

COMMERCIALIZABLE TECHNOLOGIES OF ICAR-NRRI

Information Bulletin for Industries



भाकृअनुप-राष्ट्रीय चावल अनुसंधान संस्थान

ICAR-National Rice Research Institute (NRRI)

Cuttack, Odisha, 753 006, India

Commercializable Technologies of ICAR-NRRI

Information Bulletin for Industries

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FOREWORD

I am pleased to introduce the Information Bulletin for Industry on the Commercializable Technologies of ICAR- National Rice Research Institute (ICAR-NRRI). This bulletin aims to bridge the gap between scientific research and its application in the industry. It will serve as a ready reference for the industry to choose marketable NRRI technologies for upscaling and commercialization.

ICAR-NRRI has been at the forefront of rice research and development, striving to enhance agricultural productivity, improve sustainability, and contribute to food security in India. Over the years, the institute has made outstanding progress in developing innovative technologies and solutions to address the challenges faced by farmers and the agricultural industry as a whole.

This Information Bulletin is a testimony to ICAR-NRRI's commitment in promoting collaborations between the research community and industry stakeholders. The bulletin is a valuable asset for entrepreneurs, businesses, and organizations who aim to harness state-of-the-art technologies and advancements in the field of rice cultivation and processing

The bulletin provides detailed insights into diverse commercializable technologies that have emerged from this institute. These technologies have been developed to address various aspects of rice production, including seed development, crop management, pest and disease control, post-harvest processing, value addition, and more. Each technology is accompanied by a concise yet comprehensive description of its features, benefits, and potential applications.

ICAR-NRRI's commitment to commercialization extends beyond technology transfer. The institute actively participates in capacity building and knowledge dissemination, ensuring industries' effective adoption and integration of these technologies into their operations. By fostering collaborations, promoting knowledge exchange, and supporting entrepreneurial initiatives, ICAR-NRRI is playing a crucial role in driving agricultural innovation and economic growth.

I commend the tireless dedication the scientists, researchers, and professionals at ICAR-NRRI for their extraordinary efforts in advancing agricultural science and technology. Their groundbreaking work can potentially transform the rice industry and contribute significantly to the nation's agricultural progress.

I would like to express my gratitude to the authors and contributors of this Information Bulletin for their meticulous efforts in compiling and presenting commercializable tech-

nologies of NRRI in a comprehensive and accessible manner. Their collective expertise, effort and commitment to bridge the gap between a public research institute and private industries are praiseworthy.

I encourage industry professionals, entrepreneurs, and policymakers to explore the commercializable technologies presented in this bulletin and consider how they can be effectively integrated into their operations. By embracing these innovations, we can enhance agricultural productivity, ensure food security, and foster sustainable development in the agricultural sector.

I hope that this Information Bulletin serves as a catalyst for fruitful collaborations, fosters a dynamic synergy between ICAR-NRRI and industries, and ultimately contributes to the growth and prosperity of the nation's agricultural landscape.

Dr. A.K. Nayak
Director, ICAR-NRRI, Cuttack

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ABOUT ICAR-NRRI

ICAR-National Rice Research Institute (NRRI) began its journey 76 years ago (in 1946) against the backdrop of Great Bengal famine. During its long journey, the institute made significant contributions to the famous Green Revolution and played a crucial role in making India self-sufficient in food grain production. It played a crucial role in boosting the overall rural economy of the country, achieving a record-breaking food grain production of 316 million tons during the 2021-22 crop year, with a rice production of 127.93 million tons. The institute collaborates with various rice stakeholders in India and abroad, addressing all Sustainable Development Goals (SDGs) through its current research programs and multidimensional activities that benefit stakeholders in India and the world. Over the course of its 76 - year glorious journey, the institute has released 179 high-yielding rice varieties including six hybrids, four bio-fortified varieties, ten aromatic varieties, and a number of climate resilient varieties aimed at improving livelihood security and sustaining rice productivity in a changing climate. The ICAR-NRRI is a premier research organization dedicated to developing and disseminating rice-based technologies to enhance productivity, profitability, and sustainability of rice farming systems. Since its inception, the institute has been tirelessly working on all researchable aspects of rice crops and has made significant contributions towards enriching the rice science and ensuring food security of the country. ICAR-NRRI has been involved in various aspects of rice research, such as crop improvement, crop production, crop protection, resource management, value addition, and socio-economic studies.



One of the primary objectives of ICAR-NRRI is to foster innovation and entrepreneurship in the rice sector by developing and commercializing technologies that have market demand and social impact potential. ICAR-NRRI has developed several technologies that are either ready for commercialization or have been successfully transferred to the industry. These technologies span diverse domains, including biotechnology, nanotechnology, bio-fertilizers, bio-pesticides, bio-products, machinery, post-harvest processing, and quality enhancement.

Key accomplishments @ ICAR-NRRI

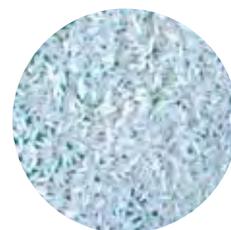
- A total of 179 varieties including 6 hybrids (~ 13% of the rice varieties released in the country) have been released by NRRI, which covers about 18% of rice area with 18.5 Mt production.
- Four rice varieties, CR Dhan 310 (>10% protein), CR Dhan 311 (>10% protein and >20ppm Zn), CR Dhan 324 (>11% protein, 22ppm Zn and 2.5 ppm Fe) and CR Dhan 411 (>10% protein) with high protein and zinc content were developed and released.
- The Institute has also developed 17 climate-smart rice varieties, including CR Dhan 801, CR Dhan 802 combined with dual traits, drought, and submergence tolerant are important.
- Four varieties namely Improved Tapaswini, Improved Lalat, CR Dhan 800 and CR Dhan 803 with bacterial blight resistance developed through MAS and commercialized.
- Nine rice varieties with high water use efficiency namely, CR Dhan 200, 201, 202, 203, 205, 206, 207, 209 and 210 were developed for adaptation under aerobic conditions in India.
- Customized color coded tensiometer based irrigation scheduling: A strategy for eco-friendly rice cultivation, Eco-friendly Irrigation Alert System (e-IAS), NRRI-ARM Sensor – A tool for real time soil moisture monitoring, Environment Friendly Non-toxic Methanotroph Formulation for Mitigation of Methane Emission in Rice, Environment Friendly Microbial Mediated Method of Rice Straw Pulp Preparation and Uses Thereof, *Tech NRRI Decomposer*, Customized leaf color chart were developed as Production Technologies.
- Alternate Energy Light Trap, Solar 24 x 7 Insect Trap, Eco-friendly light trap harmless to beneficial insects, *Trichoderma spp*: Bio-formulations to improve crop health, NRRI Bracon card (B.h) for management of rice leaf folder, *NRRI Tricho card (Tc)* for management of rice leaf folder, NRRI Tricho card (Tj) for management of rice yellow stem borer, Insecticide induced hormesis to improve fitness of egg parasitoid, *Trichogramma chilonis*, Efficient Portable Insect Collector with Automated Counter were developed as Protection Technologies.

Commercializable
Technologies

HYBRID

Ajay (CRHR-7, IET18166)

Ajay (CRHR-7, IET18166, PPVFRA Reg. No. 162, 2014) is a medium duration (125-135 days) semi-dwarf (105-110 cm) popular hybrid released and notified (2005 and 2006) for cultivation under irrigated and shallow lowland area in state of Odisha. It has good quality long slender grains with an average yield capacity of 7.0-7.5 t/ha (>15% yield superiority over standard check). It is resistant to blast and moderate resistant to rice tungro virus. It also exerted field tolerant against bacterial blight, stem borer and brown plant hopper. It can tolerate water stagnation (07-10 days) at tillering stage. Thus, this variety is suitable for enhancing rice productivity in eastern region of the county. Total eleven non-exclusive licenses are given to private seed agencies for its commercialization in the state of Odisha, Bihar and West Bengal.

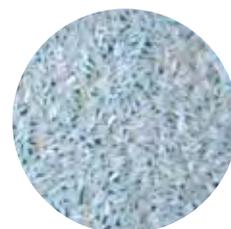


DESCRIPTION OF THE VARIETY

Name of the variety	Ajay
Plant height	105-110cm
Plant type	Erect Semi dwarf
No. of tillers/plant	10
No. of panicles/ m ²	260
Flowering duration	100
Panicle type	Long
Panicle exertion	Complete
Awning	Awnless
Apiculus colour	Green
1000-grain weight	23.2g
Kernel length (mm)	7.22
Kernel breadth (mm)	2.04
L/B ratio	4.40
Kernel appearance	LS
Hulling recovery	80.0
Milling recovery	72.0
Head - rice recovery	62.0
Alkali spreading value (ASV)	4.5
Amylose content	26.4
Grain type	LS
Grain chalkiness	NO
Maturity duration	130 days
Grain yield	7.0-7.5 t/ha

Rajalaxmi (CRHR-5, IET 19600)

Rajalaxmi (CRHR-5, IET 19600, PPVFRReg. No. 206, 2014) is first hybrid released in the country using a CMS line with diverse cytoplasm (Kalinga-I) other than WA. It is a medium duration (125-135 days) semi-dwarf statured (105-110 cm) popular hybrid possess seedling stage cold tolerance and suitable for irrigated, shallow-lowland and Boro ecosystem. It is released and notified (2005 SVRC; 2010 CVRC and 2006) for cultivation in Odisha and Assam. It has good quality long slender grains with an average yield capacity of 7.0-7.5 t/ha. It has capability to tolerate stem borer, brown plant hopper, leaf blast, bacterial leaf blight, white backed plant hopper and gall midge etc.; and can tolerate water stagnation (7-10 days) at tillering stage. Thus, suitable to enhance rice production and improve the livelihood of the farming community in the eastern part of the country. Total 18 non-exclusive license are given to private seed agencies for its commercialization in the state of Odisha, Bihar, Assam, Tripura and West Bengal. During *kharif*2022, it covered ~121000 ha area (@15kg/ha seed rate) over 06 states, namely, Odisha, West Bengal, Bihar, Chhattisgarh, Assam and Tripura.



DESCRIPTION OF THE VARIETY

Name of the variety	Rajalaxmi
Plant height	105-110cm
Plant type	Medium Tall, erect, non-lodging
No. of tillers/plant	10-13
No. of panicles/ m ²	300-350
Flowering duration	102
Panicle type	Compact long
Panicle exertion	Complete
Awning	Awnless
Apiculus colour	Green
1000-grain weight	25.0
Kernel length (mm)	7.05
Kernel breadth (mm)	2.14
L/B ratio	3.29
Kernel appearance	Long slender, white, translucent
Hulling recovery	80.0
Milling recovery	72.0
Head - rice recovery	63.0
Alkali spreading value (ASV)	5.0
Amylose content	24.96
Grain type	LS
Grain chalkiness	VOC
Maturity duration	130-132 days
Grain yield	7.0-7.5 t/ha

CR Dhan 701 (CRHR32, IET 20852)

CR Dhan 701 (CRHR32, IET 20852, PPVFRA Reg.No. 252 of 2016) is first long duration (142-145 days) hybrid released in the country. It is released (CVRC- 2010; SVRC Odisha-2014) for cultivation in shallow lowland area of Bihar and Gujrat; and Odisha (suitable for >10 mha area in coastal region). It has medium slender grains and with 6.0-6.5 t/ha average yield capacity; as a plausible substitute for popular variety Swarna in hybrid rice category (with >15% yield superiority). It can withstand water logging and low light conditions. It exerts moderate resistance to rice tungro, blight, GLH and leaf blast. Thus, very useful for north-eastern states of the country. Given to its popularity, CR Dhan 701 was conferred with prestigious Mahindra SammridhiIndia Agri Award-2014. This hybrid is being commercialized under PPP mode, licensed to 9 private seed agencies. During Kh-2022, it is covered ~75000 ha area (@15 kg/ha seed rate) over five states,namely, Odisha, West Bengal, Bihar, Gujarat and Tripura.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 701
Plant height	115-120cm
Plant type	Semi-tall, erect
No. of tillers/plant	9-12
No. of panicles/ m ²	280-300
Flowering duration	112 days
Panicle type	Compact long
Panicle exertion	Complete
Awning	Awnless
Apiculus colour	Green
1000-grain weight	23.0g
Kernel length (mm)	5.47
Kernel breadth (mm)	2.09
L/B ratio	2.61
Kernel appearance	Medium slender, white, translucent
Hulling recovery	80.0
Milling recovery	71.0
Head - rice recovery	56.6
Alkali spreading value (ASV)	5.0
Amylose content	25.61
Grain type	MS
Grain chalkiness	VOC
Maturity duration	142-145
Grain yield	6.0-6.5t/ha

CR Dhan 702 (CRHR 102, IET25231)

CR Dhan 702 (CRHR 102, IET25231) is a long duration (140-145 days) CGMS based three-lines hybrid released (SVRC-2021) for cultivation under irrigated and shallow-lowland area of Odisha. It has long slender grains with average yield capacity of 7.5 to 8.0 t/ha. Also has high HRR (67.6%), intermediate alkali value (4.0) and intermediate to high amylose content (23.99%) with good cooking quality. It can withstand water stagnation (up to 30cm) and low light conditions. Exerts moderate resistant to leaf blast, neck blast; and resistant against false smut; and MR to gall midge. It has high seed producibility (complete flowering synchronization) thus suitable for hybridizing shallow-lowland rice area in the country. Institute is getting indent from state as well as private seed agencies working in Odisha and Bihar.

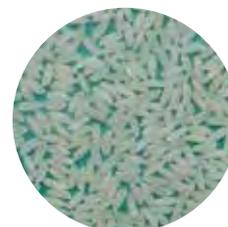


DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 702
Plant height	110-115cm
Plant type	Medium Tall, erect, non-lodging
No. of tillers/plant	10-12
No. of panicles/ m ²	320-370
Flowering duration	110-115
Panicle type	Long, compact
Panicle exertion	Complete
Awning	Awnless
Apiculus colour	Green
1000-grain weight	25.0g
Kernel length (mm)	6.58
Kernel breadth (mm)	2.13
L/B ratio	3.08
Kernel appearance	Long slender, white, translucent
Hulling recovery	81.7
Milling recovery	72.6
Head - rice recovery	67.6
Alkali spreading value (ASV)	4.0
Amylose content	23.99
Grain type	LS
Grain chalkiness	VOC
Maturity duration	145 days
Grain yield	7.5-8.0 t/ha

CR Dhan 703 (CRHR 103)

CR Dhan 703 (CRHR 103) is a long duration (140-145 days) CGMS based three-lines hybrid released (SVRC-2021) for cultivation under irrigated, shallow-lowland and Boro area of Odisha. It has long slender grains with average yield capacity of 7.5 to 8.0 t/ha. Also has high HRR (62.6%), intermediate alkali value (5.3) and intermediate amylose content (24.33%) with good cooking quality. It can withstand water stagnation (up to 30cm) and low light conditions. It has seedling stage cold tolerance, thus suitable for cultivation in boro season. It is moderately resistant leaf BLB, RTD and False smut; and MR to gall midge. Institute is getting indent from state as well as private seed agencies working in Odisha and Bihar.

