submergence	B C Patra, R K Sarkar
4.	Atiranga (RM5/232)	2008	INGR No.08109	Tolerance to complete submergence	Sasank Sekhar Chyaupatnaik, B C Marndi, P Swain
5.	Kalaputia (PCP-01)	2008	INGR No.08110	Tolerance to complete submergence	Sasank Sekhar Chyaupatnaik, B C Marndi, P Swain
6.	Gangasiuli (PB-265)	2008	INGR No.08111	Tolerance to complete submergence	Sasank Sekhar Chyaupatnaik, B C Marndi, P Swain
7.	Kusuma (PD-75)	2008	INGR No.08113	Tolerance to complete submergence	Sasank Sekhar Chyaupatnaik, B C Marndi, P Swain
8.	Mahulata (PB-294)	2008	INGR No.08112	Tolerance to Vegetative stage drought	Sasank Sekhar Chyaupatnaik, B C Marndi, P Swain
9.	Medinapore (RM5/AK-225; IC-0258990)	2010	INGR No.10147	Tolerance to complete submergence	Crri, Cuttack
10.	Andekarma (JBS-420; IC-0256801)	2010	INGR No.10148	Tolerance to complete submergence	Crri, Cuttack
11.	Champakali	2010	INGR No.10149	Tolerance to complete submergence	Crri, Cuttack
12.	Brahman Nakhi (DPS-3)	2010	INGR No.10150	Tolerance to Vegetative stage drought stress	Crri, Cuttack
13.	Sal Kaiin (PB-78; IC-0256590)	2010	INGR No.10151	Tolerance to Vegetative stage drought stress	Crri, Cuttack

Sl. No.	Name of Germplasm	Year of Registration	Registration No.	Important Trait	Name of Contributors
14.	Bhundi (JRS-9; IC0575277; AC42091)	2014	INGR No.14025	Tolerance to complete Submergence and having shoot elongation ability	R K Sarkar, Devendra Pratap Singh, Bijaya Bhattacharjee, B C Patra, B C Marndi
15.	Kalaketki (JRS-4; IC0575273; AC42087)	2014	INGR No.14026	Tolerance to 20 days complete submergence	R K Sarkar, Devendra Pratap Singh, Bijaya Bhattacharjee, B C Patra, B C Marndi
16.	CR 143-2-2 (IC0513420)	2017	INGR No.17019	Tolerance to both vegetative and reproductive stage drought stress	P Swain, On Singh, Mj Baig, N P Mandal
17.	Salkathi (AC-35181; PB-289)	2018	INGR No.17069	Resistance to brown plant hopper (BPH)	Mayabini Jena, B C Patra, B C Marndi, D R Pani, Rabindra Kumar Sahu
18.	Cherayi Pokkali (AC 39416A; IC0413644)	2019	INGR No.19004	Combined stress of drought and salinity	R K Sarkar, Koushik Chakraborty, K Chattopadhyay, B C Marndi, B C Patra
19.	Khora-1(AC 41620; IC0574806)	2019	INGR No.19006	Anaerobic Germination	R K Sarkar, Koushik Chakraborty, K Chattopadhyay, B C Patra
20.	Dhobanumberi (IC 0256804)	2019	INGR No.19005	Resistant to BPH	Mayabini Jena, R K Sahu, B C Patra , B C Marndi, Trilochan Mohapatra
21.	Kamini (AC 44118; IC 599610)	2019	INGR No.19033	Tolerant to salinity stress	R K Sarkar, Koushik Chakraborty, K Chattopadhyay, B C Marndi
22.	Talmugur (AC 43228; IC 0596460)	2019	INGR No.19034	Tolerant to salinity stress at vegetative stage	K Chattopadhyay, B C Marndi, A K Nayak, M J Maitra, Koushik Chakraborty
23.	Chettivirippu (AC39394; IC 0599610)	2019	INGR No.19035	Tolerant to salinity stress both at vegetative and reproductive stage	K Chattopadhyay, B C Marndi, Koushik Chakraborty, B C Patra, R K Sarkar
24.	*IC 121865	2019	INGR No.19037	Resistant to blast disease	Ruchi Bansal, Nk Goutam, Lv Subharao, M Srinivas Prasad, H Rajshekara, B C Patra, M Variar, A Ramanathan, Kalyani Srinivasan, Vimla Devis., Jc Rana, Ashok Kumar

