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**ICAR-NATIONAL RICE RESEARCH INSTITUTE**

Cuttack-753006, Odisha, India



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Rice remains the staple food for millions across India, and its cultivation faces ever-increasing challenges due to changing climatic conditions, emerging pests, and diseases. Among the many varieties cultivated, the Swarna variety stands out for its stability in yield performance, tolerance to various biotic stresses and its remarkable ability to recover under stress conditions. However, Swarna's susceptibility to new emerging pests, flooding, intermittent drought and lodging to certain environment has highlighted the need for developing new varieties that not only retain its desirable traits but also offer enhanced resilience against these stresses.

In this context, the concept of “mega varieties” has gained prominence. Mega varieties, like Swarna, are those that are widely adopted across large areas due to their adaptability, yield stability, and farmer-preferred traits. These varieties have played a critical role in sustaining rice production and ensuring food security. However, as the agricultural landscape evolves, there is a pressing need to develop new mega varieties that incorporate the beneficial traits of Swarna while addressing its limitations.

This bulletin presents the latest advancements made by the ICAR-National Rice Research Institute (ICAR-NRRI) in developing Swarna-traits varieties. These varieties have been bred with a focus on resistance to major biotic and abiotic stresses. These traits are crucial for survival in flood-prone areas and during periods of intermittent drought. Hopefully these new varieties can continue the legacy of Swarna as the next generation of mega varieties.

The varieties highlighted in this publication represent the culmination of years of rigorous research and breeding efforts. They are designed to meet the needs of farmers in regions where Swarna is traditionally grown, offering improved resistance to environmental stresses while maintaining high grain quality. These developments are not only a testament to the scientific innovation at ICAR-NRRI but also a strategic response to the evolving challenges faced by rice farmers.

This bulletin serves as a valuable resource for researchers, agronomists, extension workers, and farmers, providing insights into the future of rice cultivation in India. By focusing on the development of new mega varieties with Swarna-traits, ICAR-NRRI is helping to ensure that rice production remains sustainable and resilient in the face of climate change, continuing to secure the livelihoods of millions and contribute to the nation's food security.

Authors

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## 1. Introduction

Rice holds a key position as a staple food crop, serving as major crop of global food security and nutrition. Approximately, half of the rice-growing areas in India are rainfed ecologies, predominantly situated in the eastern regions. These regions face formidable challenges posed by abiotic stress such as submergence, drought and salinity along with a plethora of biotic stresses such as pests and diseases. Indeed, it is a cause of concern that these stresses are not only persisting but also intensifying in severity, largely due to the impending impact of climate change. It is imperative to develop varieties which withstand in field under single and multiple stress condition and ensuring optimal production.

Thousands of rice varieties being cultivated throughout the country consisting of notified varieties, farmers' varieties and landraces. However, few varieties secured a prime position among the farmers varietal preference list. There are few varieties widely cultivated in the country and termed as mega varieties viz., Swarna, IR 64, MTU 1010, etc. These varieties are cultivated in many parts of the country and have higher adaptability to different environments. It is also a fact that these varieties are much popular not only among farmers but also by the industries including consumers, and exporters. This widespread demand could be attributed to its adaptability to diverse situation, morphological features, favourable grain quality, high head rice recovery etc. making them more preferential varieties among the consumers.

However, growing a single variety for a long period may have certain issues. Some of the potential problems associated with prolonged cultivation of a single variety include:

- **Resistance breakdown:** If a single variety is cultivated extensively, pests and diseases may adapt to it over time, leading to breaking down of resistance and increased susceptibility.
- **Loss in genetic purity:** Over time, through natural or human-induced processes, the genetic makeup of the variety may change. This can result in a loss of the desired traits and characteristics for which variety is famous.
- **Seed quality deterioration:** It occurs when the genetic purity of seed deteriorates due to several factors during the production cycles. Such seed has low genetic purity, decreased crop yields, reduced germination rates, poor seedling establishment, increase the chances of crop failure. Farmers may experience lower production levels, leading to financial losses and food insecurity. To avoid such issue the Government of India has established a regulation for restricting the utilization of rice varieties that have been released 10 years earlier. The variety released in last 10 years is only consider under seed chain for indenting and commercial cultivation.

To address such issues, several measures are being followed. One of the important strategies is the development of new rice varieties with desirable or similar traits are often recommended. There are some new varieties developed in the background of mega varieties with same traits along with additional climate resilient traits. Developing a rice variety with a target of making it a mega variety involves a systematic breeding approach that considers the traits specific characteristics of mega varieties and adaptation to the target environment. Several rice varieties have been developed in the background of mega varieties using molecular breeding through effective collaboration among breeders,



interdisciplinary scientists, and farmers. Besides, high-yielding rice varieties have been also developed through conventional breeding with the traits of mega varieties, having higher yield potential, along with resistance to abiotic and biotic stress. This bulletin discusses about the mega varieties and the traits of Swarna along with the varieties possessing similar traits.