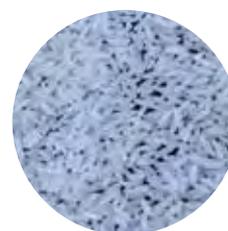


DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 703
Plant height	110-115cm
Plant type	Medium Tall, erect, non-lodging
No. of tillers/plant	10-12
No. of panicles/ m ²	300-350
Flowering duration	110-115days
Panicle type	Compact long
Panicle exertion	Complete
Awning	Awnless
Apiculus colour	Green
1000-grain weight	25.2g
Kernel length (mm)	6.65
Kernel breadth (mm)	2.15
L/B ratio	3.09
Kernel appearance	Long slender, white, translucent
Hulling recovery	83.1
Milling recovery	71.5
Head - rice recovery	60.1
Alkali spreading value (ASV)	5.3
Amylose content	25.22
Grain type	LS
Grain chalkiness	VOC
Maturity duration	145 days
Grain yield	7.5-8.0 t/ha

CR Dhan 704 (CRHR 150, IET28187)

CR Dhan 704 (CRHR 150, IET28187) is a medium duration (130-135 days) CGMS based three-lines hybrid released and notified (2023) for cultivation under irrigated, shallow-lowland and DSR condition of Odisha. It has short slender (SS) grains with average yield capacity of 7.0 to 7.5 t/ha. It has good cooking/eating quality with acceptable quality parameters, high HRR (68.25%), intermediate alkali value (5.7) and intermediate amylose content (24.72%). It can sustain 10 days' submergence at tillering stage. Exerts moderate resistant moderate resistance to false smut, leaf blast, neck blast, brown spot, sheath rot and glume discoloration. Besides, it also has moderate resistance to Gal midge. It has high seed producibility (perfect flowering synchronization) thus suitable for hybridizing irrigated and shallow-lowland rice area in the Odisha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 704
Plant height	105-110cm
Plant type	Semi-Dwarf, erect, non-lodging
No. of tillers/plant	12-14
No. of panicles/ m ²	320-370
Flowering duration	105days
Panicle type	Compact, long
Panicle exertion	Complete
Awning	Awnless
Apiculus colour	Green
1000-grain weight	12.50g
Kernel length (mm)	5.66
Kernel breadth (mm)	1.92
L/B ratio	3.05
Kernel appearance	Short slender (SS), white, translucent
Hulling recovery	80.2
Milling recovery	71.8
Head - rice recovery	68.25
Alkali spreading value (ASV)	5.4
Amylose content	24.72
Grain type	SS
Grain chalkiness	VOC
Maturity duration	130-135 days
Grain yield	7.0-7.5 t/ha

Commercializable
Technologies

UPLAND ECOSYSTEM

CR Dhan 103 (IET 22020/ CRR 451-1-B-2-1)

CR Dhan 103 (IET 22020/ CRR 451-1-B-2-1) is a drought tolerant rice variety with excellent grain quality found promising under rainfed uplands and direct seeded condition in Jharkhand. It has a yield potential of 3.3 t ha⁻¹. It has been developed through pedigree method from the cross: Vandana/ IR64. Vandana is a drought tolerant upland variety while, IR64 is a mega variety with excellent grain quality, high productivity, and disease resistance. The variety possesses very good drought tolerance both at vegetative and reproductive stages of crop growth, at par with Vandana. It may possess qDTY2.1 and qDTY2.3. It also possesses PSTOL1 gene for tolerance to low soil phosphorus. CR Dhan 103 is highly resistant to blast and brown spot, two most important diseases of rice under rainfed uplands. This variety has inherited the blast resistance genes from its parent IR64, one of the most durable blast resistant varieties. CR Dhan 103 responded very favourably to the additional doses of nitrogen. CR Dhan 103 has better grain quality features, high head rice recovery (61.4%), long slender grains (kernel length 6.68 cm & L/B ratio 3.35), intermediate ASV (4.5), acceptable amylase content (26.04%) and soft gel consistency (72). Because of its good grain quality this variety will fetch better premium at the market and partially compensate upland rice farmers for low yield.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 103 (IET 22020/ CRR 451-1-B-2-1)
Plant height	100 cm
Plant type	Intermediate
No. of tillers/ plants:	5-7
No. of panicles/sq m	231
Flowering duration	68 days
Panicle type	Compact
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Straw
1000-Grain weight	22.46g.
Kernel length (mm)	6.68 mm
Kernel breadth (mm)	1.99 mm
L/B ratio	3.35 (LS)
Kernel appearance	White
Hulling recovery	78.0%
Milling recovery	69.0%
Head rice recovery	61.4%
Alkali value	4.5
Amylose content	26.04%
Gel consistency (mm)	72

CR Dhan 107 (Unnat Vandana, IET 26337, CRR 747-12-3-B)

CR Dhan 107 (Unnat Vandana, IET 26337, CRR 747-12-3-B) derived from the cross Vandana*4/C101A51//IR84984-83-15-862-B using marker-assisted breeding at Central Rainfed Upland Rice Research Station (CRURRS), ICAR-NRRI, Hazaribag, Jharkhand. It has recorded good yield under both severe and moderate drought stress situations with good early vigour, intermediate plant height, strong erect culms good tillering ability and long slender grains. It has a yield potential of 3.31 t/ha and notified for rainfed direct seeded conditions in the state, Jharkhand during 2022. IET 26337 showed moderate resistance to leaf blast, neck blast, brown spot, sheath rot, rice tungro, glume discoloration, false smut, and moderate tolerance to WPBH and plant hopper, GMB 1, stem borer, leaf folder and case worm. It has excellent grain quality parameters such as high milling recovery (64.9%), high head rice recovery (56.1%), intermediate amylose content (23.3%), soft gel consistency of 51 and long slender grains. Molecular marker assisted screening confirmed that IET 26337 possesses three DTY QTLs for grain yield under reproductive stage drought stress (qDTY2.3, qDTY3.2 and qDTY12.1), Phosphorus starvation tolerance 1 (PSTOL1) gene for tolerance to low-Phosphorus, and blast resistance gene Pi-2.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 107
Basal Leaf: sheath colour	1
Leaf: pubescence of blade surface	3
Leaf: auricles	9
Leaf: anthocyanin	1
Leaf: shape of ligule	3
Leaf: colour of ligule	1
Time of heading (50% plant with panicles)	5 (67 days)
Flag leaf: attitude of blade	5
Spikelet: density of pubescence of lemma	3
Lemma: anthocyanin coloration of area below apex	1
Spikelet: colour of stigma	2
Stem: length	1 (97 cm)
Stem: anthocyanin colouration of nodes	1
Panicle: length of main axis	5 (22.3cm)
Flag leaf: attitude of blade	5
Panicle: curvature of main axis	3
Spikelet: colour of tip of lemma	2
Panicle: awns	1
Panicle: colour of awns	-
Panicle: distribution of awns	-
Panicle: attitude of branches	3
Panicle: exertion	5
Sterile lemma: colour	-
Decorticated grain: length	6.26 mm

Decorticated grain: width	2.04 mm
Decorticated grain: shape	LS
Decorticated grain: colour	White
Decorticated grain: aroma	Absent
Coleoptile: colour	-
Leaf intensity of grain colour	5
Leaf: anthocyanin colouration	1
Leaf sheath: anthocyanin colouration	1
Leaf sheath: intensity of anthocyanin colouration	1
leaf collar	9
Anthocyanin color of collar	1
Leaf ligule	1
Leaf: length of blade	5 (27.9 cm)
Leaf: width of blade	5 (0.9 cm)
Male sterility	-
Lemma: anthocyanin coloration of apex	1
Stem: anthocyanin colouration of nodes	1
Stem: intensity of anthocyanin colouration of nodes	1
Stem: intensity of anthocyanin colouration of internodes	1
Panicle: no. per plant	5
Lemma and palea colour	2
Panicle: presence of secondary branching	1
Panicle: secondary branching	2
Time of maturity	-

Satyabhama (CR2340-11)

Satyabhama (CR2340-11) was developed from the segregating materials of the cross IR31238-350-3-2-1 / IR41054-102-2-3-2. Its average yield under drought affected situation is 2.3 t/ha while under normal condition the average yield in the region is 4.7 t/ha and notified for the states of Orissa and Chhattisgarh. Days to 50% flowering of the culture in these region is 85 days along with semi-dwarf (100-105 cm) and non-lodging plant type. It produces long slender grain (6.75 mm), 250 panicle per m², moderate tillering (6-9) and produces long panicle (28 cm). IET 20148 possess all desirable quality characters like high head rice (60%), intermediate alkali spreading value (7.0), intermediate amylose content (24.66%) and L/B ratio of 3.35. The line exhibited resistance reaction against the pests stem borer, leaf folder and rice whorl maggot attack. While showed moderate reaction to white backed plant hopper, gall midge biotype1, biotype 5, rice hispa, rice thrips, EHB and GRH attack. It showed moderately tolerance reaction to diseases like Leaf blast, rice tungro virus disease and glume discoloration.



DESCRIPTION OF THE VARIETY

Name of the variety	Satyabhama (CR2340-11)
Plant height	100--105 cm
Plant type	Semi-dwarf
No. of tillers/plants	6-9
No. of panicles/ m ²	250
Flowering duration	85 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Awnless
Apiculus colour	Green
1000 -grain weight	23.5 g
Kernel length (mm)	6.75 mm
Kernel breadth (mm)	2.02 mm
L/B ratio	3.35 mm
Grain type	Long slender
Kernel appearance	White
Milling recovery	68 %
Head - rice recovery	60 %
Alkali value	7.0
Amylose content	24.66 %
Aroma	Absent

Commercializable
Technologies

AEROBIC

CR DHAN 204 (CR2696-IR83920-B-B-CRA-103-14-1-1-1)

CR DHAN 204 (CR2696-IR83920-B-B-CRA-103-14-1-1-1) was developed from cross of IRRI 76569-259-1-2-1/CT 6510-24-1-2. The promising line has exhibited stability for yield and other characters in region III of the country showing promising in the states of Jharkhand and Tamil Nadu. Hence, the elite line has been identified for release in these two states by Central Variety Identification Committee held during 2014. The average yield of the entry is 5.6 t/ha in region V and 3.9 t/ha in region III under aerobic AICRIP testing across 26 locations of the country. Maturity duration of the variety is 110 days with semi-dwarf plant type (100cm). The genotype is non-lodging type and is suitable for aerobic situation of Jharkhand and Tamil Nadu. It possesses medium slender grain, more panicles per m² (285) with 85 days to 50% flowering, normal tillering (7-10), medium and dense panicle with moderate test weight. It is moderately resistant to leaf blast, neck blast, brown spot, sheath rot, stem borer (both dead heart and white ear heads), leaf folder, whorl maggot, case worm and rice thrips. IET21917 has good hulling, milling and head rice recovery as compared to check varieties. It possesses intermediate amylose content and other desirable grain quality parameters.



DESCRIPTION OF THE VARIETY

Name of the variety	CR DHAN 204
Plant height	95-100 cm
Plant type	Semi-dwarf
No. of tillers/plants	7-10
No. of panicles/ m ²	280
Flowering duration	82-85 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Awnless
Apiculus colour	Normal
1000-grain weight	21.3 g
Kernel length (mm)	6.12 mm
Kernel breadth (mm)	2.32 mm
L/B ratio	2.64
Kernel appearance	White
Hulling recovery	77.5 %
Milling recovery	67.7 %
Head - rice recovery	65.4 %
Alkali value	5.5
Amylose content	

CR Dhan 205 (IET 22737)

This was developed from the breeding materials of cross N22 / Swarna. This is a yielding variety with tolerance to major diseases and insects, released and notified during 2014 the states of Tamil Nadu, Gujarat, Odisha, Madhya Pradesh and Punjab for early aerobic situation. The average yield of the proposed variety in Tamil Nadu was 6.4t/ha while the region V mean observed was 5.5 t/ha. Maturity duration of the variety is 105-110 days with semi-dwarf plant type (100cm). It possesses short bold grain, more panicles per m² (230-300) with 82-85 days to 50% flowering, normal tillering (6-9), medium and dense panicle with moderate test weight (24.5g). It is moderately resistant to leaf blast, brown spot, sheath rot, stem borer (both dead heart and white ear heads), leaf folder, whorl maggot. It has good hulling, milling and head rice recovery as compared to check varieties. It possesses intermediate amylose content, short bold grain and other desirable grain quality parameters.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 205 (IET 22737)
Plant height	100-105 cm
Plant type	Semi-dwarf
No. of tillers/plants	6-9
No. of panicles/ m ²	230-300
Flowering duration	82-85 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Awnless
Apiculus colour	Normal
1000-grain weight	24.5 g
Kernel length (mm)	6.65 mm
Kernel breadth (mm)	2.26 mm
L/B ratio	2.46
Kernel appearance	White
Hulling recovery	78.75 %
Milling recovery	69.9 %
Head - rice recovery	57.75 %
Alkali value	6.50
Amylose content	22.29 %

CR Dhan 211 (IET 29411)

CR Dhan 211 (IET 29411) CR Dhan 211 was developed from the cross between IR10L146 / IR10L149. CR Dhan 211 (IET 29411) is a high-yielding, mid-early duration (114-118 days) variety with long slender grain and desirable grain quality. This variety is photo-insensitive, suitable for both kharif and rabi seasons under direct sown aerobic conditions suits well to existing cropping systems and sequences. It measures a plant height of 95-102 cm, compact and well exerted panicle, with a test grain weight of 24.51 g. The variety belongs to non-lodging plant type, intermediate grain shattering, fertilizer responsive and mid-early maturity type. The variety CR Dhan 211 performed well under 50% and 100% nitrogen fertilizer than national check and zonal check. It is moderately resistant to stem borer (dead heart and white ear head), leaf folder and gundhi bug insect pests. It is moderately resistant to neck blast, leaf blast, brown spot, sheath rot and grain discolouration. It is consistently outperformed the check varieties under national testing in the Eastern Zone (Zone III, Odisha, Bihar, Jharkhand), Northern Zone (Zone II, Haryana), North Eastern Zone (Zone IV, Tripura), Central zone (Zone V, Chhattisgarh) and Western Zone (Zone VI, Maharashtra, Gujarat). It showed 16%, 19% and 19% yield superiority over the best check in Zone II (5414 kg/ha), Zone IV (4779 kg/ha) and Zone III (4542 kg/ha) respectively. CR Dhan 211 has good hulling (79%), milling (69%) and head rice recovery (66%) as compared to checks and qualifying varieties. It possesses intermediate amylose content (24.86%), long slender grain and other desirable grain quality parameters. The variety is released for mid-early aerobic situations for Odisha, Bihar, Jharkhand, Maharashtra, Gujarat, Tripura, Chhattisgarh and Haryana. The average yield of the variety is 4.5 t/ha, but the yield ranges from 4.2 -5.5 t/ha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 211 (IET 29411)
Plant height	95-102 cm
Plant type	Semi-dwarf
No. of tillers/plant	8-10
No. of panicles/ m ²	247-334
Flowering duration	83-86 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Green
1000-grain weight	24.51 gm
Kernel length (mm)	7.28 mm
Kernel breadth (mm)	2.10 mm
L/B ratio	3.49
Kernel appearance	White
Hulling recovery	79%
Milling recovery	69%
Head - rice recovery	66 %
Alkali spreading value (ASV)	7.0
Amylose content	24.86 %
Grain type	Long slender
Grain chalkiness	Very occasionally
Maturity duration	114-118 days

CR Dhan 212 (IET 29424)

CR Dhan 212 was developed from the cross between IR09L337 / IR09L154. CR Dhan 21 (IET 29424) is a high-yielding, mid-early duration (110-113 days) variety with long bold grain and desirable grain quality. This variety is photo-insensitive, suitable for both *kharif* and *rabi* seasons under direct sown aerobic conditions suits well to existing cropping systems and sequences. It measures a plant height of 90-108 cm, compact and well exerted panicle, with a test grain weight of 25.45 g. The variety belongs to non-lodging plant type, intermediate grain shattering, fertilizer responsive and mid-early maturity type. The variety CR Dhan 212 performed well under 50% and 100% nitrogen fertilizer than national check and zonal check. It is moderately resistant to stem borer (dead heart and white ear head), leaf folder, whorl maggot and gundhi bug insect pests. It is moderately resistant to neck blast, leaf blast, brown spot, sheath rot, RTD and grain discolouration. It has consistently outperformed the check varieties under national testing in the Eastern Zone (Zone III), Central zone (Zone V) and Western Zone (Zone VI) from 2020-2022 (Table 1a). The promising line has exhibited stability for yield and other characteristics in Zone III of the country comprising states of Odisha, Bihar and Jharkhand, Zone II of Haryana, Zone V of Chhattisgarh and Zone VI of Gujarat. The mean yield in Zone III was 4451 kg/ha showing 24, 16.7 and 23.7% higher yield than National, Zonal and Local checks, respectively (Table 1a). In Zone VI, the entry recorded 4369 kg/ha with 10.9, 35.4 and 10.5% superiority over the National, Zonal and Local checks, respectively. Similarly, the mean yield in Zone V was 3465 kg/ha showing 26.6, 3.6 and 3.2% higher yield than National, Zonal and Local checks, respectively. Its weighted mean grain yield was, 5706 Kg/ha in Haryana, 4889 Kg/ha in Gujarat, 4489 kg/ha in Bihar, 4449 Kg/ha in



Odisha, 3824 Kg/ha in Jharkhand and that was > 29% in Haryana, > 12 % in Gujarat, >11 % in Bihar, >21 % in Odisha and >31% in Jharkhand than the best check respectively. CR Dhan 211 has High hulling (80%) and milling recovery (71.5%), head rice recovery (60.15%), LS grain, very occasionally grain chalkiness present, 4.5 alkali spreading value and intermediate amylose content (23.5%), long bold and other desirable grain quality parameters. The variety is released for mid-early aerobic situations for Odisha, Bihar, Jharkhand, Haryana, Gujarat and Chhattisgarh. The average yield of the variety is 4.2 t/ha, but the yield ranges from 4.0-5.3 t/ha.