Sl. No.	Name of Germplasm	Year of Registration	Registration No.	Important Trait	Name of Contributors
25.	*IC 199562	2019	INGR No.19038	Resistant to blast disease	Ruchi Bansal, Nk Goutam, Lv Subharao, M Srinivas Prasad, H Rajshekara, B C Patra, M Variar, A Ramanathan, Kalyani Srinivasan, Vimala Devi S., Jc Rana, Ashok Kumar
26.	AC 42997 (IC0576152)	2021	INGR No. 21002	Vegetative stage drought tolerance, prolific roots. High water use efficiency	P Swain, Mj Baig, Goutam Kumar Dash, B C Patra, Madhusmita Barik, Ruchi Bansal
27.	Wild rice: *Oryza nivara* (IC330611)	2021	INGR No. 21003	Vegetative stage drought tolerance, prolific roots. High water use efficiency	B C Patra, P Swain, B C Marndi, L K Bose, Gak Kumar, Ruchi Bansal
28.	Wild rice: *Oryza nivara* (IC330470)	2021	INGR No. 21004	Vegetative stage drought tolerance.	B C Patra, P Swain, B C Marndi, M J Baig, L K Bose, S R Dhua, Gak Kumar, Ruchi Bansal
29.	Dubaraj (IC301206)	2021	INGR No. 21005	Very high 1000-grain weight. Long grain rice (LGR).	B C Patra, Kalyani Srinivasan, Vimala Devi S, T Mohapatra, A K Tyagi, J Thakur
30.	ARC 10075 (Minatik Charang) (IC 0597237)	2021	INGR No. 21092	High protein content rice	Torit Baran Bagchi, K Chattopadhyay, B C Marndi, Awadhesh Kumar, L K Bose, P Swain, B C Patra, Sg Sharma, Ruchi Bansal
31.	CRR747-12-3-B (IET26337)	2021	INGR No. 21114	Highly drought tolerant elite line. Resistant to blast disease	N P Mandal, Somnath Ray, Amrita Banarjee
32.	Rahaspunjar (IC-575321; AC 42138)	2021	INGR No. 21116	Tolerant to salinity stress. Tolerant to stagnant flooding (both fresh and saline water). Has high anaerobic germination potential	Koushik Chakraborty, K Chattopadhyay, B C Patra, B C Marndi, P Swain, R K Sarkar
33.	Remeni Pokkali (AC 41585)	2021	INGR No. 21117	Tolerant to salinity at vegetative stage (12 dS m1). Tolerant to salinity at reproductive stage (8 dS m-1).	Koushik Chakraborti, K Chattopadhyay, B C Patra, B C Marndi, P Swain

Sl. No.	Name of Germplasm	Year of Registration	Registration No.	Important Trait	Name of Contributors
34.	CRR 363-36 (IET 19251)	2021	INGR No. 21177	Aromatic early maturing rice eliteline for rainfed uplands	N P Mandal, Somnath Ray, Amrita Banerjee
35.	Kalakeri	2021	INGR No. 21179	A rice landrace with tolerance to Drought and other abiotic stresses	N P Mandal, Somnath Ray, Amrita Banerjee, P Swain, B C Patra
36.	RR 433-2-1 (IET 19252)	2021	INGR No.21178	A drought tolerant high yielding elite line for rainfed direct seeded upland conditions	N P Mandal, Somnath Ray, Amrita Banerjee
37.	Dular	2022	INGR No. 22107	A rice cultivar with tolerance to multiple abiotic stresses	Somnath Ray, Koushik Chakraborty, N P Mandal, Amrita Banerjee, P Swain, Priyamedha, B C Patra
38.	AC43037 (Gurum)	2022	INGR No.22110	Multiple Abiotic Stress (Drought, Salinity, Submergence & Anaerobic Germination) Tolerant Rice Germplasm with low stomatal density	P Swain, Koushik Chakraborty, Mj Baig, Goutam Kumar Dash, Madhusmita Barik, Akhil Kumar Debata, B C Patra
39.	AC43012 (Chariesid)	2022	INGR No.22108	Drought Tolerant Rice Germplasm with low transpiration and high WUE	P Swain, Koushik Chakraborty, Mj Baig, Goutam Kumar Dash, Madhusmita Barik, Akhil Kumar Debata, B C Patra
40.	AC43025 (Dudha Charisda)	2022	INGR No.22109	Multiple Abiotic Stress (Drought, Salinity, Submergence & Anaerobic Germination) Tolerant Rice Germplasm	P Swain, Koushik Chakraborty, Mj Baig, Goutam Kumar Dash, Madhusmita Barik, Akhil Kumar Debata, B C Patra
41.	Black Gora (IC0640862)	2023	INGR No.23004	Tolerant to submergence with high anaerobic germination potential.	Somnath Ray, Koushik Chakraboty, N P Mandal, Amrita Banerjee, Priyamedha, B C Verma, B C Patra

Annexure-VI

Varieties with NBPGR registered genoytpe by NRRI as parents

S. No.	Variety	Parents	Designation	Released year	Released state
1.	Sneha	Annada × CR 143-2-2	CR 19-2	1991	Odisha
2.	Vyttila 4	Chettivirippu × IR 4630-22-2-17	KAU 906	1991	Kerala
3.	CR Dhan 310	ARC10075(HP-2) × Naveen	CR 2829-PLN-37	2022	Assam
4.	CR Dhan 311	ARC10075(HP-2) × Naveen	CR 2829-PLN-100	2022	Assam
5.	Vandana	C 22 × Kalakeri	RR 167-982	2002	Odisha
6.	Birsadhan 106	(Bala × Black Gora) × (OS 6 × CH.1039)	BAU 149-134	1995	Jharkhand
7.	Gopinath (CR Dhan 206)	Brahmana nakhi × NDR 9930077	CR 2996-1-14-29-3-1	2014	Odisha

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