## 2. Concept of Mega variety

The concept of “mega varieties” in rice refers to rice varieties that have a significant impact on rice production due to their superior performance such as yield, disease resistance, and adaptability to diverse environments. These varieties are typically characterized by their wide adoption across large areas and their ability to meet the demands of consumers. A variety cultivated in 1-million-hectare area are generally considered as Mega variety. There are no such citation on it, but upon discussion with different stakeholders, the following criteria could be considered as the key characteristics of mega varieties:

- 1. High Yield Potential:** Varieties offer a higher yield compared to traditional or other modern varieties. More importantly, these varieties endowed with higher yield stability across the diverse environments.
- 2. Fertilizer responsive:** Mega varieties have higher nutrient use efficiency either to single or multiple nutrients.
- 3. Resistance/tolerance to biotic and abiotic stress:** Mega varieties possess multiple stress tolerance for biotic and abiotic stresses.
- 4. Superior Quality:** Varieties with improved grain quality such as head rice recovery, better taste, texture, and cooking properties, which are important for both domestic consumption and export.
- 5. Farmers Acceptance:** They are widely accepted and preferred by farmers due to consistent performance, maturity duration, appearance of the husk, grain etc.

### 3. 'Swarna' a Mega variety

Swarna, a mega rice variety has developed at the Regional Agricultural Research Station (RARS), Maruteru, Acharya N G Ranga Agricultural University, Guntur, Andhra Pradesh. Swarna an *indica* variety, developed using the pedigree breeding method. The variety is derived from the cross between Vasista and Mahsuri and it is cultivated on nearly 5 million hectares worldwide (Merugumala et al., 2019). The plant is semi-dwarf, erect plant type, panicle type that is well exerted with a height of 90-110 cm, 250-260 panicles per square meter, dark green foliage and mature in 145-150 days. The variety is awnless with yellowish apiculus colour, and its test weight is 21.5 grams. The kernels are 5 mm in length and 2.46 mm in breadth. Swarna's white kernels exhibit hulling, milling, and head rice recovery percentages of 78%, 68%, and 65% respectively. The variety has an alkali spreading value of 4 and an amylose content of 24.5%. One of importance phenotypic marker in the variety is husk, which is golden colour. The grains shows very occasional chalkiness. The average grain yield of the variety is 5.5 t/ha. The variety is resistant to bacterial leaf blight (BLB). However, it has moderate lodging resistance, moderate early seedling vigour, moderate root architecture, and high nitrogen and phosphorus use efficiency. The variety has short bold grains and has intermediate amylose content. Farmers widely adopt this variety due to its high yielding capacity under low input management. The Swarna rice variety is usually grown in both rainfed and irrigated condition. The variety shows higher buffering capacity across variable environment (Mohapatra et al., 2021).

### 4. Key traits of the Swarna like mega variety

#### 1. Ecology

The variety thrives well in rainfed and irrigated conditions and adapted to various climatic conditions, soil types, and water availability of regions.

## **2. Plant height**

The plant height is between 90-100 cm. Semi-dwarf height offers better resistance to lodging, especially under high input conditions. However, in some regions, a slightly taller plant (up to 100 cm) might be preferred for better grain filling and to avoid submergence under shallow floods.

## **3. No. of panicles/m<sup>2</sup>**

A high tillering variety with 236-254 panicles/m<sup>2</sup> indicates vigorous growth and a dense plant canopy, which is essential for achieving high yields. The panicle number should be balanced to avoid excessive competition among tillers, which can reduce grain filling.

## **4. Flowering duration**

The variety flowers in 111-120 days and ideal for irrigated late maturity or shallow lowland condition. It is well suited for rainfed and irrigated late condition.

## **5. Panicle type**

The variety produces intermediate to semi-erect panicle types which provide a balance between grain yield and resistance to shattering. Semi-erect panicles are preferred in areas with heavy rain or wind during grain filling, as they are less prone to breakage.

## **6. Panicle exertion**

Well-exerted panicles ensure that the grains are fully exposed to sunlight, which is important for uniform grain filling and less susceptible to panicle diseases.

## **7. Apiculus colour**

A consistent yellowish husk and apiculus colour is desirable for uniformity and market acceptance. This trait is often linked with consumer preferences, as the appearance of the grain affects its market value.

## **8. Lodging resistance**

The variety shows moderate to low lodging resistance which prevents crop loss during adverse weather conditions like heavy rains or strong winds. Lodging

resistance is particularly important for maintaining yield and quality. Swarna is lodging resistant. , however recently in some areas of Andhra Pradesh it showed moderately to low lodging resistant.

### **9. Early seedling vigour**

The variety Swarna has moderate early seedling vigour. A high seedling vigour ensures quick establishment in the field, leading to better competition with weeds and higher overall plant health.

### **10. N use efficiency**

The variety is known for its moderate to high nitrogen use efficiency (NUE). It is responsive to low nitrogen condition and has dark green foliage. The variety is also used as tolerant check in Low Nitrogen Trial of AICRP on Rice. A yield of 3.5 t/ha and 4.1 t/ha was reported in a yield trial under 0% of nitrogen and 50% nitrogen doses, respectively in Advance Varietal Trial-1, Low nitrogen trial 2022.

### **11. P use efficiency**

The variety is known for its moderate to high phosphorus use efficiency, responsive to low phosphorus condition. Efficient use of phosphorus is critical for root development and overall plant health. The variety is also used as tolerant check in Low Phosphorus Trial of AICRP on Rice. A yield of 4.2 t/ha and 4.4 t/ha was recorded in a yield trial under 0% of phosphorus and 50% phosphorus doses respectively, in Advance Varietal Trial-1, Low Phosphorus Trial 2022.