DESCRIPTION OF THE VARIETY

Name of the variety	CR DHAN 212 (IET 29424)
Plant height	90-108 cm
Plant type	Semi-dwarf
No. of tillers/plant	8-10
No. of panicles/ m2	262-317
Flowering duration	81-83 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Green
1000-grain weight	25.45 gm
Kernel length (mm)	6.45 mm
Kernel breadth (mm)	2.26 mm
L/B ratio	2.825
Kernel appearance	White
Hulling recovery	80%
Milling recovery	71.5%
Head - rice recovery	60 %
Alkali spreading value (ASV)	4.5
Amylose content	23.5 %
Grain type	Long bold
Grain chalkiness	Very occasionally
Maturity duration	110-113 days

Commercializable
Technologies

IRRIGATED ECOSYSTEMS

CR Dhan 307 (Maudamani)

CR Dhan 307 (Maudamani) was developed from the segregating materials of the cross Dandi/Naveen//Dandi. This is medium duration (130-135 days), semidwarf (100-105 cm), non-lodging genotype, released and notified during 2014 and found suitable for irrigated rice growing area of Odisha and Assam. It produces short bold grain (L/B ratio-2.15), 278 panicles per m², good tillering (7-10) with high grain number/ panicle. IET 20925 possess all desirable quality characters like high milling % (72%), intermediate alkali spreading value (7.0), intermediate amylose content (23.73%) and gel consistency of 26.0. The line exhibited moderate resistance reaction against the pests stem borer, leaf folder, rice whorl maggot, green leaf hopper and gall midge biotype 6 attack. While it showed moderate reaction to white backed plant hopper, gallmidge biotype5, rice hispa and rice thrips. It exhibited moderately tolerance reaction to diseases like Leaf blast, neck blast and brown spot (Table 3). The entry showed stable yield in the western region and found to be responsive to fertilizer application as compared to checks and qualifying varieties. The culture is suitable for 100% as well as for 150% nitrogen application.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 307 (Maudamani)
Plant height	100--110 cm
Plant type	Semi-dwarf
No. of tillers/plants	9-12
No. of panicles/ m ²	278
Flowering duration	98-102 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Awnless
Apiculus colour	Green
1000 -grain weight	24.6 g
Kernel length (mm)	5.27 mm
Kernel breadth (mm)	2.44 mm
L/B ratio	2.15 mm
Kernel appearance	White
Hulling recovery	79.6 %
Milling recovery	72.0 %
Head - rice recovery	66.6 %
Alkali spreading value	7.0
Amylose content	23.73 %
Aroma	Absent

CR Dhan 308 (IET 25523)

CR Dhan 308 (IET 25523) was developed from the breeding materials of cross IR 36/Vijetha. It has average yield of 5.0-5.5t/ha and notified for irrigated situation of Chattisgarh and Maharashtra during 2020. The genotype is photo-insensitive with average maturity duration of 130-135 days in both kharif and rabi season. It possesses medium slender grain with a long, branch panicle having moderate test weight (17.8g). It has long, erect, broad leaves with dark green colour and has high nitrogen use efficiency. - It is resistant to False smut, Glume Discolouration and Rice Tungro disease. Also moderately resistant to Brown spot, Bacterial Blight and Neck Blast (table 3). It is resistant to stem borer (both dead heart and white ear heads) and tolerant leaf folder, whorl maggot and rice hispa insect pests. Moderately tolerant to Gall midge (GMB4M and GMB?) biotype. CR Dhan 308 has good hulling, milling and head rice recovery as compared to checks and qualifying varieties. It possesses intermediate amylose content, medium slender grain and other desirable grain quality parameters.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 308 (IET 25523)
Plant height	110-120 cm
Plant type	Semi-dwarf
No. of tillers/plant	10-14
No. of panicles/sq.m	298
Flowering duration	100-103 days
Panicle type	semi-spreading/lax
Panicle exertion	well exerted
Awning	No awn
Apiculus color	No color
1000-seed weight	21.6 g
Kernel length (mm)	5.35
Kernel breadth (mm)	1.91
L/B ratio	2.79
Kernel appearance	MS
Hulling recovery	77.6
Milling recovery	69.2%
Head-rice recovery	66.9
Alkali value	4.7
Amylose content (%)	23.01

CR Dhan 312 (IET 25997)

Rice variety CR Dhan 312 (CR 3808-13, IET25997), developed at ICAR-National Rice Research Institute (NRRI), Cuttack from male sterility facilitated recurrent selection population was released and notified by Central sub-committee on 'Crop Standards, Notification and Release of Varieties for Agricultural crops' in 2020 for irrigated areas of Maharashtra and Chhattisgarh under medium duration. It is suitable for cultivation in irrigated lands. It has semi-dwarf plant type and matures in 135-140 days. The genotype possesses good hulling and milling quality with white kernels, medium slender grains, no grain chalkiness and desirable alkali spreading value. This variety is moderately resistant to leaf blast, neck blast and rice tungro virus. It is highly responsive to fertilizer application. This variety may substitute Naveen in irrigated ecology with average yield of 6.4 t ha⁻¹.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 312 (CR 3808-13, IET 25997)
Plant height (cm)	101
Plant type	Semi-dwarf
No. of tillers/plants	8-10
No. of panicles/ m ²	283
Days to 50% flowering	106 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	No awn
Apiculus colour	Straw
1000 -grain weight (g)	21.8
Kernel length (mm)	5.5
Kernel breadth (mm)	2.1
L/B ratio	2.62
Kernel appearance	White
Hulling recovery (%)	77.8
Milling recovery (%)	67.5
Head rice recovery(%)	58
Alkali spreading value	4.0
Amylose content (%)	26.2
Grain type	Medium Slender
Maturity duration	135-140 days
Grain yield	6.4 t/ha

CR Dhan 318

ICAR-National Rice Research Institute has developed CR Dhan 318 (IET 27883), a variety suitable for irrigated ecology. The variety was developed from the cross between GSR IR1-8-S6-S3-Y2 / GSR IR1-8-Y7-D2-S1. It has been officially released and approved by the Central subcommittee on Central Sub-committee on Crop Standards, Notification, and Release of Varieties for Agricultural Crops, in 2021 for 4 Bihar and West Bengal (Zone III) and Uttarakhand and Haryana (Zone II). CR Dhan 318 can be cultivated in both Kharif and Rabi seasons, and it is very much suitable for early irrigated situation. This variety is photo-insensitive and has a semi-dwarf plant type, longer grain with desirable grain quality, and matures in 118–120 days. Its leaves are long, erect, and broad with a dark green colour, non-lodging, intermediate grain shattering, fertilizer responsive. It possesses long slender grains with a moderate test weight of 22.3 g. CR Dhan 318 is characterized as an early maturity type, moderately resistant to false smut, neck blast, leaf blast, (table 3) also having high field tolerance for sheath rot, RTD and bacterial blight. highly tolerant to leaf folder, stem borer (dead heart), and whorl maggot insect pests. Moderately tolerant to gall midge (Biotype 1) and stem borer (white ear heads). CR Dhan 318 yield ranged from 4.8 to 6.6 t/ha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 318 (IET278830)
Plant height	105-115cm
Plant type	Semi-dwarf
No. of tillers/plant	8-10
No.of panicles/m ²	280-300
Flowering duration	85-88days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Green
1000-grainweight	22.3gm
Kernel length(mm)	6.61mm
Kernel breadth(mm)	1.96mm
L/Bratio	3.37
Kernel appearance	White
Hulling recovery	78.45%
Milling recovery	67.55%
Head-rice recovery	58.95%
Alkali spreading value (ASV)	6.4
Amylose content	23.08%
Grain type	Long slender
Grain chalkiness	Very occasionally
Maturity duration	118-120days
Grain yield	4.8 to 6.6 t/ha

CR Dhan 321

CR Dhan 321 (IET 28354), a variety suitable for irrigated ecology. The variety was developed from the cross between IET 22296 and RR 2-6. It has been officially released and approved by the Central subcommittee on “Crop Standards, Notification, and Release of Varieties for Agricultural Crops” in 2022. for 9 states of viz; Odisha, Bihar, Jharkhand, West Bengal, Uttar Pradesh, Tripura, Assam, Chhattisgarh, and Maharashtra CR Dhan 321 can be cultivated in both Kharif and Rabi seasons, and it is very much suitable for irrigated medium lands. It exhibits a photo-insensitive trait and has a semi-dwarf plant type; good panicle branching and matures in 118–120 days. Its leaves are long, erect, and broad with a dark green color. Additionally, CR Dhan 321 responds to fertilizer application, and performed under 50% and 100% nitrogen fertilizers. It possesses medium slender grains with a moderate test weight of 17.7 g. CR Dhan 321 is characterized as an early maturity type, resistant to lodging, moderately resistant to false smut, neck blast, leaf blast, brown spot, and grain discoloration. It also exhibits high field tolerance for sheath rot. Moreover, CR Dhan 321 demonstrates a high level of resistance to common insect pests such as the leaf folder and the stem borer (dead heart). This variety can substitute Naveen variety in irrigated ecology with an average yield of 5.96 t/ha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 321 (IET 28354)
Plant height	95-108 cm
Plant type	Semi-dwarf
No. of tillers/plant	8-10
No. of panicles/ m ²	276-331
Flowering duration	88-90 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Green
1000-grain weight	17.7 gm
Kernel length (mm)	5.82 mm
Kernel breadth (mm)	2.13 mm
L/B ratio	2.73
Kernel appearance	White
Hulling recovery	80.2%
Milling recovery	70.75%
Head - rice recovery	68.20 %
Alkali spreading value (ASV)	4.0
Amylose content	24.52 %
Grain type	Medium slender
Grain chalkiness	Very occasionally
Maturity duration	118-120 days
Grain yield	5.96 t/ha

CR Dhan 323

CR Dhan 323 (IET 25992), a medium-late duration Doubled Haploid (DH) variety suitable for irrigated and shallow lowland ecology. It is DH derivative of hybrid CRHR32, developed through anther culture approach. It has been released and notified for state of Odisha during 2023. It is suitable for cultivation in both seasons, *Kharif* and *rabi* under irrigated and shallow lowland condition. It is a medium tall, non-lodging, high-yielding and matures in 135-140 days. CR Dhan 323 responds to fertilizer application, up to 80 kg N in *Kharif* and 100 kg N in *rabi*. It possesses short bold grains with average yield of yield 5.0-5.5 t/ha (*Kharif*) and 5.5-6.0 t/ha (*Rabi*). It is resistant to false smut, moderately resistant to leaf blast, neck blast, bacterial blight, grain discoloration, RTD. Moreover, CR Dhan 323 demonstrates resistance to gall midge. This variety can substitute CR Dhan 304 variety in irrigated and shallow lowland ecology average in Odisha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 323 (IET 25992)
Plant height	115-120 cm
Plant type	Medium tall
No. of tillers/plant	10-12
No. of panicles/ m ²	280-320
Flowering duration	105-110 days
Panicle type	Long and Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Green
1000-grain weight	25.0 gm
Kernel length (mm)	5.10 mm
Kernel breadth (mm)	1.76 mm
L/B ratio	2.89
Kernel appearance	White
Hulling recovery	77.5%
Milling recovery	72.1%
Head - rice recovery	65.20 %
Alkali spreading value (ASV)	4.0
Amylose content	23.97 %
Grain type	Short bold
Grain chalkiness	Absent
Maturity duration	135-140 days
Grain yield	5.0-5.5 t/ha (<i>Kharif</i>) and 5.5-6.0t/ha (Rabi).

CR Dhan 326 (Panchatatva) CR 4202-298-2-2-1, IET 28491

ICAR-National Rice Research Institute has developed CR Dhan 326 (IET 28491), a Bacterial blight (BB) resistant rice variety suitable for irrigated ecology. It has been officially released and approved by the Central Sub-committee on "Crop Standards, Notification, and Release of Varieties for Agricultural Crops" in 2023 for Odisha. The variety was developed from the cross between Naveen and IRBB 66. This variety carries five bacterial blight resistance genes (*Xa4*, *xa5*, *Xa7*, *xa13* and *Xa21*) and was developed through Marker Assisted Pedigree Breeding. Presence of *Xa4* gene enhanced the culm strength which can save the crop from lodging caused by unseasonal rain at maturity. CR Dhan 326 is a photo-insensitive fertilizer responsive semi tall variety with very strong culm which matures in 135-140 days and recorded average yield of 6.2 t/ha. The grains are medium slender types with good hulling, milling and cooking qualities. This is first rice variety released in India with five bacterial blight resistance genes and can provide durable broad-spectrum resistance against the pathogen and save crop from future epidemics.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 326 (CR 4202-298-2-2-1, IET 28491)
Plant height	110- 115 cm
Plant type	Semi tall with very strong culm
No. of tillers/plant	9
No. of panicles/ m ²	240-250
Days to 50% flowering	105-110 days
Seed to seed duration	135-140 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Straw
Lemma palea colour	Straw
1000-grain weight	21.03 g
Kernel length (mm)	5.83 mm
Kernel breadth (mm)	1.97 mm
L/B ratio	2.95
Kernel appearance	White
Hulling recovery	76.4%
Milling recovery	66.4%
Head - rice recovery	60.2%
Alkali spreading value (ASV)	5.0
Amylose content	24.8 %
Grain type	Medium slender
Kernel appearance	White
Grain chalkiness	Absent
Maturity duration	135-140 days
Grain yield	6.2 t/ha

CR Dhan 328 (Divya)

ICAR-National Rice Research Institute, Cuttack has developed CR Dhan 328 (IET 26420), a variety suitable for irrigated late situation as well as favourable shallow lowlands of Odisha. It was developed through cross of IR 73963-86-1-5-2 and CR 2324-1 at ICAR-NRRI, Cuttack. This was officially released and notified by the Central subcommittee on “Crop Standards, Notification, and Release of Varieties for Agricultural Crops” in 2023 for the state of Odisha. The average yield of the entry was 67.7 q/ha, in AICRIP testing in Odisha, where as it exhibited 60.3 q/ha in eastern zone (Z III). Similarly, it recorded 64.9 q/ha in state adoptive trials of Odisha.

It has excellent response to higher dose of fertilizer as tested in agronomy trials. The genotype was a kind of modified New Plant Type with maturity duration of 143 days. It shows semi-dwarf plant type with slightly increased height (115cm) with strong culm. It has moderately long and heavy panicle, moderately high grain number with long bold grains and high fertility. It possesses moderate panicles per m² (233-270) with 118 days to 50% flowering, moderately long and dense panicle with relatively high-test weight. This produces little shy tillers, long and wide top three leaves with erect canopy and high biomass. All three leaves are on the top of panicle height. It has recorded high photosynthetic efficiency too. It recorded high resistance to leaf folder, resistant reaction to stem borer (% dead heart incidence) and moderately susceptible to plant hopper based on % leaf folder damaged leaf under field condition. It has intermediate resistance for RTD and leaf scald and showed moderately susceptible to neck blast; field tolerance to major diseases. CR Dhan 328 has good hulling, milling and head rice recovery. It possesses intermediate amylose content, long bold grains and other desirable grain quality parameters.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 328 (Divya)
Particulars	SalientFeatures
Planttype	SemiDwarf
Leaflength(cm)	32.4
Leafwidth(cm)	1.67
Leafangel	Erect
Daysto50%flowering	118
Paniclexertion	Full
Stigmacolour	White
Apiculus colour	Straw
No.ofeffectivetillers/plant	7-8
No.ofpanicles/sq.mt	233-270
Plantheight(cm)	114
Paniclelength(cm)	26.4
Panicletype	ModeratelyLax
Awning	Absent
Daystomaturity	143-148
Kernel colour	White
Kernellength(mm)	6.45
Kernelbreadth(mm)	2.19
GrainL/Bratio	2.94
Kernelappearance	LB
1000grainweight(gms)	22.96
Threshability	Easy
Huskcolour	Straw
Hullingrecovery(%)	78.0
Millingrecovery(%)	68.0
Headricerecovery-HRR (%)	63.0
Chalkiness	Very occasionallypresent
Amylosecontent(%)	24.2
GC	22.0
Aroma	Absent

CR Dhan 320

CR Dhan 320 is an inbred rice variety developed at Central Rainfed Upland Rice Research Station, ICAR-National Rice Research Institute, Hazaribag, Jharkhand from the cross between IR 10L146 x IR 10L137. It has been released and notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties (CSC on CSN&RV) for Agricultural Crops in 2021 for irrigated areas of Jharkhand, Bihar and West Bengal under early duration transplanted condition. It is suitable for cultivation in both kharif and rabi seasons under both high and low fertility conditions.

It has semi-dwarf, erect, highly vigorous, non-lodging plant type with long panicles (23.2 cm). The variety is 99.8 cm tall and matures in 117 days. CR Dhan 320 possesses very good grain quality attributes of Hulling (79.5%), Milling (70.0%) and Head Rice Recovery (62.4%), long slender (LS) grains, chalk absent, low gelatinization temperature (ASV 7.0), intermediate amylose content of 26.82% and soft gel consistency (GC) of 62.5 mm. It is moderately resistant to major disease such as blast, brown spot and sheath rot. It has also moderate tolerance to brown plant hopper (BPH), leaf folder and stem borers. CR Dhan 320 has a high response towards fertilizer application and showed high average yield of 5.5-6.0 t/ha. This variety has also performed well under moderate drought stress in rainfed trials and will require less number of irrigation even in irrigated condition. This variety can effectively substitute old mega varieties like Lalat, IR64, MTU1010, NDR97, Abhishek, Naveen etc. in early irrigated ecology.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 320 (IET 27914)
Plant height	98-99.8 cm
Plant type	Semi-dwarf
No. of tillers/plant	8-10
No. of panicles/ m ²	285-395
Flowering duration	84-88 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Straw
1000-grain weight	21.3 gm
Kernel length (mm)	6.96 mm
Kernel breadth (mm)	2.05 mm
L/B ratio	3.40
Kernel appearance	White
Hulling recovery	79.5%
Milling recovery	70.0%
Head - rice recovery	62.4 %
Alkali spreading value (ASV)	7.0
Amylose content	26.82 %
Grain type	Long slender
Grain chalkiness	Absent
Maturity duration	114-118 days
Grain yield	5.53 t/ha

CR Dhan 314

CR Dhan 314 (IET 27263, CR 4113-3-2-1) was developed from the breeding materials of cross CR 3724-1 and TJ 171-1 (CR 2668-6-7). The objective was to breed New Plant Type for obtaining very high grain yield conducive for irrigated mid situation of the country in general and eastern region in particular with sufficient tolerance to major diseases and insects. This has recorded average yield of 6.0-6.5 t/ha and notified for the states of **Odisha and Bihar**. The genotype was a kind of modified New Plant Type with maturity duration of 130-135 days. It shows semi-dwarf plant type with slightly increased height (111.5cm) but non-lodging due to strong culm. It has moderately long and heavy panicle (~5g panicle weight), moderately high grain number with long bold grains and high fertility. This produces little shy tillers, long and wide top three leaves with erect canopy and high biomass. All three leaves are on the top of panicle height. It is suitable for irrigated and favorable shallow lowlands of eastern region particularly in Odisha and Bihar. It possesses moderate panicles per m² (205-349, avg 253) with 95-110 days to 50% flowering, little shy tillering (7.6), moderately long and dense panicle with relatively high test weight. It is highly resistant to false smut, moderately susceptible to leaf blast and neck blast. Similarly, it is resistant to leaf folder and moderately resistant to stem borer (Dead heart). It has got field tolerance to major diseases and insect pests. It has good hulling, milling and head rice recovery. It possesses intermediate amylose content, long bold grains and other desirable grain quality parameters.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 328 (Divya)
Plant height	91-132.(avg 111.48)
Plant type	Semi-dwarf with little raised height
No. of tillers/plants	6.2-10.6 (Avg 7.6)
No. of panicles/ m ²	205-349 (Avg 253)
Flowering duration	95-110 (Avg 103)
Panicle type	Moderately Compact
Panicle exertion	Well exerted
Awning	Awnless
Apiculus colour	Normal
1000-grain weight (g)	25.25g
Kernel length (mm)	6.42 mm
Kernel breadth (mm)	2.34 mm
L/B ratio	2.74
Kernel appearance	White
Hulling recovery	79.1%
Milling recovery	69.3%
Head - rice recovery	56.65%
Alkali value	5
Amylose content	25.13

CR Dhan 316

CR Dhan 316 (IET 27267; CRR1 Gaurav 1) was developed through hybridization of IR 73963-86-1-5-2 and CR 2324-1. The average yield of the entry was 6.5-7.0 q/ha with excellent response to higher dose of fertilizer. The genotype was a kind of modified New Plant Type with maturity duration of 130- 135 days. It shows semi-dwarf plant type with slightly increased height (112cm) but non-lodging due to strong culm. It has moderately long and heavy panicle (~5g panicle weight), moderately high grain number with long bold grains and high fertility. This produces little shy tillers, long and wide top three leaves with erect canopy and high biomass. All three leaves are on the top of panicle height. It is suitable for irrigated and favorable shallow lowlands of eastern region particularly in Odisha. It possesses moderate panicles per m² (avg 224) with 111 days to 50% flowering, moderately long and dense panicle with relatively high test weight. It is moderately susceptible to gloom discoloration and field tolerance to major diseases. It is also showed resistant reaction against stem borer based on % Dead heart incidence. Screening results showed moderately resistant reaction to Leaf folder based on % leaf folder damaged leaf under field condition. It possesses intermediate amylose content, long bold grains and other desirable grain quality parameters.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 316
Plant height	112-120
Plant type	Semi-dwarf
No. of tillers/plants	6.0
No. of panicles/ m ²	224
Flowering duration	111
Panicle type	Moderately Compact
Panicle exertion	Well exerted
Awning	Awnless
Apiculus colour	Normal
1000-grain weight (g)	25.0g
Kernel length (mm)	6.19 mm
Kernel breadth (mm)	2.28 mm
L/B ratio	2.71
Kernel appearance	White
Hulling recovery	78.4%
Milling recovery	69.3%
Head - rice recovery	54.65%
Alkali value	5
Amylose content	24.69

CR Dhan 317

CR Dhan 317 (Roshan) (CR 2711-76, IET 24409), is a derivative line from cross of Tapaswini x Dholanumberi (IC0256804 or INGR19005). This variety showed an average yield of 5.014 t/ha in Odisha. It has a strong resistance reaction against BPH. This variety has very high head rice recovery (64.10%) and good cooking quality as evident from its alkali spreading value (4) and intermediate amylose content (20.75%). Thus, this variety has very potential to sustain yield under Odisha situation especially in BPH endemic areas. Further, this would be the first known rice variety of Odisha state having tolerance against BPH, with preferred grain quality.

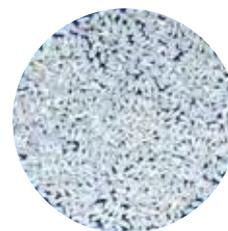


DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 317
Plant height	95-110 cm
Plant type	Semi-dwarf
No. of effective tillers /plant	9
No. of panicle / sq. m.	242
Days to 50% flowering	105-110 days
Seed to seed duration	135-140 days
Panicle type	Compact
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Straw
Lemma palea colour	straw
1000 grain weight	23.5 gm
Kernel length	5.25 mm
Kernel breadth	2.15 mm
L/B ratio	2.44
Grain type	Short bold
Kernel appearance	Very occasionally chalkiness
Milling recovery (%)	69.5
Head rice recovery (HRR %)	64
Alkali spreading value (ASV)	4.0
Amylose content (AC%)	20.75

CR Dhan 327

CR Dhan 327 (IET 27689) was developed from the breeding materials of cross Birupa / Pusa 44. The genotype is photo-insensitive, semi-dwarf, non-lodging with average maturity duration of 135 days in *kharif* season. It possesses medium slender grain with a medium length (26 cm), branched compact panicle having moderately high grain test weight (21.2g). It is resistant to False smut. Also moderately resistant to Neck blast, Bacterial blight and Brown spot. It is highly tolerant to whorl maggot and leaf folder insect pests. It is moderately tolerant to stem borer (both dead heart and white ear heads) and plant hopper. It is a non-lodging, high fertilizer responsive, easy in threshing and non-shattering variety. CR Dhan 327 has good hulling (77.75%), milling (67.8%) and head rice recovery (59.95%) as compared to checks and qualifying varieties. It possesses intermediate amylose content (24.21) with desirable grain quality parameters. Released for irrigated land in Odisha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 327 (IET 27689)
Plant height (cm)	98-101
Plant type	semi dwarf
No. of tillers/plant	8-10
No. of panicles/m ²	298
Flowering duration	98 days
Panicle type	compact
Panicle exertions	well exerted
Awning	Awnless
Apiculous colour	Straw
1000 grain weight	21.06
Kernel length (mm)	5.29
Kernel Breadth(mm)	1.92
L/B ratio	2.74
Kernel appearance	white
Husk colour	Straw
Threshability	Good
Hulling recovery (%)	77.75
Milling recovery (%)	67.8
Head rice recovery (%)	59.95
Alkali spreading value	5.0
Amylose content (%)	24.21
Gel consistency	22.0
Chalkiness	Very occasionally present
Aroma	Absent

CR Dhan 332

CR Dhan 332 (IET 28506) was developed from the breeding materials of cross Pooja / IR64 MAS. Maturity duration of the variety is 110-115 days with semi-dwarf plant type. It possesses long slender grain, more panicles per m² with 100-105 days to 50% flowering, moderate tillering, long and dense panicle with moderate test weight (23.5g). It is moderately resistant to brown spot and sheath rot, leaf folder, whorl maggot and thrips attack. It has excellent grain quality with good hulling, milling and head rice recovery as compared to check varieties. It possesses intermediate amylose content, long slender grain and other desirable grain quality parameters.



CR Dhan 309

CR Dhan 309 (IET 25345) was developed from the breeding materials of cross IR77080-B-34-3/IRRI132. Maturity duration of the variety is 110-115 days with semi-dwarf plant type. It possesses long slender grain, more panicles per m² (281) with 85-90 days to 50% flowering, normal tillering (8-15), medium and dense panicle with moderate test weight (23.5g). It is resistant to stem borer (dead heart & white ear head), leaf folder and whorl maggot leaf while moderately tolerant to leaf blast and RTV. It has excellent grain quality with good hulling, milling and head rice recovery as compared to check varieties. It possesses intermediate amylose content, long slender grain and other desirable grain quality parameters. Released and notified for irrigated ecosystem of Assam, Chhatisgarh, Uttar Pradesh.



Commercializable
Technologies

BIOFORTIFIED

CR Dhan 315 (IET 27179: CR 2826-1-1-2-4B-2-1)

This high zinc biofortified rice variety is notified for the states of Gujarat and Maharashtra. CR Dhan 315 was one of the 17 biofortified varieties dedicated to nation by Hon'ble Prime Minister on 16th October 2020 on the eve of 75th Anniversary of FAO, United Nation. The elite line IET 27179 (CR 2826-1-1-2-4B-2-1) was developed through bulk-pedigree method of selection from the cross Swarna/ARC10075 in the Biofortification breeding programme at NRRI, Cuttack with the objective to breed high yielding biofortified rice varieties with high nutritional value such as high zinc and protein. It performed well especially in Zone VI with an average 27.2 ppm and 26.5 ppm zinc content in 2017 and 2018 and it showed an average 24.9 ppm zinc content in milled rice under Biofortification trial over the years (2017-2019) in zone VI. Based on the mean performance over the years, under zone VI, in Gujarat state, IET 27179 out-performed yield checks, BPT 5204, DRR Dhan 45 and IR 64 with 11.85%, 15.80% and 14.64% yield advantages, respectively. In another state under Zone VI, Maharashtra, IET 27179 performed significantly better than BPT 5204 and DRR Dhan 45 with 21.63% and 8.65% yield superiority, respectively and performed at par with IR 64.

CR Dhan 315 has medium maturity duration (125-135 days) with semi-dwarf (110 cm) plant type. It possesses medium slender grain, more panicles per m² (300) with 100 days to 50% flowering, normal tillering (7-10), long, dense panicle with moderate test



weight (23.1g). It was resistant to leaf folder and moderately resistant to stem borer (dead heart & white ear head) while moderately tolerant to leaf blast, neck blast and brown spot in national screening nursery over the years. IET 27179 (CR Dhan315) has excellent grain quality with good hulling and milling percentages, high head rice recovery (65%), medium slender grain, very occasionally grain chalkiness, good cooking quality with intermediate amylose content (25.2%) and intermediate alkali spreading value (4) combined with low GC (22).

DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 315 (IET 27179)
Plant height	110 cm
Plant type	Semi-dwarf
No. of effective tillers /plant	8
No. of panicle / sq. m.	300
Days to 50% flowering	100 days
Seed to seed duration	130 days
Panicle type	Compact
Panicle exertion	Well exerted
Awning	Absent
Number of spikelets/panicle	232
1000 grain weight	23.1 g
Grain type	Medium slender
Lodging trait	Non-lodging

CR Dhan 324

CR Dhan 324 (IET 28698), a Doubled Haploid (DH) variety suitable for irrigated ecology. It is DH derivative of hybrid CRHR32, developed through anther culture approach. It has been officially released and approved by the Central/Odisha State Subcommittee on “Crop Standards, Notification, and Release of Varieties for Agricultural Crops” in 2023. for state of Odisha. CR Dhan 324 can be cultivated in both *kharif* and *rabi* seasons, and it is very much suitable for irrigated lands. It has high protein (11.68%) and medium high zinc (23.2ppm) and moderate Fe (2.7 ppm). It is a semi-dwarf, non-lodging, and matures in 115-120 days. CR Dhan 324 responds to fertilizer application, up to 80 kg N in *kharif* and 100 kg N in *rabi*. It possesses long slender grains with a moderate test weight of 24.0 g. CR Dhan 324 is characterized as a mid-early duration type, moderately resistant leaf blast, neck blast, brown spot, grain discoloration and false smut. Moreover, CR Dhan 324 is resistant to leaf folder and Gall midge. This variety can substitute CR Dhan 311 variety in irrigated ecology with an average yield 4.5-5.5 t/ha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 324 (IET 28698)
Plant height	105-110 cm
Plant type	Semi-dwarf
No. of tillers/plant	10-12
No. of panicles/ m ²	280-340
Flowering duration	90-95 days
Panicle type	Long and Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Green
1000-grain weight	24.0 gm
Kernel length (mm)	6.63 mm
Kernel breadth (mm)	2.14 mm
L/B ratio	3.09
Kernel appearance	White
Hulling recovery	78.9%
Milling recovery	70.4%
Head - rice recovery	67.9 %
Alkali spreading value (ASV)	4.0
Amylose content	25.66%
Grain type	Long slender
Grain chalkiness	Very Occasionally Chalkiness
Maturity duration	115-120 days
Grain yield	4.5-5.5 t/ha

CR Dhan 411 (Swarnanjali)

Rice is staple food for half of the world population and hence the main source of nutrition for them. Therefore, biofortification of rice for grain protein content (GPC) is definitely beneficial for them and can also significantly contribute to reduce malnourishment. With the objective of quantitative and qualitative improvement of GPC in popular high yielding background of Swarna (MTU 7029), a backcross population was developed using high GPC donor, ARC 10075 (INGR21092). Introgressed lines with high GPC (>10%) in 'Swarna' were detected through high throughput screening with the calibrated NIR spectroscopy. A few genotypes phenotypically similar to Swarna were detected with higher GPC, grain yield, protein yield and desirable amylose content. One of them namely, CR 2830-PLS-17 was detected with elevated level of some of the essential amino acids indicating the improvement in protein quality. Compiled data from AICRIP testing, station trial and trials at farmers' fields in Odisha over the four years (2016-2019) exhibited that the mean protein content and protein yield of CR 2830-PLS-17 (IET 26398) were 10.01% and 529.2 kg/ha, respectively which were 29% and 31% higher than the values for Swarna. It was released and notified for cultivation in Odisha as CR Dhan 411 (Swarnanjali). Due to its high genetic and phenotypic resemblance with Swarna especially for yield potentiality, grain shape and husk colour, Swarnanjali is becoming increasingly popular among farmers, millers and consumers and it can possibly be a valid replacement for Swarna. A biochemical test and a few morphological and molecular markers can differentiate Swarnanjali from its recurrent parent Swarna thus meeting the requirement for efficient seed production module. Extensive cultivation and introduction of Swarnanjali in public distribution system and mid-day meal programme can combat protein energy malnutrition among millions of people, especially the school going children.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 411 (Swarnanjali)
Coleoptile: Colour	Colourless
Basal leaf : Sheath colour	Green
Leaf: Intensity of green color	Dark
Leaf: Anthocyanin colouration	Absent
Leaf: Distribution of anthocyanin colouration	-
Leaf sheath: Anthocyanin colouration	Absent
Leaf sheath: Intensity of anthocyanin colouration	-
Leaf: Pubescence of blade surface	Medium
Leaf: Auricle	Present
Leaf: Anthocyanin colouration of auricle	Colourless
Leaf: Collar	Present
Leaf: Anthocyanin colouration of collar	Absent
Leaf : Ligule	Present
Leaf : Shape of ligule	Split
Leaf : Colour of ligule	White
Leaf : Length of blade	Medium
Leaf : Width of blade	Medium
Culm : Attitude (for floating rice only)	-
Culm : Attitude	Erect
Time of heading (50% of plants with panicles)	Late
Flag leaf : Attitude of blade (early observation)	Erect
Spikelet : Density of pubescence of lemma	Strong
Male sterility	Absent
Lemma : Anthocyanin colouration of keel	Strong
Lemma : Anthocyanin colouration of area below apex	Strong
Lemma : Anthocyanin colouration of apex	strong
Spikelet : Colour of stigma	White
Stem : Thickness	Thick
Stem : Length	Very short
Stem : Anthocyanin colouration of nodes	Absent
Stem : Intensity of anthocyanin colouration of nodes	-

Stem : Anthocyanin colouration of internodes	Absent
Panicle : Length of main axis	Medium
Flag leaf: Attitude of blade(late observation)	Semi erect
Panicle : Curvature of main axis	Deflexed
Panicle : Number per plant	Medium
Spikelet: Colour of tip of lemma	Yellowish
Lemma and Palea: Colour	Brown furrows on straw
Panicle: Awn	Absent
Panicle : Colour of awns (late observation)	-
Panicle : Length of longest awn	-
Panicle : Distribution of awns	-
Panicle : Presence of secondary branching	Present
Panicle : Secondary branching	Strong
Panicle : Attitude of branches	Erect to Semi erect
Panicle : Exsertion	Mostly exserted
Time of maturity	Late
Leaf : Senescence	Intermediate
Sterile lemma : Colour	Straw
Grain : Weight of 1000 fully developed grains	Medium
Grain : Length	Short
Grain : Width	Medium
Grain : Phenol reaction of lemma	Present
Decorticated grain : Length	Medium
Decorticated grain : Width	Medium
Decorticated grain : Shape	Short bold
Decorticated grain : Colour	White
Endosperm : Presence of amylose	Present
Endosperm : Content of amylose	Medium
Varieties with endosperm of amylase absent only polished grain : Expression of white core	-
Gelatinization temperature through alkali spreading value	Medium
Decorticated grain : Aroma	Absent

CR Dhan 310 (CR2829-PLN-37)