### **12. test weight (g)**

Grain weight is a critical factor in determining yield and marketability. The variety showed an average grain weight of 19.0 - 21.0g. The grain is short bold grain type.

### **13. Grain yield (t/ha)**

The average grain yield of Swarna variety is 5-6 t/ha. The variety has stable yield performance across different environments.

### **14. Reaction to diseases and pests**

In areas where Swarna is grown, varieties should have tolerance to major pests

and diseases such as bacterial leaf blight (BLB) and brown plant hopper. The Swarna variety is moderately tolerant to many diseases and pests. Besides, it is tolerant to bacterial leaf blight.

### **15. Kernels**

The kernels are white with an average kernel length of 5.05 cm, breadth of 2.17 cm and length to breadth ratio of 2.32 is reported for this variety. The breadth should complement the length to achieve the preferred length-to-breadth ratio, which affects the grain's cooking quality and appearance.

### **16. Hulling recovery (%)**

A hulling recovery of 75-80% is observed in this variety reflects the efficiency of converting paddy into brown rice. Higher hulling recovery indicates less wastage during processing, which is economically beneficial for both farmers and millers.

### **17. Milling recovery (%)**

A milling recovery of 68-70% in this variety reflects the percentage of white rice obtained from brown rice. Higher milling recovery is preferred as it increases the amount of marketable rice.

### **18. Head rice recovery (%)**

A head rice recovery of 65-68% is observed in the variety which indicates the amount of unbroken rice after milling. Higher head rice recovery means better market quality and higher prices, as consumers prefer whole grains.

### **19. Alkali spreading value (ASV)**

ASV is an indicator of the cooking quality of rice. A moderate ASV of 4 in this variety ensures that the rice is neither too soft nor too hard when cooked, meeting the preferences of a wide range of consumers.

### **20. Amylose content (%)**

Amylose content of 23.5-24.5% in this variety showed a good balance between softness and non-sticky ness when cooked. Higher amylose content up to 24% results in firmer and non-sticky rice, which is preferred in many regions.

## 21. Husk colour

Golden husk colour in Swarna variety is one of the most important traits for acceptability. Husk colour can affect the market perception of rice.

## 22. Grain chalkiness

The grain chalkiness is very-occasional in this variety. Chalkiness affects the transparency and overall appearance of the rice grain. Chalky grains are often considered lower quality and can reduce market value.

# 5. Development of varieties with Swarna-traits

ICAR-NRRI, Cuttack has developed several rice varieties with Swarna traits. These varieties were either developed through trait improvement in Swarna background using marker assisted backcross breeding or through conventional hybridization of plant with diverse background. The derived breeding line with Swarna traits were selected.

## 5.1 Varieties developed in Swarna background

Five varieties were developed in Swarna background viz; Swarna *Sub1*, CR Dhan 800, CR Dhan 801, CR Dhan 802 and CR Dhan 411 (<https://icar-nrri.in/popular-nrri-varieties/>) incorporating additional agronomic traits while maintaining the desirable characteristics of the original Swarna variety. These varieties exhibit a high genome recovery of over 90%, to preserve the genetic integrity and core phenotypic traits of Swarna. As a result, these new lines retain phenotypic similarity to Swarna, including its high yield potential and preferential traits, while introducing enhancements such as submergence tolerance, improved disease resistance, drought tolerance and high grain protein. This strategic breeding approach maximizes the benefits of Swarna's genetic background while addressing specific agronomic challenges.

## Swarna Sub1 (IET 20266)

“Swarna-Sub1” is a flood-tolerant rice variety developed in the background of popular mega-variety “Swarna” (MTU 7029). The variety was jointly developed by ICAR- National Rice Research Institute, Cuttack and International Rice Research Institute, Phillipines. Swarna Sub1 is similar to most of the traits of Swarna including grain yield and grain quality. However, it has an added advantage - it can withstand full submergence for up to 2



**Field view of Swarna Sub1**

weeks, making it very well-suited for regions prone to flooding. One noticeable difference between Swarna and Swarna-Sub1 is the colour of the husk. Swarna has a golden husk colour, while Swarna-Sub1 has a white (straw) husk colour. This variety provides farmers an option to mitigate the challenges posed by flooding while maintaining the grain quality and yield they expect from Swarna. The variety was released in 2009 for Rainfed shallow lowland areas of Odisha. The variety was developed from the cross of Swarna\*3/ IR 49830-7-1-2-3 (IR 82809-237). It exhibits a semi-tall plant type with a height of 100 cm and produces 236 panicles per square meter. The flowering duration is 120 days, with

semi-erect panicles that are partly exerted to fully exerted. The variety is awnless with a yellowish apiculus. It has a test weight of 19.86 grams, a kernel length of 5.40 mm, and a breadth of 2.13 mm, resulting in a length-to-breadth ratio of 2.54. The kernels are white in appearance. Hulling recovery stands at 79%, milling recovery at 74%, and head rice recovery at 66%. The alkali spreading value (ASV) is 5.0 and the amylose content is 23.72%. It is a medium-short (MS) grain type with very occasional grain chalkiness and matures in 145 days. The grain yield ranges from 5.0 to 5.5 tons per hectare. This variety has tolerance to complete submergence for 15-17 days.