CR Dhan 310 (CR2829-PLN-37), a derivative of the cross, ARC10075/Naveen belongs to BC₃F₅ generation. This variety is medium early with semi-dwarf, compact plant type and has good initial growth and tillering ability. It has more than 10% protein content in polished grain which is much higher than high yielding parent (Naveen) and other checks and qualifying checks in the trial as reported in AICRIP trial and independently verified by CIFA, Bhubaneswar. This variety has been found better or at par with the checks with regard to its response to important biotic stresses. It was found tolerant or moderately tolerant to leaf blast, brown spot, sheath rot, stem borer, gall midge biotype 1 and leaf folder. The proposed variety has very high head rice recovery (69.7%) and it has good cooking qualities as realized from its alkali spreading value (5) and intermediate amylose content (25.1%). It also contains moderate level of Zn (15 ppm) in polished grain. This high protein line having high yielding ability has been identified for release for Odisha, Uttar Pradesh, Assam and Madhya Pradesh by the Varietal Identification Committee.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 310 (CR2829-PLN-37)
Plant height	109 cm
Plant type	Semi-dwarf
No. of effective tillers /plant	12
No. of panicle / sq. m.	311
Days to 50% flowering	97 days
Seed to seed duration	125 days
Panicle type	Compact
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	straw
Lemma palea colour	straw
1000 grain weight	24gm
Kernel length	5.49 mm
Kernel breadth	2.06 mm
L/B ratio	2.66
Grain type	Medium slender
Kernel appearance	Very occasionally chalkiness
Milling recovery	71.9%
Head rice recovery (HRR)	69.7%
Alkali spreading value (ASV)	5.0
Amylose content (AC)	25.1%
Gel consistency	37 mm

CR DHAN 311 (MUKUL)

CR DHAN 311 (MUKUL), a derivative of the cross, ARC10075/Naveen belongs to BC₃F₆ generation. This variety is medium early with semi-dwarf, compact plant type and has good initial growth and tillering ability. It contains a moderately high level of Zn (21 ppm) in 10% polished grain. This is significantly important to combat the micronutrient (Zn) malnutrition in people dependent on rice based diet. The proposed variety has been found at par with the checks with regard to its response to important biotic stresses. IET 24772 showed tolerance to leaf blast, glume discoloration, brown spot, RTD and bacterial leaf blight and moderate tolerance against brown plant hopper, gall midge and stem borer. The proposed variety has very high head rice recovery (60.15%) and good cooking quality as evident from its alkali spreading value (5) and intermediate amylose content (23.67%). It performed at par with its parent, Naveen in station and state trials. Moreover, the protein content and protein yield of the proposed variety, IET 24772, were found significantly higher than Naveen under station trial and at farmers' field condition in Odisha. The protein content of this line and check, Naveen was independently verified by CIFA, Bhubaneswar. This high protein variety was found promising for higher yield and higher than the threshold level of Zn (120ppm) under the Biofortification trials in 2014-2015.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 311
Plant height	110 cm
Plant type	Semi-dwarf
No. of effective tillers /plant	10
No. of panicle / sq. m.	288
Days to 50% flowering	97 days
Seed to seed duration	125 days
Panicle type	Compact
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	straw
Lemma palea colour	straw
1000 grain weight	24gm
Kernel length	5.49 mm
Kernel breadth	2.12 mm
L/B ratio	2.66
Grain type	Medium slender
Kernel appearance	Very occasionally chalkiness
Milling recovery	71.9%
Head rice recovery (HRR)	68.7%
Alkali spreading value (ASV)	5.0
Amylose content (AC)	23.1%
Gel consistency	40 mm

Commercializable
Technologies

AROMATIC

CR Sugandh Dhan-907

CR Sugandh Dhan-907 (2013) is first semi dwarf, short grain aromatic rice variety with high yield (4.0-4.2 t/ha) and wide adaptability released in India at central level (for three zones) that can greatly help in enhancing the income of the farmers. CR Sugandh Dhan-907 is a high yielding short grain aromatic variety with semi dwarf stature, erect flag leaf, dark green leaf with awned grains. It was developed with an objective to replace Dubraj (an awned aromatic genotype), the most popular aromatic landrace of MP and Chhattisgarh. This semidwarf variety was derived from the cross, Dubraj × Pusa 44. It is a non-lodging variety and responds well to high dose of nitrogen application and possesses grain quality traits similar to popular variety Dubraj. It has a medium slender (MS) grain with high HRR (62%), good kernel elongation after cooking, intermediate amylose (23.38%) and ASV (score 4) and pleasant aroma. It has a mean flowering duration of 122 days and matures in 150-152 days. With medium slender grains it showed best milling and cooking quality traits. It has moderate resistance to leaf blast, neck blast, brown spot and sheath rot. It is also moderately resistant to Leaf folder and resistant to stem borer under the natural condition. No damage was observed against abiotic stresses related to the ecology where the variety can be grown. The variety was released by CVRC and identified for the states of Chhattisgarh, Odisha, Gujarat and Andhra Pradesh. This high yielding aromatic culture with a non-lodging semi dwarf



plant type and excellent grain quality traits is highly acceptable to the farmers. Presence of aroma with excellent grain quality traits contributes to high consumer acceptability. High head rice recovery, short slender aromatic rice assists in easy marketability and fetches higher profitability to the miller. Standard seed production practices like time isolation and rouging of mixture is to be followed to maintain the seed purity.

DESCRIPTION OF THE VARIETY

Name of the variety	CR Sugandh Dhan-907 (2013)
Plant height	95 cm
Plant type	Semi Dwarf
No. of tillers/plants	8
No. of panicles/ m ²	273
Flowering duration	122
Panicle type	Compact
Panicle exertion	Full
Awning	Present
Apiculus colour	Straw
1000 -grain weight	18.7 g
Kernel appearance	White, translucent
Kernel length (mm)	5.25
Kernel breadth (mm)	1.79
L/B ratio	2.93
Chalkiness	Absent
Grain type	MS
Milling recovery	66.4
Head rice recovery	63.7
Alkali spreading value	4.0
Amylose content	23.79
Gel consistency (mm)	22
KLAC(mm)	9.0
ER	1.66
Aroma	Present

CR Sugandh Dhan 908

CR Sugandh Dhan 908 (2017), developed through hybridization of Swarna and long slender aromatic rice variety Geetanjali (a mutant of Basmati 370). The variety was released and notified for irrigated ecosystem of the state of Odisha, West Bengal, Uttar Pradesh, Assam and Maharashtra. The maturity duration is 143-148 days and the plant type is semi-dwarf and erect with good number (250-290/ m²) of compact type of panicles. It takes 115-118 days to 50% flowering. It is moderately resistant to bacterial leaf blight, leaf blast, neck blast, brown spot and stem borer, leaf folder and WBPH. In the N response trial, the variety responded well up to 100Kg of N and found to yield in low nitrogen level with maximum mean grain yield of 6.21 t/ha and ranked overall first in the trial (Draft Proceedings of 51st Annual Rice Research Group Meetings, 2016 Page 68). The medium slender grain of the variety has a test weight of 17.4g with no kernel chalkiness, has high HRR (63.8%). It possesses soft GC, intermediate amylose content and ASV. The variety with its high yield combined with superior quality aromatic rice, will fetch a premium market value to the farmers. It was identified for release under irrigated ecology in the states Odisha, West Bengal, Uttar Pradesh, Assam and Maharashtra. It is also suitable both for high and low fertility. Standard seed production practices like time isolation, rouging of field mixture and avoiding threshing floor mixtures should be followed. This high yielding aromatic culture with a non-lodging semi dwarf plant type and excellent grain quality traits is expected to be highly acceptable to the farmers, consumers, and industry.



CR Dhan 909

ICAR-National Rice Research Institute has developed CR Dhan 909(IET 23193)(CRL74-89-24-1), a scented rice variety suitable for irrigated and rainfed shallow lowland ecology. The variety was developed from the cross Pankaj/ Padumoni by pedigree method of selection at Regional Rainfed Lowland Rice Research Station (RRLRRS), Gerua, Assam. It has been notified by the Central Seed Committee vide Notification S.O. 399 (E) in the year 2018 for release in the states of Assam, Bihar, Uttar Pradesh and Maharashtra. CR Dhan 909 is suitable for cultivation under both in favourable rainfed lands during *kharij/sali* as well as in irrigated lands during *boro* season in the North Eastern Region. It matures in 145 days during *kharij/sali* season which is very suitable for cultivation in *sali*. It has a semi-dwarf plant type (105-110 cm) with 8-12 bearing tillers and long panicle (24-28 cm). It has aroma with medium slender grain and high Head Rice Recovery (70%). It has tolerance to leaf blast, neck blast, sheath rot, RTD diseases and stem borer, leaf folder and whorl maggot under natural conditions. The variety CR Dhan 909 is non-shattering, non-lodging and fertilizer responsive with good plant type. Rice variety CR Dhan 909 has the potential to provide 5.0-5.5 t/ha during *boro/ahu* season.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 909 (IET 23193)
Plant height	105-110 cm
Plant type	Semi-dwarf
No. of tillers/plant	8-12
No. of panicles/ m ²	250-350
Flowering duration	111-115 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Normal
1000-grain weight	24.6 gm
Kernel length (mm)	5.80 mm
Kernel breadth (mm)	2.19 mm
L/B ratio	2.65
Kernel appearance	Translucent
Hulling recovery	79.1%
Milling recovery	71.3%
Head - rice recovery	70.0 %
Alkali spreading value (ASV)	7.0
Amylose content	24.02 %
Grain type	Medium slender
Grain chalkiness	Absent
Maturity duration	145 days
Grain yield	4.5-5.0 t/ha

CR Sugandh Dhan 910

CR Sugandh Dhan 910 (CR 2713-180, IET 22649, 2016) was developed through hybridization of Swarna and Geetanjali, a basmati type variety with long slender grains with pleasant aroma. It was released and notified for Odisha, having average yield of 3.5-4.2 t/ha. The maturity duration of the variety is 142-145 days and the plant type is semi-dwarf. It is moderately resistant to blast, neck blast, sheath rot, RTV, stem borer, leaf folder and WBPH. The variety responded well to higher dose (180 kg) of fertilizer application. The medium slender grains of the variety have a test weight of 17.3g with no kernel chalkiness and has high HRR (68.8%). It possesses soft GC, intermediate amylose content and ASV. The proposed variety with its high yield combined with superior grain quality and aroma, is expected fetch a premium market value to the farmers. This variety with wider adaptability has been released by Odisha state as CR Sugandh Dhan 910.



Commercializable
Technologies

**CLIMATE
RESILIENT**

CR Dhan 408 (Chakaakhi)

ICAR-National Rice Research Institute has developed CR Dhan 408 (CR491-1590-330-2-1, IET 20265), a variety suitable for Rainfed Shallow Lowland Ecology. The variety was developed from the segregating materials of the cross CR149-5010-228/T1242. It has been officially released and approved by the Central subcommittee on “Crop Standards, Notification, and Release of Varieties for Agricultural Crops” in 2018 for the state of Odisha under late duration. It has semi-tall plant type with plant height 130-140cm and maturation in 165 days. It is popular due to presence of basal purple color, apiculous seed along with good cooking quality traits especially for wet rice preparation. It has long bold grain, with an average yield of 4500kg/ha. IET 20265 possess desirable quality characters like high head rice (60%), high milling (68%) and intermediate amylose content (23.03%). This variety is moderately resistant to leaf blast, neck blast, bacterial blight and sheath rot. Similarly, it exhibited moderate resistance reaction against the pests stem borer, leaf folder, white backed plant hopper and rice whorl maggot attack.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 408 (CR491-1590-330-2-1, IET 20265)
Plant height (cm)	130-140
Plant type	Semi-tall
No. of tillers/plants	7-10
No. of panicles/ m ²	250-300
Days to 50% flowering	135 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Sporadic
Apiculus colour	Purple
1000 -grain weight (g)	25.5
Kernel length (mm)	6.1
Kernel breadth (mm)	2.46
L/B ratio	2.48
Kernel appearance	White
Hulling recovery (%)	-
Milling recovery (%)	68
Head rice recovery(%)	59
Alkali spreading value	4.0
Amylose content (%)	23.03
Grain type	Long bold
Maturity duration	165 days
Grain yield	4.5t/ha

CR Dhan 412 (NICRA Dhan: Luna Ambiki)

Around 4 lakh ha area distributed in seven coastal districts of Odisha is affected by salinity. Rice is the main crop in about 300,000 ha of this coastal alluvial land suffers from tidal inundation. Tall indica varieties such as Patnai 23, SR 26B and improved varieties such as Lunishree, Luna Suvarna and Luna Barialare grown in this rainfed salinity affected lowland areas. But there is immense scope for improvement of salinity tolerance resulting in increasing yield potentiality in this ecosystem. CR Dhan 412 (IET 27852: CR 2851-S-1-6-2B-4-1), a derivative of the cross, Gayatri/SR-26-B has been developed through bulk-pedigree method of breeding. In AICRIP trials (CSTVT- 2018 and 2019) in Odisha with average grain yield of 3021 kg/ha the this variety out-yielded all checks including local check, Luna Suvarna with 13.13% yield advantage under salinity stress condition (6.8-7.5 dSm-1). Under state multi-locational testing (Kharif 2018-2019) in three coastal districts, it out-performed (4618 kg/ha) the released varieties for coastal saline areas, Luna Suvarna and Luna Barial with 13.41% and 12.88% yield advantages under various level of salinity stresses (EC=2.2-7.2 dSm-1). This variety was not found susceptible to any major biotic stress as compared to check varieties. It was found moderately tolerant to neck blast and sheath rot and moderately resistant against stem borer and leaf folder. In Odisha, it was found tolerant to BLB, moderately tolerant to sheath rot, moderately resistant to



stem borer and resistant to leaf folder. It has acceptable head rice recovery (57.4%) and good cooking quality with 27.77% amylose content coupled with soft GC (45). It was found tolerant to moderately tolerant to salinity stresses at seedling and reproductive stages at EC level upto 6-7 dSm-1 as reported at national testing. This proposed variety IET 27852 is late duration (140 days) with semi-dwarf, compact plant type and has good initial growth and tillering ability. Moreover, with average grain yield of 4380 kg/ha it showed yield superiority over the released varieties Luna Suvarna and Luna Barial and other local checks at national and state multi-locational testing at various level of salinity in coastal saline ecosystem in Odisha. Due to its salinity tolerance, non-lodging plant type and yield advantages over the existing recommended varieties it is well accepted by growers in coastal saline areas in Odisha. Acceptable grain type and milling and cooking quality will help its acceptability by millers and consumers. It was released and notified in Odisha for coastal saline ecology in 2021.

DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 412 (NICRA Dhan: Luna Ambiki)
Coleoptile Colour	-
Basal Leaf Sheath Colour	Green (1)
Leaf: Intensity Of Green Colour	Dark (7)
Leaf: Anthocyanin Colouration	Absent (1)
Leaf: Distribution of Anthocyanin Colouration	NA
Leaf Sheath : Anthocyanin Colouration	Absent (1)
Leaf Sheath :Intensity Of Anthocyanin Colouration	Very weak (1)
Leaf :Pubescence Of Blade Surface	Strong (7)
Leaf: Auricle	Present (9)
Leaf :Anthocyanin Colouration Of Auricle	Colourless (1)
Leaf: Collar	Present (9)
Leaf: Anthocyanin Colouration Of Collar	Absent (1)
Leaf: Ligule	Present (9)
Leaf: Shape Of Ligule	Split (3)
Leaf: Colour Of Ligule	White (1)
Leaf: Length Of Blade	Medium (5) (30-45cm)
Leaf: Width Of Blade	Medium (5) (1-2cm)
Culm: Attitude (For Floating Rice Only)	NA
Culm: Attitude	Erect (1)

Time Of Heading(50% Of Plants With Panicle)	Medium (5)(91-110Days)
Flag Leaf: Attitude Of Blade(Ealy Observation)	Semi - Erect (3)
Spikelet : Density Of Pubescence Of Lemma	Medium (5)
Male Sterility	Absent (1)
Lemma: Anthocyanin Colouration Of Keel	Absent Or Very Weak (1)
Lemma: Anthocyanin Colouration Of Area Below Apex	Absent (1)
Lemma: Anthocyanin Colouration Of Apex	Absent (1)
Spikelet: Colouration Of Stigma	White(1)
Stem: Thickness	Thick (7) (>0.55cm)
Stem: Length (Excluding Panicle, Excluding Floating Rice)	Very Short (<91cm)
Stem :Anthocyanin Colouration Of Nodes	Absent(1)
Stem: Intensity Of Anthocyanin Colouration Of Nodes	NA
Stem :Anthocyanin Colouration Of Internodes	Absent(1)
Panicle :Length Of Main Axis	Long(7)(26-30cm)
Flag Leaf: Attitude Of Blade(Late Observation)	-
Panicle : Curvature Of Main Axis	-
CHARACTERSTIC	DESCRIPTION (SCORE)
Panicle :Number Per Plant	Medium(5)(11-20)
Spikelet: Colour Of Tip Of Lemma	Yellow(2)
Lemma And Palea: Colour	Straw(1)
Panicle : Awn	Absent(1)
Panicle : Colour Of Awn(Late Observation)	NA
Panicle: Length Of Longest Awn	NA
Panicle: Distribution Of Awns	NA
Panicle: Presence of Secondary Branching	Present(9)
Panicle : Secondary Branching	Strong(2)
Panle : Attitude Of Branches	Erect To Semi Erect (3)
Panicle : Exertion	Well Exserted(7)
Time Of Maturity	140 days
Leaf: Senescence	-
Sterile Lemma: Colour	Starw(1)
Grain: Weight Of Fully Developed Grains 1000	Medium(5)(21-25 g)
Grain: Length	Medium(5)(8.6-10.5 mm)

Grain: Width	Medium(5)(2.6-3.0 mm)
Grain :Phenol Reaction Of Lemma	-
Decorticated Grain: Length	Medium(3)
Decorticated Grain: Width	Medium(5)(2.0-2.5 mm)
Decorticated Grain : Shape(In Lateral View)	Medium slender
Decorticated Grain: Colour	White(1)
Endosperm :Presence of Amylose	y
Endosperm :Content of Amylose	25%
Varieties With Endosperm of Amylose Absent Only Polished Grain: Expression of White Core	VOC
Gelatinization Temperature Through Alkali Spreading Value	5
Decorticated Grain: Aroma	Absent (1)

CR Dhan 414

It is released and notified for Odisha, West Bengal (Zone-III) and Andhra Pradesh (Zone VII) in 2022. It was derived from Gayatri/ SR 26B (SR 26 B : multiple stress tolerant). CR Dhan 414 has released after 14 years of releasing of any variety at national level for coastal saline areas. In Odisha it performed well ($EC= 5.5-7.5 \text{ dSm}^{-1}$) with 8% and 10% yield advantages over coastal saline check, Bhutnath and the local check, Luna Suvarna. It stood 2nd in 2017 (IVT-CSTVT) and 1st in 2020 (AVT- CSTVT). In West Bengal it registered 4979 kg/ha grain yield over the situation ($EC= 2- 6.7 \text{ dSm}^{-1}$) with 16% and 7% more grain yield over Bhutnath and local check, Gosaba-5. In Andhra Pradesh it performed well under saline situation ($EC= 7.86-10.9 \text{ dSm}^{-1}$) with 5303 kg/ha grain yield which was 71% and 22% more than Bhutnath and the local check, respectively. It has been tested for 5 years in Andhra Pradesh and stood either 1st or 2nd in 3 out of 5 years and detected with very high significant superiority over checks under saline situation ($EC= 7.86-10.9 \text{ dSm}^{-1}$)

In AICRIP Physiology trial it was found tolerant and moderately tolerant under the following condition.

- Highly tolerant to Anaerobic germination stress with high anaerobic germination (>80%) potential
- Tolerant to osmotic stress under 1% and 2% mannitol stress
- Moderately tolerant to salinity at seedling stage (SES score= 5)

CR Dhan 414 has late maturity duration (145-150 days) with moderately tall (115 cm) plant type. It possesses medium slender grain, more panicles per m^2 (300) with 120 days to 50% flowering, normal tillering (7-10), long, dense panicle with moderate test weight (23.5g).



It was resistant to leaf folder and moderately resistant to stem borer (dead heart & white ear head) while moderately tolerant to neck blast and Rice tungro virus in national screening nursery over the years.

It has excellent grain quality with good hulling and milling percentages, high head rice recovery (61%), medium slender grain, very occasionally grain chalkiness, good cooking quality with intermediate amylose content (26.3%) and with soft GC (41).

DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 414
Plant height	113 cm
Plant type	Semi-dwarf
No. of effective tillers /plant	8
No. of panicle / sq. m.	285
Days to 50% flowering	113 days
Seed to seed duration	145 days
Panicle type	Compact
Panicle exertion	Well exerted
Awning	Absent
Number of spikelets/panicle	155
1000 grain weight	23.5 g
Grain type	Medium slender
Lodging trait	Non-lodging

CR Dhan 415 (Kamesh)

Central Rainfed Upland Rice Research Station, Hazaribag of ICAR-National Rice Research Institute has developed CR Dhan 415 (IET 22097), a variety suitable for rainfed drought-prone shallow low ecology (Don2) of Jharkhand. The variety was developed from the cross between Apo and IR64. Apo is a drought tolerant aerobic variety, released in The Philippines and IR64 is a mega variety with excellent grain quality, high productivity, and disease resistance. It has been officially released by SVRC, Jharkhand and approved by the Central sub-committee on “Crop Standards, Notification, and Release of Varieties for Agricultural Crops” in 2022 for the state of Jharkhand.

CR Dhan 415 is mid-early duration, semi-dwarf, erect, highly vigorous, non-lodging, non-shattering and dark green in colour. The plant comes to flowering in 96 days, plants are 112 cm tall, and it produce good biomass, long panicle, and have medium bold grain with white kernel. It is resistant to leaf blast & moderately resistant to brown spot and also resistant Gall Midge-biotype 4 & 1, WBPH and moderately resistant to stem borer and leaf folder. CR Dhan 415 possess very good grain quality attributes of Milling (68.4%) and Head Rice Recovery (64.9%), short bold grains, chalk very occasionally present, moderate gelatinization temperature (ASV-3.5), intermediate amylose content of 22.09 and soft GC of 41. It matures in about 12-125 days and showed average yield of 5.0 to 5.5 t/ha.

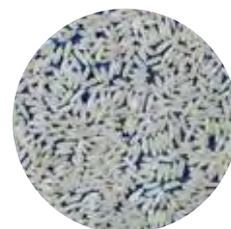


DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 415 (IET22097)
Plant height	112 cm
Plant type	Intermediate
No. of tillers/ plants:	7-9
No. of panicles/sq m	262
Flowering duration	96 days
Panicle type	Compact
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Brown
1000-Grain weight	21.03g.
Kernel length (mm)	5.27 mm
Kernel breadth (mm)	2.34 mm
L/B ratio	2.26 (SB)
Kernel appearance	White
Hulling recovery	78.7%
Milling recovery	68.4%
Head rice recovery	64.9%
Alkali value	3.5
Amylose content	22.09%
Gel consistency (mm)	41
Grain chalkiness	Very occasionally
Maturity duration	120-125 days
Grain yield	5.0-5.5 t/ha

CR Dhan 407

CR Dhan 407 (CR 2459-12-8), is derivative of cross Swarna and IR 64. This is semi dwarf culture having plant height of 102 cm with 120 days to 50% flowering possesses long bold grain, high HRR (63.6%), ASV 6 and intermediate amylose content (24.57%). It has moderate resistance to BLB, moderately resistant to white backed plant hopper, whorl maggot and responds to high level of N application. The culture with brown husk, desirable grain quality traits and high head rice recovery will be accepted by farmers of rainfed shallow lowland areas and preferred by millers. This has average yield of 5.0 t/ha and released and notified for cultivation under coastal regions in West Bengal and Odisha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 407
Plant height	97-103 cm
Plant type	Semi dwarf
No. of tillers/plant	9-12
No. of panicles/ m ²	280-306
Flowering duration	120-123 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Awn less
Grain colour	Brown
Apiculus colour	Brown
1000 grain weight	22.8 g
Kernel length (mm)	6.58
Kernel breadth (mm)	2.21
. L/B ratio	2.96
Grain type	LB
Kernel appearance	White
Hulling recovery	80.0
Milling recovery	70.6
Alkali spreading value	6
Amylose content	23.5
Gel consistency	42.5

Commercializable
Technologies

MAS PRODUCT

CR Dhan 805 (CR 4331-85-1-1-1, IET 29203)

ICAR-National Rice Research Institute has developed CR Dhan 805 (IET 29203), a Brown Planthopper (BPH) resistant rice variety suitable for irrigated ecology. It has been officially released and approved by the Central Sub-committee on “Crop Standards, Notification, and Release of Varieties for Agricultural Crops” in 2023 for Odisha. It is a near isogenic line (NIL) of popular irrigated rice variety “Naveen” carrying two BPH resistant QTLs *qBph4.3* and *qBph4.4* and has been developed through marker assisted backcross breeding. These QTLs were identified from the ‘Salkathi’ landrace of Sambalpur district of Odisha and subsequently transferred to the pre-breeding line CR 3006-8-2 which has been used as donor. Development of CR Dhan 805 is the output of complete indigenous effort of identification of novel germplasm, mapping the underlying QTLs and their effective introgression in native varieties. Growing this NIL can save the popular variety Naveen from BPH infestation while retaining its all the other advantages of yield and grain quality. This photo-insensitive medium early duration variety confers resistance through both antixenosis and antibiosis and can be cultivated in both *kharif* and *rabi* seasons in irrigated areas.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 805 (CR 4331-85-1-1-1, IET 29203)
Plant height	100-105cm
Plant type	Semi-dwarf
No. of tillers/plant	8-10
No. of panicles/ m ²	242
Days to 50% flowering	95-100 days
Seed to seed duration	125-130 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Straw
Lemma palea colour	Straw
1000-grain weight	21.13 g
Kernel length (mm)	5.35 mm
Kernel breadth (mm)	2.07 mm
L/B ratio	2.57
Kernel appearance	White
Hulling recovery	75.05%
Milling recovery	65.65%
Head - rice recovery	61 %
Alkali spreading value (ASV)	4.0
Amylose content	25.6%
Grain type	Medium slender
Kernel appearance	White
Grain chalkiness	Absent
Maturity duration	125-130 days
Grain yield	4.8 t/ha

CR Dhan 807 [CR 4333-35-2-2-1 (IET 30438)]

ICAR-National Rice Research Institute has developed CR Dhan 807 (IET 30438), a non-GMO herbicide (Imazethapyr) tolerant near isogenic line (NIL) of mega variety Sahbhagidhan developed through marker assisted backcross breeding. It has been identified for release by Variety Identification Committee (VIC) in 2023 for the gazette notified and adaptable states of Sahbhagidhan *viz.*, Jharkhand, Odisha, Andhra Pradesh, Tamil Nadu, Chhattisgarh and Gujarat. The variety was developed from the cross between Sahbhagidhan and Robin. It is suitable for early direct seeded rainfed upland condition. Weed management (including weedy rice) is one of the most critical problems in this ecology. Herbicide tolerant version of Sahbhagidhan can address this problem. Imazethapyr application didn't cause any phytotoxicity in CR Dhan 807 and the genotype yielded significantly higher than the recurrent parent Sahbhagidhan grown in weed free plots managed through manual weeding at all trial zones. As an added advantage, the NIL also yielded significantly better than the recurrent parent under no weed control measures at all test sites indicating its better ability to compete with the weeds. Till date, no chemical control measure is available to manage weedy rice in paddy fields which is an emerging problem. Even manual weeding is not possible before flowering stage. Application of Imazethapyr herbicide in this variety can effectively control weedy rice. The herbicide tolerance gene (*AHAS*) is located within *APO-qDTY2.1* haplotype homologue in donor parent Robin (N22 mutant), and the region was also transferred to CR Dhan 807 during introgression. This variety will enable complete mechanization of rice cultivation and address the major issues of labour scarcity and increased cost of cultivation of rice in the country. DSR cultivation will also reduce water usage and greenhouse gas emission from rice fields. It exhibits a photo-insensitive trait and has a semi-dwarf plant type; good panicle branching and matures in 105-110 days. It has good hulling, milling and cooking qualities. This variety can substitute Sahbhagidhan variety in rainfed upland ecology with an average yield of 4.0 t/ha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 807 [CR 4333-35-2-2-1 (IET 30438)]
Plant height	100-105cm
Plant type	Semi-dwarf
No. of tillers/plant	8-10
No. of panicles/ m ²	244
Days to 50% flowering	80-85 days
Seed to seed duration	105-110 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Lemma palea colour	Golden brown
1000-grain weight	22.84 g
Kernel length (mm)	5.51 mm
Kernel breadth (mm)	1.92 mm
L/B ratio	2.86
Kernel appearance	White
Hulling recovery	72.5%
Milling recovery	66.0%
Head - rice recovery	58 %
Alkali spreading value (ASV)	7.0
Amylose content	22.78%
Kernel appearance	White
Grain chalkiness	VOC
Maturity duration	105-110 days
Grain yield	4.0 t/ha

CR Dhan 800

CR Dhan 800, is medium late (145 days), semi-dwarf (85-90cm) rice variety released for Odisha state by SVRC, Odisha during the year 2016. The variety is resistant to bacterial blight of rice. CR Dhan 800 was developed by pyramiding of *xa5*, *xa13* and *Xa21* bacterial blight resistance genes in the popular variety, Swarna. It is developed through marker-assisted breeding approach at the National Rice Research Institute, Cuttack. This variety has the medium slender grain, intermediate alkali spreading value and amylose content identical to the parent, Swarna. The variety is suitable for bacterial blight endemic areas Odisha state.

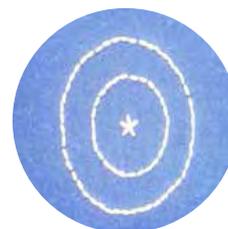


DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 800
Plant height	85-90 cm
Plant type	Semi-dwarf
No. of tillers/plant	9-12
No. of panicles/m ²	250-300
Flowering duration	115 days
Panicle type	Compact panicle
Panicle exertion	Well exerted
Awning	Awnless
Apiculus colour	Green
1000 -grain weight	18.98 g
Kernel length (mm)	5.30 mm
Kernel breadth (mm)	2.06 mm
L/B ratio	2.57
Kernel appearance	White
Hulling recovery	79.6 %
16. Milling recovery	69.9 %
Head - rice recovery	66.7 %
Alkali value	4-5
Amylose content	22.68 %

CR Dhan 801

The variety, CR Dhan 801 is recommended for cultivation in the states of Odisha, West Bengal, Andhra Pradesh, Telangana and Uttar Pradesh. It was developed from the cross of IR81896-B-B-195/2*Swarna-Sub1//IR91659-54-35 by marker-assisted breeding method. The variety has tolerance to submergence and drought condition. The variety is weakly photosensitive with average maturity duration of 140-145 days with plant height of 100cm. The average yield of the variety is 6350 kg/ha under normal condition and about 3000 kg/ha under drought and submergence stress condition. It possesses short bold grain with a test weight of 20.5g. It is resistant to stem borer (both dead heart and white ear heads), leaf folder and case worm while moderately resistant to bacterial blight and rice tungro virus. It has good hulling, milling, head rice recovery, alkali spreading value and intermediate amylose content. It possesses intermediate amylose content, short bold grain and other desirable grain quality parameters.

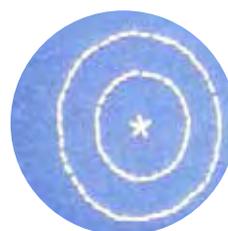


DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 801
Plant height	100 cm
Flowering	114 days
Maturity duration	140 days
1000-grain weight (g.)	20.6
Lodging	Non-lodging
Panicle type	Intermediate
Panicle exertion	Well exeserted
Hulling (%)	79.6
Milling (%)	69.9
Head Rice Recovery (%)	66.2
Kernel Length(mm)	5.15
Kernel Breadth(mm)	2.22
L/B Ratio	2.31
Grain type	SB
Grain Chalkiness.	VOC
Alkali Spreading Value	4.0
Amylose Content (%)	25.13
Gel Consistency (mm)	39

CR Dhan 802 (Subhas)

CR Dhan 802 (Subhas), was developed from the breeding materials of cross Swarna-Sub1 *4 / IR81896-B-B-195 is recommended for cultivation in the states of Bihar and Madhya Pradesh. Selection, evaluation and testing of the NILs were done at ICAR-National Rice Research Institute, Cuttack, Odisha with the objective to breed high yielding variety with tolerance to submergence and drought condition. CR Dhan 802 was released in the year 2019. The average yield of the variety is 6508 kg/ha under normal condition and 2344 kg/ha under drought stress. CR Dhan 802 is weakly photosensitive with average maturity duration of 140-145 days. It possesses short bold grain with a test weight of 19g. It is resistant to stem borer (both dead heart and white ear heads), leaf folder, plant hopper and case worm while moderately resistant to bacterial blight, sheath rot and rice tungro virus. It possesses intermediate amylose content, short bold grain and other desirable grain quality parameters.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 802 (Subhas)
Plant height	100 cm
Flowering	116 days
Maturity duration	145 days
1000-grain weight (g.)	20.4
Lodging	Non-lodging
Panicle type	Intermediate
Panicle exertion	Well exeserted
Hulling (%)	77.85
Milling (%)	70.2
Head Rice Recovery (%)	64.25
Kernel Length (mm)	5.0
Kernel Breadth (mm)	2.16
L/B Ratio	2.31
Grain type	SB
Grain Chalkiness.	VOC
Alkali Spreading Value	4.5
Amylose Content (%)	25.0
Gel Consistency (mm)	39.5

CR Dhan 803

CR Dhan 803 (Trilochan, CR3932-7;IET 26744) was developed from the popular variety, Pooja through marker-assisted backcrossing. The elite line was developed from the breeding materials of the cross Pooja*3 / Swarna- Sub1. It has consistently out-performed or at par with the recipient parent and sensitive check under submergence condition. The average yield of the culture was 5.0t/ha under normal condition and 3.5t/ha and notified for Odisha state. The genotype is photosensitive type with average maturity duration of 150 days. It possesses short bold grain with a test weight of 19.95g. It was resistant to stem borer (dead heart) and BPH and moderately resistant to white ear head attack, WBPH, leaf folder, plant hopper, and case worm. The variety was moderately resistant to neck blast and rice tungro virus. CR Dhan 803 has good hulling, milling and head rice recovery as like the recipient parent and qualifying varieties. It possesses intermediate amylose content, Short bold grain and other desirable grain quality parameters.