In Odisha, Swarna Sub1 showed a 4.20% higher number of panicles per square meter compared to Swarna. The variety Swarna Sub1 showed a kernel length of 1.50% longer, 3.67% higher L/B ratio, 4.76% higher head rice recovery, and 15.27% superior grain yield over Swarna variety.



## CR Dhan 800 (IET 20672)

Bacterial blight caused by *Xanthomonas oryzae* is a serious constraint for rice production in the rainfed and irrigated environments. In absence of proper chemical control, growing resistant varieties is the only option available to the farmers of these rice growing ecologies. The variety CR Dhan 800 (CRMAS 2232-85, IET 20672) was developed from the cross between Swarna x IRBB 60 (a near isogenic line in the background of IR 24 carrying three important bacterial blight resistance genes,



**Field view of Swarna Sub1**

*xa5*, *xa13* and *Xa21*). The variety was developed at ICAR- National Rice Research Institute, Cuttack to make Swarna resistance to bacterial blight disease. CR Dhan 800 carries all the three important bacterial blight resistance genes, *xa5*, *xa13* and *Xa21* together. In essence, this breeding strategy offers a promising and effective solution for tackling bacterial blight in rice by incorporating multiple resistance genes into one variety, providing a broader and more durable defence against

this destructive disease. The variety was released in the year 2016 for states of Gujarat, Maharashtra, and recommended for cultivation in the states of Gujarat and Maharashtra, for shallow lowland ecologies. The plant height is 85-90 cm, and produce 308 panicles per square meter, with intermediate panicles. The panicle is well exerted. The variety is awnless, with a yellowish apiculus colour. The kernels length is 5.30 mm long and 2.06 mm wide, giving it a length-to-breadth ratio of 2.57. The grains have a white appearance, and with hulling recovery of 77.8%, milling recovery of 69.9%, and head-rice recovery of 66.7%. The variety has a flowering duration of 113 days and matures in about 140-145 days. It produces a thousand grains that weigh of 20.0 grams. The alkali spreading value (ASV) is 4.5, indicating a moderately soft gel consistency, while the amylose content is 22.68%. Grain chalkiness is observed only very occasionally. CR Dhan 800 yields approximately 5.7 tons per hectare under normal conditions and shows moderate resistance to diseases such as Bacterial Leaf Blight and Sheath Blight, making it a good choice for farmers (Pradhan et al., 2021).

CR Dhan 800 produced 7.32% more panicles per square meter, 0.38% longer kernel length, with a 5.99% narrow kernel breadth, resulting in a 5.33% higher L/B ratio than Swarna variety. The variety also showed a higher milling recovery of 2.04%, head rice recovery of 5.04%, and grain yield of 14.11% higher than the variety Swarna. CR Dhan 800 also demonstrates better nitrogen use efficiency than Swarna.

## CR Dhan 801 (IET 25667)

CR Dhan 801 variety has both submergence and drought tolerance ability. The variety was developed in the background of mega rice variety 'Swarna'. Globally this variety is unique and developed first time in rice research. The varieties contain *Sub1* gene for submergence tolerance and QTLs for yield under drought viz., *qDTY1.1*, *qDTY2.1* and *qDTY3.1*. The drought QTLs were stacked in the background of Swarna *Sub1* using marker-assisted backcross breeding. Genome recovery of recipient parent was more than 95%. The variety was developed from the cross of IR81896-B-B-195/2\* Swarna *Sub1* // IR91659-54-35.



**Field view of CR Dhan 801**

The rice variety CR Dhan 801 (IET 25667) is released for cultivation in multiple states, including Odisha, West Bengal, Uttar Pradesh, Andhra Pradesh, and Telangana in 2019. It thrives well in shallow lowland ecologies and is classified as a semi-dwarf variety, with plant height of about 100 cm, with a flowering duration of 115 days, and matures in 140-145 days.

This variety produces 285 panicles per square meter, with intermediate, well-exerted panicles. The grains are white, awnless and have a yellowish apiculus. The kernels measure 5.15 mm in length and 2.22 mm in breadth, resulting in a length-to-breadth ratio of 2.31. The variety showed a hulling recovery of 79.6%, milling recovery of 69.9%, and head-rice recovery of 66.2%. The variety has an alkali spreading value (ASV) of 4.0, indicating a moderately soft gel consistency, and an amylose content of 25.13%. The grain type is short bold (SB) type and grain chalkiness is observed very occasionally. It produces a thousand grains weighing 20.80 grams. This variety is particularly suitable for submergence and drought-prone areas, yielding about 4.0 tons per hectare under submergence conditions and 2.9 tons per hectare under drought conditions. Additionally, it exhibits resistance to major pests such as stem borer (both dead heart and white ear heads), leaf folder insect pests, and case worm, making it a resilient choice for challenging environments (Pradhan *et al.*, 2021).

In AICRP on Rice the CR Dhan 801 was tested against Swarna Sub 1 (which is an improved submergence tolerance variety in the Swarna background). Compared to Swarna Sub1 variety, the variety CR Dhan 801 produced 7.52% longer kernel length, with a 5.71% increase in kernel breadth, leading to a 1.32% higher L/B ratio. CR Dhan 801 also showed a 2.71% higher hulling recovery, 5.75% improvement in milling recovery, and 20.18% superiority in head rice recovery compared to Swarn Sub1. The variety CR Dhan 801 showed a grain yield of 6.64% higher under normal conditions, 14.73% higher under submergence stress conditions, 59.04% higher drought condition and 11.44% higher under moderate drought stress condition as compared to Swarna Sub1.