CR Dhan 806 (Varshdhan Sub1)

CR Dhan 806 (Varshdhan Sub1) was developed from the breeding materials of the cross Varshadhan*3/IR49830-7. The average yield of the culture is 3.5-4.0 t/ha under submergence stress condition in Odisha state. The genotype is photosensitive type with average maturity duration of 150 days. It possesses long bold grain with a test weight of 24g. It was resistant to stem borer (dead heart) and BPH. The variety was resistant to false smut and moderately resistant to neck blast. Varshadhan-Sub1 has good hulling, milling and head rice recovery as like the recipient parent and qualifying varieties. It possesses intermediate amylose content, long bold grain and other desirable grain quality parameters. Hence, the entry IET 29032 (CR Dhan 806) is released and notified in Odisha state.



Commercializable
Technologies

DOUBLED HAPLOID

Contract services and licensing Doubled Haploid technology

Rice as a cereal grain is the predominant staple food for large part of the world's human population, especially in Asia. Despite the fact that rice plays an important role in the food and agrarian ecosystems, traditional rice producing countries are facing issues such as declining arable land owing to industrialization, resource constraints and climate change consequences. Since increase maximum amount yield in rice has become static after green revolution, globally hybrid rice is considered as a best option showing significant yield advantages over inbreds. However, although a number of rice hybrids are released for commercial cultivation in India, still it doesn't gain its popularity among the Indian farmers for the reasons being: 1) high seed cost 2) farmers can't use their seed from one year to another 3) quality of produce. Doubled Haploid (DH) technology through androgenesis have proven to be an effective tool for plant breeding, producing homozygous lines within a short span of time.

Technology Details

DH technique best available speed breeding technology, accelerates development and facilitates fast delivery of high performing varieties within 5-6 years with doubled genetic gain than conventional approach that takes- 8 to 10 years, thus saving time, labour and financial resources. DHs are 100% homozygous, can be utilized for mapping or elucidating the traits which are highly additive in nature and controlled by recessive alleles. Besides, DHs are also fit for application of biotechnological strategies, MAS, trait mapping, genetic transformation or editing and proteomic studies.

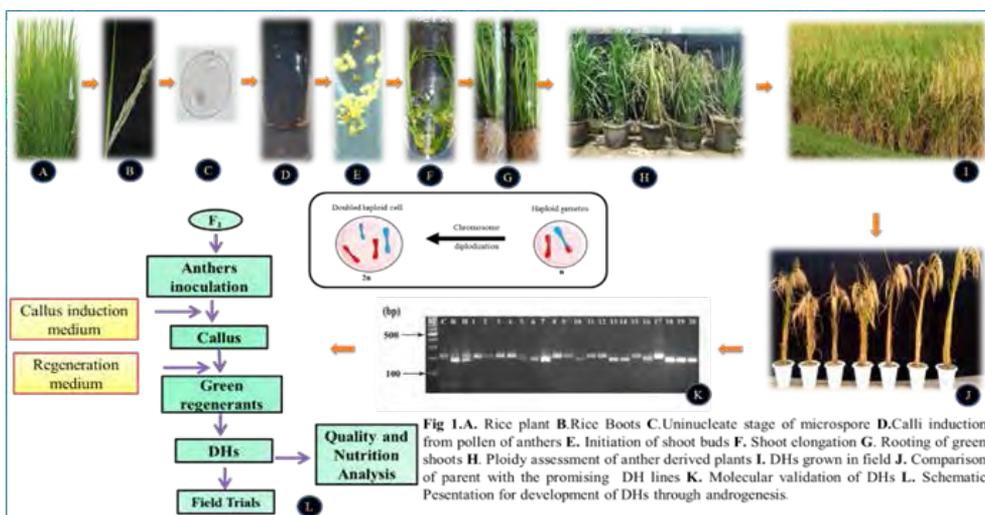


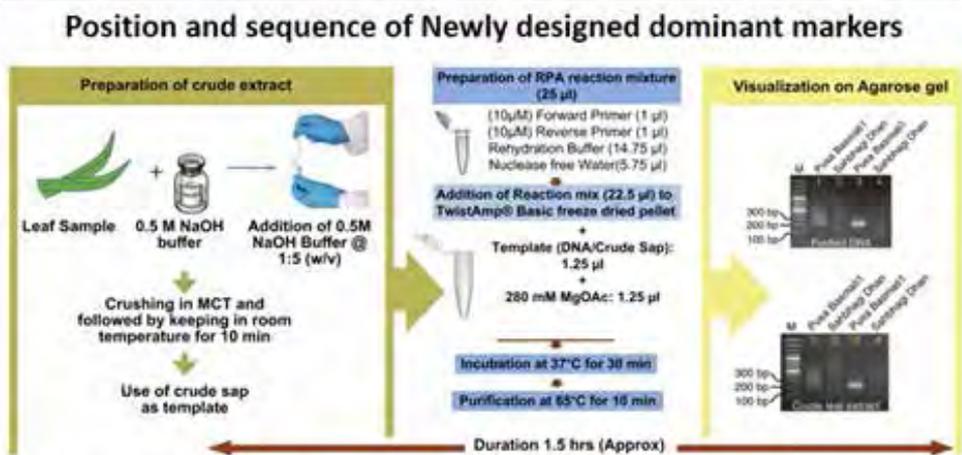
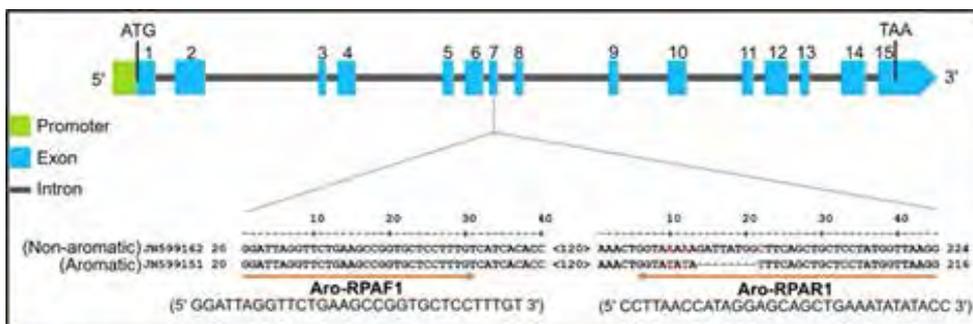
Illustration of Doubled Haploid (DH) Technology

Technology Profile

Simple template based rapid detection of aroma gene in rice

Summary of the product/technology

A simple template based isothermal detection protocol for aroma gene in rice has been developed utilizing recombinase polymerase amplification (RPA) assay. A dominant marker (Aro-RPAF1/R1) based on eight-base pair deletion and three SNP (8 bp-FNP) in exon 7 of the gene encoding betaine aldehyde dehydrogenase 2 (BADH2) on chromosome 8 of *Oryza sativa* (the key factor for fragrance in rice) has been designed to differentiate between aromatic and non-aromatic cultivars. The developed RPA protocol using the marker is able to differentiate aromatic and non-aromatic rice directly from crude leaf extract lysed in 0.5 M NaOH solution (1:5; w/v) within 1.5 hrs under isothermal conditions at 37°C. The developed protocol is highly specific and sensitive in detecting the functional mutation up to 10⁻⁷ dilution of crude leaf extract and up to 0.0001 ng μl^{-1} of DNA. It was validated on diverse aromatic rice germplasm as well as on the hybrid plants [(Pusa Basmati 1 (aromatic) × Sahbhagi Dhan (non-aromatic))].



Flow chart of simple template based detection of aroma gene in rice

Uniqueness of the technology in comparison to existing ones

Aromatic rice is a highly valued rice varietal group because of its pleasant and highly desirable aroma, and other grain quality such as superfine kernels, high kernel elongation after cooking, and texture of cooked rice. In aromatic rice breeding, a number of sensory methods are adopted by the breeders to select desired lines. However, evaluation a large sample using these methods is labour-intensive, and less reliable because the aroma is subjected to human preference. Molecular markers, especially functional markers linked to aroma have been developed to provide a rapid, simple and relatively inexpensive way of selecting aroma in rice samples based on the most frequent 8bp-FNP in Badh2. Although these markers have been widely used by the rice breeders around the world, there is still many laboratories in the developing countries lacking thermal cyclers and associated instruments. Therefore, a less expensive but simple and reliable technique is required for selecting aroma.

The developed RPA based protocol is capable to detect rice aroma gene within 1.5 hrs directly from the crude leaf extract, while the PCR based detection is only possible using extracted DNA. Therefore, the developed assay will be highly useful for a rapid and sensitive selection of aromatic lines under resource-limited setup. It can be utilized for rapid screening of rice germplasm for the aroma gene for selecting parents in aromatic rice breeding programme as well as to screen adulterations in Basmati rice varieties.

Proposed stakeholders

Rice breeders: For donor screening

Seed industry: For easily differentiate between aromatic and non-aromatic entries including Basmati

Commercial potential, if any

This lateral flow strip-based rapid on-site detection kit for rice aroma gene could be developed adopting this protocol for commercial use.

Publication/photos/video clipping, if any

Research article

Banerjee Amrita, Bharti S, Kumar J, Sar P, Priyamedha, Mandal NP, Sarkar S and Roy S (2023). Recombinase Polymerase Amplification Based Rapid Detection of Aroma Gene in Rice. Rice Science. 30(2): 96-99 (NAAS IF: 10.41)

CR Dhan 911

CR Dhan 911 (IET 28414), a Doubled Haploid (DH) variety suitable for irrigated ecology. It is DH derivative of hybrid BS6444G, developed through anther culture approach. It was released and notified during 2023 for the state of Odisha. CR Dhan 911 can be cultivated in both *kharif* and *rabi* seasons, and very much suitable for irrigated lands. It is a semi-dwarf, non-lodging, aromatic and matures in 120-125 days. CR Dhan 911 responds to fertilizer application, up to 80 kg N in *kharif* and 100 kg N in *rabi*. It possesses long slender grains with a moderate test weight of 20.5 g. CR Dhan 911 is characterized as a medium duration type, resistant to false smut, moderately resistant to leaf blast, brown spot, grain discoloration. Moreover, CR Dhan 324 is moderately resistant to leaf folder and Gall midge. This variety can substitute Geetanjali variety in irrigated ecology with an average yield 4.5-5.5 t/ha.



DESCRIPTION OF THE VARIETY

Name of the variety	CR Dhan 911 (IET 28414)
Plant height	95-105 cm
Plant type	Semi-dwarf
No. of tillers/plant	10-12
No. of panicles/ m ²	280-320
Flowering duration	95-100 days
Panicle type	Long and Compact panicle
Panicle exertion	Well exerted
Awning	Absent
Apiculus colour	Green
1000-grain weight	20.5 gm
Kernel length (mm)	5.77 mm
Kernel breadth (mm)	1.40 mm
L/B ratio	4.12
Kernel appearance	White
Hulling recovery	75.0%
Milling recovery	71.67%
Head - rice recovery	68.2%
Alkali spreading value (ASV)	3.0
Amylose content	21.03%
Grain type	Long slender
Grain chalkiness	Absent
Maturity duration	120-125 days
Grain yield	4.5-5.5t/ha

PRODUCTION TECHNOLOGIES

Customized Color Coded Tensiometer for Scheduling Irrigation in Rice

Rice crop is known to have high water requirement. In traditional rice cultivation, farmers generally keep the field continuously flooded from transplanting to physiological maturity of rice crop. However, it is well established that continuous flooding is not necessary for rice to achieve high yields. After seedling establishment phase, even in the absence of standing water in field, rice plant can extract soil water from the below surface soil around root zone. Over the past few decades, water scarcity has emerged as one of the biggest challenges for sustaining rice production. Development of novel water saving technologies is an important step to help rice farmers cope with water scarcity. It is well proved that soil water potential as measured by tensiometer can be used as an irrigation index for scheduling irrigation in rice.



The tensiometer consists of a rigid and sealed body tube and a porous ceramic cup filled with water. The body tube is transparent so that water within the tube can easily be seen. The tensiometer tube along with the ceramic cup is inserted in the soil preferably at the plant root zone depth to provide a direct measurement of soil water potential- the force by which the soil particles hold the water. The wetter the soil, the lower the soil water potential. The ceramic cup is porous so that water can move through it to equilibrate with the soil water. As the soil dries out, water is sucked out of the tensiometer through the porous ceramic tip. This creates a partial vacuum in the sealed tensiometer tube which is measured by the electronic gauge. When the soil is watered the converse happens. The core

idea behind the use of tensiometer is the identification of threshold soil water potential for optimizing irrigation scheduling. Such irrigation scheduling can maximize water productivity by reducing irrigation water input, because farmers generally over-irrigate the crop irrespective of its requirement.

A simplified and farmer-friendly version of a tensiometer tube for real-time soil water potential based irrigation management was developed by ICAR – National Rice Research Institute, Cuttack. In this tensiometer, the usual measuring gauge has been replaced by stripes of light blue, deep blue, orange, and brown color. While the water level in the tensiometer tube at light blue stripe signifies no need for irrigation, there is a need to irrigate when the water level enters the deep blue stripe. The entry into the orange and brown stripes may adversely affect the crop yield and hence should be avoided.

Interpretation of the color stripes of Customized color coded tensiometer

Color Stripe	Interpretation
Light Blue	No need of Irrigation
Deep Blue	Irrigation should be applied
Orange	Immediate need of irrigation
Brown	Adverse effect on grain yield and hence should be avoided

Customized color coded tensiometer based irrigation scheduling: A strategy for eco-friendly rice cultivation

Evaluation of Customized color coded tensiometer for irrigation scheduling in rice revealed that irrigation scheduling based on customized color coded tensiometer resulted in a par grain yield with significantly higher water productivity (28%) as compared to the conventional method of rice cultivation. It also mitigates methane emission by 51% and global warming potential by 21%. Its cost-benefit ratio varies from 0.4 to 0.5.

Commercial potential

This technology is useful for irrigated rice eco-system (about 26.0 Mha) accounting for about 60% of the total area under the crop. It includes the areas in Punjab, Haryana, Uttar Pradesh, Jammu & Kashmir, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka, Odisha, Himachal Pradesh and Gujarat.

Tensiometer based soil moisture monitoring and alert system

In order to maximize water productivity in rice farming, irrigation scheduling based on soil water potential is practiced. For real time measurement of soil water potential by installing Tensiometer, electronic measuring device is essentially required. The high cost of electronic measuring device, limits its use by farmers. Therefore, a simplified and farmer friendly Tensiometer based soil moisture monitoring and alert system was developed by ICAR – NRI, Cuttack. In this Tensiometer based soil moisture monitoring and alert system, a non- contact sensor is attached to the Tensiometer tube to sense the water level in the Tensiometer tube. The sensor is connected to a microcontroller and relay module.

After the irrigation event in the field the water level in the Tensiometer tube is at its maximum level. But after some days the soil in contact with the ceramic cup of the sensor starts drying there is an outflow of tube water through the ceramic cup which results in decrease in the water level of the Tensiometer tube. As soon as the water level in the tube enters the threshold limit the sensor attached to the tube communicates a signal to the inbuilt microcontroller and GSM modem and sends an alert message to the farmers' mobile number registered with the system. The alarm in the form of message on mobile phone alerts the farmer for immediate arrangement of irrigation.

This system provides real time monitoring and is automatically controlled and hence eliminates the need of daily monitoring of water level in the tube. This system avoids over irrigation or/and under irrigation and thus reduces the wastage of irrigation water. This system runs on clean energy, hence, it eliminates the necessity of electricity. It has the potential to increase water productivity by around 28% without any significant decrease in grain yield. It also increases net return for farmers by reducing pumping costs and fuel consumption. Field trials demonstrated that irrigation scheduling based on Tensiometer based soil moisture monitoring and alert system mitigates methane emission by 51% and global warming potential by 21%.



Tensiometer based Irrigation alert system

Eco-friendly Irrigation Alert System (e-IAS)

In traditional rice cultivation, farmers generally keep the field continuously flooded from transplanting to physiological maturity of rice crop. However, it is well established that continuous flooding is not necessary for rice to achieve high yields. After seedling establishment phase, even in the absence of standing water in field, rice plant can extract soil water from the below surface soil around root zone. Over the past few decades, water scarcity has emerged as one of the biggest challenges for sustaining rice production. Development of novel irrigation scheduling technologies is an important step to help rice farmer cope with water scarcity.