## CR Dhan 802 (IET 25673, Subhas)

CR Dhan 802 was bred with the combination of submergence and drought tolerance ability and it is highly resilient to adverse environmental conditions. This variety has *Sub1* gene, which provide submergence tolerance ability up to 15-17 days. The variety was also introgressed with QTLs for yield under drought (QTLs: *qDTY1.1* and *qDTY2.1*). These traits were introgressed into the genetic background of the Swarna variety using marker-assisted backcross breeding, ensuring that over



**Field view of CR Dhan 802**

95% of the recipient parent's genome was retained. CR Dhan 802 exhibits weak photosensitivity. This variety shares similarities with the recipient parent Swarna in terms of hulling, milling, head rice recovery, and other grain quality parameters. The variety was developed from the cross of Swarna-*Sub1*\*4 / IR81896-B-B-195.

The rice variety CR Dhan 802 (IET 25673, Subhas) is recommended for cultivation in Madhya Pradesh and Bihar, particularly for rainfed shallow lowland ecologies.

This semi-dwarf variety grows to a height of 100 cm and produces 287 panicles per square meter. The panicles are of an intermediate type and are well exerted. The variety is awnless, with a yellowish apiculus colour. The kernels are white, measure 5.0 mm in length and 2.16 mm in breadth, giving them a length-to-breadth ratio of 2.31. CR Dhan 802 exhibits strong processing characteristics, with a hulling recovery rate of 77.85%, milling recovery of 70.20%, and head-rice recovery of 64.25%. The alkali spreading value (ASV) is 4.5, indicating a moderately soft gel consistency, while the amylose content is 25.0%, placing it in the short bold (SB) grain type category. Grain chalkiness is very occasionally observed. This variety has a flowering duration of 108 days and matures in approximately 140 days. The thousand-grain weight is 19.0 grams. CR Dhan 802 is particularly well-suited for challenging environments, showing excellent submergence and drought tolerance ability. It yields up to 6.5 tons per hectare under normal conditions, 4.3 tons per hectare under submergence, and 2.3 tons per hectare under drought conditions. Additionally, it is resistant to several pests, including stem borer (both dead heart and white ear heads), leaf folder, plant hopper, and case worm, and it shows moderate resistance to bacterial blight, sheath rot, and rice tungro virus also (Pradhan *et al.*, 2021).

The variety CR Dhan 802 was tested against Swarna Sub1 (Which is an improved submergence tolerance variety in the Swarna background) under the AICRP on Rice. CR Dhan 802 showed a kernel length of 8.47% longer, with a 10.77% wider kernel breadth, resulting in a 2.94% lower L/B ratio compared to Swarna Sub1. The variety exhibits a 1.17% higher hulling recovery, 5.82% improvement in milling recovery, and 10.96% superiority in head rice recovery over Swarna Sub1. The grain yield was higher in CR Dhan 802 by 3.06% under submergence stress conditions, 8.21% under normal condition, 27.38% under drought stress conditions, and 14.31% under moderate drought conditions over Swarna Sub1.

## CR Dhan 411 (IET 26398, Swarnanjali)

This high-protein rice variety CR Dhan 411 (IET 26398, CR2830-PLS-17) was developed in the background of the popular rice variety Swarna. It demonstrated high protein of greater than 10% in polished grain, making it nutritionally superior. Additionally, the variety exhibits favourable agronomic features and grain quality, making it an attractive choice for growers and consumers alike. This biofortified High-Protein Swarna (CR Dhan 411) variety has the potential to address malnutrition, particularly among malnourished children. The variety was developed from the cross of Swarna x ARC-10075.



**Field view of CR Dhan 411**

The rice variety CR Dhan 411 (IET 26398, Swarnanjali) is developed for cultivation in Odisha, particularly in shallow lowland ecologies. This semi-dwarf variety has a plant height of 102 cm and produces 283 panicles per square meter. The variety flower in 108 days and matures in about 148 days. The variety is awnless, with a

yellowish apiculus color. The kernels are white, measuring 5.01 mm in length and 2.12 mm in breadth, resulting in a length-to-breadth ratio of 2.36. CR Dhan 411 demonstrates good processing qualities, with a hulling recovery of 77.8%, milling recovery of 66.8%, and head-rice recovery of 55.3%. The alkali spreading value (ASV) is 4.0, indicating a moderately soft gel consistency, while the amylose content is 25.9%. The grain type is short bold (SB) type and very occasionally chalkiness is observed. It has a grain yield of 5.6 tons per hectare. The variety also showed moderate tolerance to leaf blast, neck blast, brown spot, rice tungro disease, and bacterial leaf blight, along with moderate resistance to stem borer.

CR Dhan 411 demonstrated a 2.63% higher grain protein content and 15.65% increase in single-grain protein content compared to Swarna. Despite an at-par grain yield, CR Dhan 411 shows a significant 21.76% superiority in protein yield over Swarna under multi-year testing.



## 5.2 Varieties with Swarna traits in other background

Rice breeding programs often focus on developing varieties with improved traits such as disease resistance, yield potential, and environmental adaptability by selecting parents with diverse genetic background. However, finding a Swarna traits in the varieties have rarely been successful. Efforts were made to develop rice varieties using different genetic backgrounds with Swarna traits. These varieties are crucial for maintaining genetic diversity, which is essential for breeding programs to cope with challenges such as climate change, evolving pests and diseases. Breeders use different parental lines with Swarna trait to develop new varieties that can outperform existing ones in specific environments or under certain stress conditions. Varieties developed from genetic backgrounds other than Swarna, typically exhibit some Swarna traits and some additional traits, making them suitable for diverse agro-ecological zones and farming systems. The development of such varieties is essential for diversifying options for farmers, reducing risk, enhancing production and ensuring food security in those regions where Swarna variety is popular. Some of the varieties are CR Dhan 322, CR Dhan 328, and CR Dhan 331 (<https://icar-nrri.in/popular-nrri-varieties>). The varieties were selected based on their close similarity to the original Swarna in terms of maturity duration, agronomic traits, and grain quality. Additionally, these varieties demonstrated superior performance in grain yield and resistance to pests and diseases. This selection process ensures that the new lines not only meet the agronomic and quality standards of Swarna, but also offer improved resilience and productivity.

## CR Dhan 322 (IET 28544)

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CR Dhan 322 was developed from the cross of IR-73930-31-3-2-2 and Pratikshya. Pratikshya is a variety derived from the cross of Swarna and IR 64 (DRD report, 2024). The variety is released for cultivation in 2022 for Maharashtra and Chhattisgarh. This variety is a semi-dwarf plant type with an average plant height of 100 cm. The plant produces 254 panicles per square meter. The panicles are moderately compact and well-exserted, awnless, straw colour apiculus and matures in 135-140



**Field view of CR Dhan 322**

days. Kernels are white, measuring 6.26 mm in length and 2.03 mm in breadth, with a length-to-breadth ratio of 3.11, indicating a long and slender grain type. The test weight is 19.51 grams. The variety exhibits excellent processing qualities, with a hulling recovery of 79.4%, milling recovery of 69.8%, and head-rice recovery of 67.3%. The alkali spreading value is 3.75, and the amylose content is 24.67%, making it a desirable choice for both yield and quality in rice production. The

variety showed a yield of 6.5 tons per hectare in Chhattisgarh which is 19.6% superior over Swarna and 6.0 ton per hectare in Maharashtra which is 15.4 % superior over Swarna, in the Advance Varietal Trial 1- Late, during Kharif 2021. It showed moderately resistant to stem borer (dead heart), leaf folder and grain discoloration whereas, moderately susceptible to leaf blast and neck blast under insect and disease screening nursery.

Under AICRP on Rice, in the state of Chhattisgarh, CR Dhan 322 showed 36.56% more panicles per square meter compared to Swarna. Although, the test weight was at par, CR Dhan 322 has a 20.38% longer kernel length and an 8.14% narrower kernel breadth, resulting in a 32.34% higher L/B ratio. Hulling recovery was 1.02% higher, milling recovery was 0.43% higher, and head-rice recovery showed 4.18% improvement over Swarna. Grain yield was 4.69% higher in CR Dhan 322, although Swarna showed better nitrogen use efficiency. In Maharashtra, CR Dhan 322 showed 4.69% lower number of panicles per square meter compared to Swarna, but it exhibits a 9.52% higher test weight. The kernel length was 22.75% longer, while the kernel breadth remains at par compared to Swarna. CR Dhan 322 showed 6.20% higher hulling recovery, 3.75% higher milling recovery, and 4.78% higher head-rice recovery than Swarna. Additionally, CR Dhan 322 showed 5.89% higher grain yield compared to Swarna in Maharashtra.

## CR Dhan 328 (IET 26420)

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The variety CR Dhan 328 was developed through hybridization of IR 73963-86-1-5-2 and CR 2324-1. The rice variety described is a semi-dwarf plant type with a height of 114 cm, making it suitable for cultivation in various ecologies. It exhibits a green coleoptile and basal leaf sheath, with the same green hue extending to the leaf blade. The plant demonstrates highly vigorous early growth and pubescent leaves,



**Field view of CR Dhan 328**

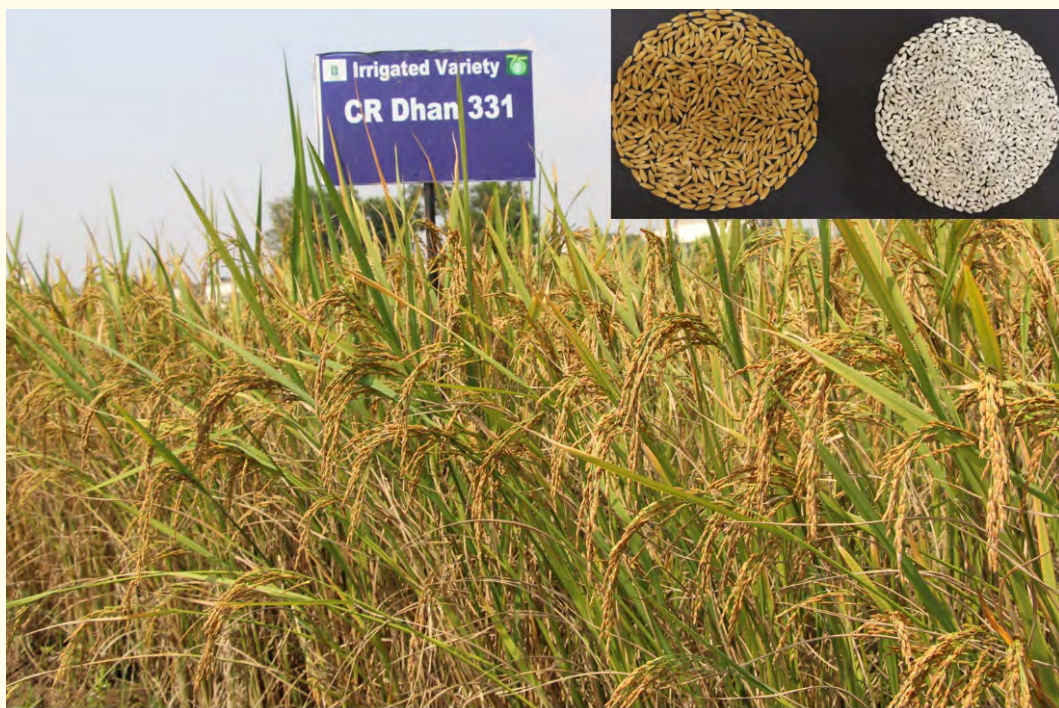
measuring 32.4 cm in length and 1.67 cm in width, with an erect leaf angle. The variety endows stay green and dark green colour resembling Swarna. The variety matures in 145 days. The panicles shows full exertion with straw-colored apiculus. Although the variety produces a less number of tiller (shy tillering habit) but the number of effective tillers are more, it produces 270 panicles per square meter.

The kernels have a length of 6.45 mm, a breadth of 2.19 mm, and a length-to-breadth ratio of 2.94, with a long bold type of grain. The test weight is 22.96 grams, and the variety offers easy threshability with a straw-colored husk. It has a hulling recovery of 78.0%, milling recovery of 68.0%, and head rice recovery of 63.0%, with appearance of chalkiness very occasionally. The amylose content is 24.2%, the gel consistency is 22.0. The variety showed a yield of 6.77 tons per hectare in Odisha which is 43.94% superior over Swarna in Odisha state under Advance Varietal Trial 1- Late trial.. It is highly resistance to leaf folder, resistant reaction to stem borer (% dead heart incidence) and moderately tolerant to plant hopper based on % leaf folder damaged leaf under field condition. It has shown moderate tolerance to neck blast, rice turgor virus and leaf scald.

CR Dhan 328 showed 6.30% higher number of panicles per square meter, 24.04% longer kernel length, and 25.11% higher L/B ratio than the variety Swarna. The variety was at par with Swarna for hulling %, milling recovery, and in head-rice recovery. In terms of grain yield CR Dhan 328 showed 27.10% superiority in grain yield over Swarna under AICRP on Rice.

## CR Dhan 331 (IET 28508)

CR Dhan 331 is released for cultivation under irrigated late conditions. The variety was released in 2023 for Maharashtra and Chhattisgarh. The rice variety CR Dhan 331 (IET 28508) is a semi-dwarf plant, with a height of 103 cm and produces 251 panicles per square meter. The panicles are compact and well exerted, contributing to its high yield potential. CR Dhan 331 features white kernels with dimensions of



**Field view of CR Dhan 331**

5.13 mm in length and 2.19 mm in breadth, resulting in a length-to-breadth ratio of 2.31. The variety matures in approximately 140 days and showed a yield of 6.14 tons per hectare in Maharashtra which is 5.05% superior over Swarna and 5.7 ton per hectare in Chhattisgarh which is 3.6 % superior over Swarna, in the Advance Varietal Trial 1- Late, during Kharif 2021.

The kernels exhibit very good quality characteristics, with a hulling recovery of 79.5%, milling recovery of 71.8%, head-rice recovery of 70.1% along with an amylose content of 24.55%. The grain type is short bold type. The husk colour of this variety resembles that of Swarna. The variety is tolerant to neck blast and moderately tolerant to bacterial blight, leaf blast, and sheath rot, demonstrating better tolerance scores than Swarna. Additionally, it is resistant to leaf folder and moderately resistant to stem borer.

The variety showed a slight improvement of 0.13% in hulling recovery, 1.55% increase in milling recovery, 2.63% higher head rice recovery and 16.35% superiority in grain yield over Swarna in the state of Maharashtra under AICRP on rice multi-year testing. In Chhattisgarh state, the number of panicles per square meter was 7.33% higher, test weight remains the same, 3.75% decrease in kernel length and 4.94% reduction in the L/B ratio in CR Dhan 331 compared to Swarna was observed. The variety has a marginal 0.13% improvement in hulling recovery and 1.55% increase in milling recovery. CR Dhan 331 also has a 2.63% higher head rice recovery and shows a 9.08% superiority in grain yield compared to Swarna under AICRP on rice multi-year testing.

## 6. Comparison of traits in developed variety with Swarna

The table in the document compares several traits of different rice varieties against the variety Swarna. Traits such as plant height, number of panicles per square meter, flowering duration, panicle type, kernel characteristics, yield, and others are listed for each variety. Each trait for the developed varieties is marked to indicate whether it is better, similar, or lower than Swarna. Additionally, for some traits, information is not available (marked as NA). The traits have been classified viz., Moderately lower/other than Swarna: This indicate a trait that is slightly less expressed/value compared to Swarna and qualitative traits other than Swarna; similar to Swarna: indicates that the trait is on par with Swarna; higher/better than Swarna: indicates an improvement/higher value in that specific trait over Swarna; lower than Swarna: indicates that the trait is less expressed/value than Swarna. Each of these varieties has been assessed for multiple traits to provide a comprehensive comparison with Swarna (Table 1).




















































**Table 1. Comparison of traits in developed variety with Swarna**

| Trait                     | Swarna | Swarna Sub1 | CR Dhan 800 | CR Dhan 801 | CR Dhan 802 | CR Dhan 411 | CR Dhan 322 | CR Dhan 328 | CR Dhan 331 |
|---------------------------|--------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Plant height (cm)         | ●      | ●           | ●           | ●           | ●           | ●           | ●           | ●           | ●           |
| No. of panicles/ m2       | ●      | ●           | ●           | ●           | ●           | ●           | ●           | ●           | ●           |
| Flowering duration (days) | ●      | ●           | ●           | ●           | ●           | ●           | ●           | ●           | ●           |
| Panicle type              | ●      | ●           | ●           | ●           | ●           | ●           | ●           | ●           | ●           |
| Panicle exertion          | ●      | ●           | ●           | ●           | ●           | ●           | ●           | ●           | ●           |
| Awning                    | ●      | ●           | ●           | ●           | ●           | ●           | ●           | ●           | ●           |

● Moderately lower/other than Swarna   ● Similar to Swarna   ● Higher/better than Swarna   ● Lower than Swarna

NA- Information not available

|                              |  |  |  |  |  |  |   |
|------------------------------|--|--|--|--|--|--|---|
| <b>Apiculus colour</b>       |   |   |   |   |   |   |   |
| <b>1000-grain weight (g)</b> |   |   |   |   |   |   |   |
| <b>Kernel length (mm)</b>    |   |   |   |   |   |   |   |
| <b>Kernel breadth (mm)</b>   |   |   |   |   |   |   |   |
| <b>L/B ratio</b>             |   |   |   |   |   |   |   |
| <b>Kernel appearance</b>     |   |   |   |   |   |   |   |
| <b>Hulling (%)</b>           |  |  |  |  |  |  |  |

 Moderately lower/other than Swarna 
  Similar to Swarna 
  Higher/better than Swarna 
  Lower than Swarna

NA-Information not available

|                                 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| <b>Milling (%)</b>              |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Head - rice recovery (%)</b> |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Alkali spreading value</b>   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Amylose content (%)</b>      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Husk colour</b>              |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Grain type</b>               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Grain chalkiness</b>         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Moderately lower/other than Swarna 
 Similar to Swarna 
 Higher/better than Swarna 
 Lower than Swarna

NA-Information not available

|                          |  |  |  |  |  |    |    |
|--------------------------|--|--|--|--|--|----|----|
| Maturity duration (Days) |  |  |  |  |  | NA | NA |
| Grain yield (t/ha)       |  |  |  |  |  |    | NA |
| Lodging resistance       |  |  |  |  |  |    |    |
| Early seedling Vigour    |  |  |  |  |  | NA | NA |
| Resistance to flooding   |  |  |  |  |  |    |    |
| N use efficiency         |  |  |  |  |  |    |    |
| P use efficiency         |  |  |  |  |  |    |    |

Moderately lower/other than Swarna 
 Similar to Swarna 
 Higher/better than Swarna 
 Lower than Swarna

NA-Information not available

## 7. Way Forward

The ICAR-National Rice Research Institute has made improvement in developing rice varieties with enhanced traits derived from the mega variety Swarna. These new varieties are designed to address challenges like biotic and abiotic stresses, improving resilience and yield under varying environmental conditions. In future the continuing efforts could be to ensure that these improved varieties are widely adopted and benefit farmers facing the challenges of climate change. Additionally, ongoing research should focus on combining multiple stress-resistant traits to develop varieties that can withstand extreme conditions, while maintaining high productivity. Collaborative efforts between breeders, other discipline scientists along with participatory efforts of farmers, are essential to refine these varieties.

Additionally, breeding programs should adapt to climate change by developing varieties that are resilient to shifting environmental conditions and promoting resource use efficiency to support sustainable agriculture. Integration of genomic selection and gene editing will further streamline the breeding process. Engaging farmers in participatory breeding and tailoring varieties to local needs and conditions will ensure the practical relevance and adoption of new varieties. Moreover, efforts are being made to develop multiple stress tolerance variety in Swarna background with higher yield potential. The advanced breeding lines with favorable alleles for bacterial leaf blight, brown plant hopper, blast, submergence, drought in Swarna background is under evaluation, which will be released after validation. By introducing these new varieties with advancement of the traits, millions of farmers will be benefited in the face of evolving agricultural challenges.

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## **ICAR-National Rice Research Institute**

Cuttack - 753006, Odisha, India

Phone: 0671-2367757, Fax: 0671-2367663

Email: [director.nrri@icar.gov.in](mailto:director.nrri@icar.gov.in)  
[directorcrricuttack@gmail.com](mailto:directorcrricuttack@gmail.com)

Website: <http://www.icar-nrri.in>



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