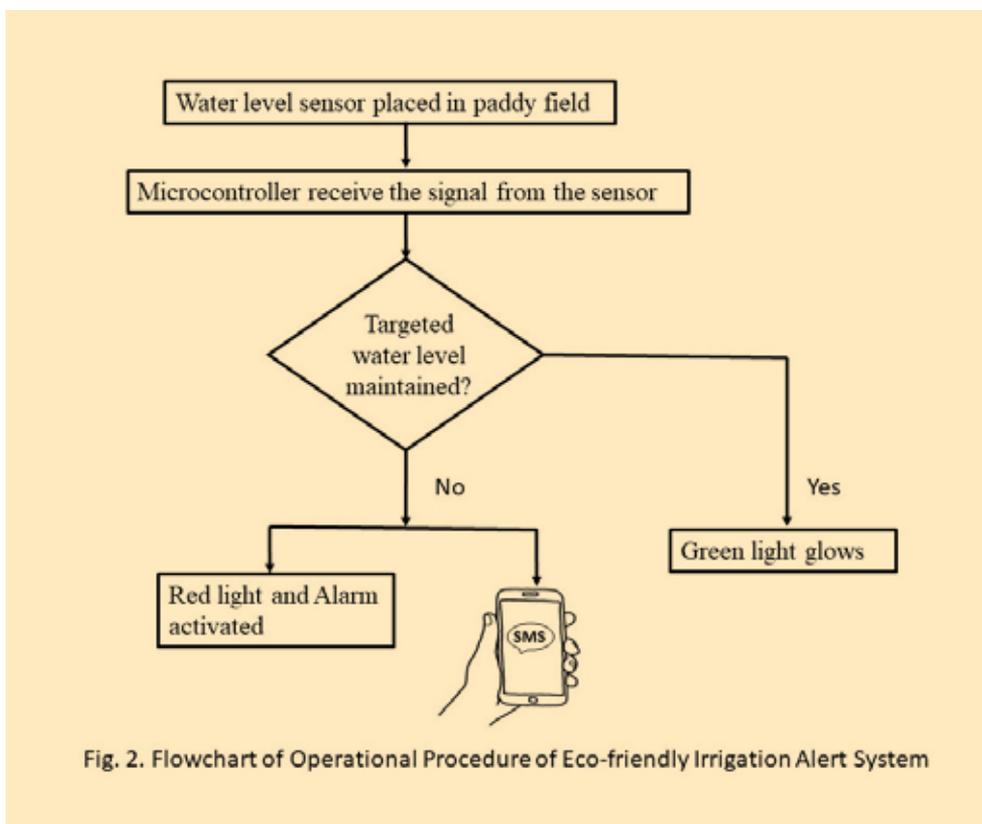
One of the important decisions in irrigation scheduling is to decide the right time of irrigation. One of the methods is the use of perforated pipe in rice fields for deciding the right time of re-irrigation. In this practice a perforated pipe (40 cm length and 15 cm diameter) with drilled holes (2 cm apart) is sunk into the rice field until 20 cm protrudes above soil level. The perforations permit the water to enter inside the tube from the soil, where a scale is used to measure water depth below the soil surface. The water level in the pipe is monitored regularly and the field is irrigated as soon as the water level reaches a threshold level (15 cm). Monitoring the water level in the pipe on regular basis in the distant fields is a difficult task for the farmers, very often, the monitoring is not done properly, which results in late irrigation, and ultimately the adverse effect is reflected in the crop performance. For overcoming the manual monitoring, ICAR – NRRI has developed Eco-friendly Irrigation Alert System (e-IAS). In this system, a sensor is attached with the perforated pipe installed in the rice field at desired depth. The sensor is connected to a microcontroller and relay module. The whole system is powered by a 12V battery and the battery is charged by a solar panel installed at the top of the structure. As soon as the water level in the rice field goes down below the desired level, the sensor communicates the signal to the microcontroller, which switches on the red bulb and alarm. The glow of red bulb and alarm sound aware the farmer for the irrigation event. Moreover, on reaching the threshold level, the microcontroller and GSM modem also sends an alert message to the farmers mobile number registered with the system.



Fig. 1. Eco-friendly Irrigation Alert System (e-IAS) installed in the field

Methodology

This is a fully automated system controlled by microcontroller (ATmega 328) and powered by photovoltaic system consisting of solar panel and battery as energy storage.



The system consists of:

1. **The Sensing Module**
 2. **The Control Module**
 3. **The Communication Module**
1. **The Sensing Module**

This unit is responsible for real time sensing the water level in the field. The system consists of a perforated pipe and a water level sensor. The sensor is placed inside the perforated tube (40 cm length and 15cm diameter) with drilled holes (2 cm apart). The perforated tube is sunk in the field and the perforations present in the pipe allows the soil water to enter the pipe. The sensor is placed at a depth of 15 cm in the perforated tube. Once the water level in the tube falls below 15 cm, the sensor sends signal to the microcontroller.

2. The Control Module

The control module generates a control action based on the water level. It consists mainly of an Arduino AT mega 328 microcontroller (Master Arduino), and a relay block module for receiving instructions from the Arduino AT mega 328 microcontroller (master controller). The master Arduino via the water level sensor receives the real time water level data and with the help of relay block it controls the light and sound alert system.

Range A – The microcontroller sends a signal to enable the green light, until the water level in the field is upto desired level.

Range B – The microcontroller sends a signal to enable the red light and sound alert system as soon as the water level in the field falls below the desired level.

Range C – The microcontroller sends a signal to enable the GSM modem to send an SMS to registered mobile number of the end user as soon as the water level in the field falls below the desired level.

3. The Communication Module

The GSM communication system is connected to the microcontroller directly and text messages (SMS) are sent to the registered mobile number of the end user.

Power Requirements

The system is powered via a combination of a solar panel and a 12V battery system. The solar panel charges the battery and powers the system during the day and the battery pack supplies the required power at night and gets recharged the following day in sunlight via the solar panel and solar charge controller.

Advantages

This system provides real time monitoring and is automatically controlled. This system avoids over irrigation or/and under irrigation and thus reduces the wastage of irrigation water. This system runs on clean energy (solar power), hence, it eliminates the necessity of electricity. This system alerts the end user through SMS, light and sound alarm and thus it facilitates effective monitoring of real time water level in the field. It has the potential to save around 30% of irrigation water without having any negative impact on grain yield. Thus, it increases the water productivity by 40%. It also increases net return for farmers by reducing pumping costs and fuel consumption. It also curtails the methane emission from rice field by around 37%.

Commercial potential

This technology is useful for Irrigated rice eco-system (about 26.0 Mha) accounting for about 60% of the total area under the crop. It includes the areas in Punjab, Haryana, Uttar Pradesh, Jammu & Kashmir, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka, Odisha, Himachal Pradesh and Gujarat.

NRRI-ARM Sensor – A tool for real time soil moisture monitoring



Over the past few decades, water scarcity has emerged as one of the biggest challenges for sustaining rice production. Hence, development of novel water saving technologies is an important step to help rice farmers cope with water scarcity. In order to maximize the water use efficiency in rice production, it is essential to apply right amount of irrigation water at right time. The timing of irrigation is a critical factor for improving the water use efficiency under limited water supply conditions. Due to lack of fixed criteria for re-watering the alternate wet and drying often results in over-irrigation or under irrigation. It is difficult to decide when the best time to re-water the rice crop is?

In an effort to enhance water use efficiency in rice under water deficit condition, ICAR – NRRI, Cuttack has developed a farmer friendly electronic moisture-indicating device named NRRI-ARM Sensor (NRRI-Aerobic Rice Moisture Sensor). This device aids the rice farmers in deciding the right time of re-irrigation in rice crops and thus results in substantial saving of water and increasing water use efficiency.

Construction of NRRI-ARM sensor

NRRI- ARM Sensor comprises two sensor rods and a casing. The two metal sensor rods are placed at a distance of about 3.5 cm. The casing houses an electronic circuit board with an integrated circuit, electronic components, three LEDs, a provision for batteries and an on/ off switch. This device works on the principle that electrical conductivity of the soil depends on the soil moisture content of the soil between the rods. The electronic circuit is designed in such a way to display moisture levels by glow of one LED lamp out of 3 LED lamps at a time.

How to use NRRI-ARM sensor?

It is well established that maintaining standing water in rice field is not necessary to achieve high water productivity in rice production. However, keeping sufficient moisture in the field is essential to avoid any moisture deficit stress. For assessing optimum moisture in the rice field, NRRI-ARM sensor is installed in the rice field. The rods of the device should be properly inserted into the soil upto the required depth (approximately 25-30 cm). The inbuilt electronic circuit in the device interprets resistance or conductance between the sensor rods and illuminates one of the LED bulbs out of the three, depending on the soil moisture content. The electronic circuit is designed in such a way that different colored LED bulb corresponds to different levels of soil moisture content. Blue light indicates abundant

moisture, hence irrigation not required; yellow light indicates low moisture content, hence irrigation is recommended and red light indicates very low moisture content, hence immediate irrigation is required.

Table 1. Interpreting Soil Moisture status from NRRI-ARM sensor

Color of bulb	Soil moisture status	Interpretation
Blue	Sufficient moisture	Irrigation not needed
Yellow	Low moisture	Irrigation advisable
Red	Very Low moisture	Immediate need of irrigation

Advantages

- No need to install this device permanently in the field.
- It is portable and easy to handle.
- Easy to install in the field
- Provides instant indication of the real time soil moisture status.
- Indicates soil moisture level in the form of different colors, which can be easily interpreted by farmers.
- Irrigation scheduling based on this device can save irrigation water upto 20-43%, without any significant yield loss as compared to the conventional practice of rice cultivation.

Limitations

This device doesn't provide exact soil moisture content. The LED color indications of this device can only be used for objective indication of soil moisture. This device works well for varied type of soil, however, in case of heavy clay soil/sandy soils/ saline soils, this device often gives erroneous results

Precautions

- When the LED glow of the device is dim, replace/recharge the batteries.
- This device has two sharp metal rods. Keep the device away from the reach of children to avoid any personal injury.

Upscaling

This user-friendly device can be upscaled by imparting training and demonstration by taking leverage of several government schemes. Policy support and systematic extension will help popularization of this device among different stakeholders.

Commercial potential

This technology is useful for Irrigated rice eco-system (about 26.0 Mha) accounting for about 60% of the total area under the crop. It includes the areas in Punjab, Haryana, Uttar Pradesh, Jammu & Kashmir, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka, Odisha, Himachal Pradesh and Gujarat.

Environment Friendly Non-toxic Methanotroph Formulation for Mitigation of Methane Emission in Rice

The present invention relates to a '**Tamarind-Acacia-based Methanotroph Formulation**' useful for reducing the methane (CH_4) emission from the rice field. This novel methanotroph strain, *Methylobacterium sp.* (MT22_NRRI) has been isolated from Sundarban mangrove sediment. The *Methylobacterium sp.* was registered in National Centre for Biotechnology Information (NCBI) with accession number MZ683316 dated 09-08-2021. The specific combination of tamarind seed coat and gum-acacia powder would be mixed with novel methanotrophs for making the formulation. The formulation could reduce the methanogenesis (methane production in soil) and at the same time oxidize methane in rice field. Tamarind-acacia-based methanotroph formulation was applied in the rice-based cropping system (rice-rice and rice-green gram) in both the *khariif* and *rabi* seasons. The formulated products applied at two splits (at 7 and 45 days after transplanting) in rice, showed more effective than the single dose of application. The percentage of methane emission reduction due to the application of tamarind-acacia-based methanotroph formulation was ranged from 8 to 12% as compared to the RDF treatment.

Commercialization Importance

- The India is committed for net zero Carbon emission by 2070, in which mitigation (reduction) of GHGs in general and methane in particular in rice will play a crucial role.
- Presently, the rice production system in India contributed around 20% of methane emissions. Methane has 24 times more global warming potential than carbon dioxide.
- Therefore, not only adaptation to climate change the Mitigation of GHGs emissions (Climate change) now is important.
- Government also focusing on those aspects in several projects and policies. The formulated methanotrophs product has the potential to reduce the methane emissions by 8-12% (*khariif* season, when most of the rice is grown in our country).
- The product could be given to farmers through government subsidies or different commercial farmers for promoting "Nature Positive Solution" to climate change. OR by Project through NGOs, International Organization, Carbon –credit initiatives, Ecosystem Service based payments-project.

Environment Friendly Microbial Mediated Method of Rice Straw Pulp Preparation and Uses Thereof

The rice farmers in India burn the straw in their fields due to lack of economically viable alternative option to utilize the straw. About 16% crop residues are burnt on farm in India and out of which 60% is rice straw. Rice straw pulp-plate is an environment friendly alternative of plastic plates which causing environmental menace. In our innovative process we used novel microbial consortium (*Bacillus* sp.: MN784664 + *Penicillium* sp.: MK855473), along with low temperature, 60°C (65% less temperature than commercial technique) and low concentration of sodium hydroxide (only 6%; 60% less than commercial techniques) for pulp making. Thereafter physical sieving and hydraulic press is used for plate making which are economic and environment friendly. This process could save 65-70% energy use for pulp-plate making from rice straw which have the potential to reduce carbon footprint and help in climate change mitigation.

Commercialization Importance

- Rice straw pulp-plate is biodegradable and a good alternative of plastic plates which causing environmental menace.
- The straw is available in plenty in our country which is cheap (approx. 120 mt).
- The process recommended in cheaper than existing methods and environmentally friendly (per plate made up of sugarcane and maize residues available in Market approx. @ Rs.3-5/ Plate).
- The process requires cheap equipment (Total approx. 2.5 lakh) and chemical (only 6% NaOH).
- Moreover, energy requirement is less for its production.
- And can be produced locally by small industries or start-ups. (Saving of Rs. 24000/- per ton straw conversion to pulp).



Preparation of Rice straw pulp plate

Tech NRRI Decomposer

Paddy straw decomposition is not so easy to decompose within a short time as it contains lignin and silica apart from cellulose and hemicellulose. Hence, ICAR-NRRI has developed a decomposing microbial consortium to convert rice straw/ other agricultural wastes into valuable manures within 50 days under *ex-situ* conditions.

Tech NRRI Decomposer was developed by using three efficient lignocellulolytic microbial strains viz., *Aspergillus awamori* (NRRI-CPD-COMF5), *Trichoderma asperellum* (NRRI-CPD-COMF6) and *Streptomyces griseorubens* (NRRI-CPD-COMA4). The above said three strains were used for microbial consortium preparation using sterile talc as carrier material. Application of 1.0 kg carrier-based microbial consortium per tonne of paddy straw along with 0.5 % (w/w) urea with 1.0 % (w/w) cow dung could decompose (C: N ratio around 20:1) the paddy straw within 50 days. During the time of decomposition around 55-60% moisture should be maintained.

Application of this compost to crop cultivation will provide 20-22 kg N ha⁻¹ per application and other nutrients like P, K and silica apart from other invisible beneficial effects like improvement of physical and microbial properties of soil.

Commercialization Importance

The microbial strains used in this consortium apart from having lignocellulytic potential, it has multi-beneficial plant growth promoting activities.

No requirement for secondary level multiplication of microbial cultures at field level. The microbial formulations can directly suspend in water and apply.

This consortium can be used for decomposition of paddy straw as well as other agricultural wastes under *ex-situ* condition. It can be used in any area except very cold condition.

Selling through ATIC, ICAR-NRRI, Cuttack @ Rs. 60 per 500 gm pocket

Submitted to Agrinnovate India Ltd for commercialization



Customized leaf color chart

Customized leaf colour chart (CLCC) for nitrogen management in rice developed at NRRI Cuttack based on the fact that greenness of leaf is associated with leaf N content which is closely related to photosynthetic rate and biomass production. The five panels of CLCC represent gradual transition of color from yellowish green to dark green matching the color range of rice leaves that cover a continuum from leaf N deficiency to excessive leaf N content. The CLCC is an effective, low-cost, easy to use diagnostic tool which can be used by the farmers to monitor the relative greenness of rice leaf as an indicator of the leaf N status and decide when and how much N should be applied to the crop. This real time N management tool ensures high yield and N use efficiency [Published as: Nayak et al. (2013). *Customized leaf color chart for nitrogen management in rice for different ecologies*. Central Rice Research Institute, Cuttack (India)].

The CLCC is commercialized and MoU was signed with M/S Nitrogen Parameters, Chennai and M/S Fine Trap, Maharashtra for manufacturing and distributing the CLCC. The **CLCC is published in three languages English, Hindi and Odia for its wider adaptability and reach.**

Commercialization: The CLCC is commercialized and MoU was signed with M/S Nitrogen Parameters, Chennai for manufacturing and distributing the CLCC. Currently CLCC is priced at Rs 140/- per piece. Demand of CLCC is from various line departments personnel from different states, farmers.

CLCC is included in eNAM website of GOI for sale. There is growing awareness for using CLCC in different rice ecologies. As evident by the purchase and distribution of CLCC by different State Governments (Odisha, Bihar, Chhattisgarh, Madhya Pradesh, Jharkhand, West Bengal, Uttar Pradesh and Gujrat). Till now, more than 2.5 lakhs units of CLCC have been sold to different stakeholders including IRRI. Various awareness programs have been conducted till now with coverage in Newspapers, TV talk for its popularisation. Various field demonstrations are being conducted at different locations in various projects and schemes. Positive responses of farmers regarding production and saving of N fertilizers have been documented and strategies have been designed and adopted by the R&D organisation with the collaborative efforts of both State and Central Ministry.

Projected Monetary Benefit

Results of on station and farmers' field experiment showed that at same level of N application yield advantages of 0.5-0.7 t ha⁻¹ and 0.5-1.0 t ha⁻¹ could be achieved following CLCC recommendation over RDF application and farmer's practice, respectively. That can lead to monetary benefits of Rs. 6,680-10,080/- and Rs. 7,776-14,544/- respectively per hectare. In addition to this, use of CLCC has a potential of cutting down approximately 25% total fertilizer consumption in low land rice that can save upto Rs. 1,514/- crores from the total urea subsidy bill of Govt. of India.



CLCC folder with written instruction for using the CLCC

Taking reading in the rice for matching the greenness of rice leaf with CLCC panels



The five panels of CLCC

Capacity building of women farmers for using the CLCC



PROTECTION TECHNOLOGIES

Alternate Energy Light Trap

Technology in brief

The solar based Alternate Energy Light Trap (AELT) developed by ICAR-National Rice Research Institute, Cuttack, Odisha was awarded the patent (Patent No. 357993 dated. 08 February 2021). AELT consists of a light source as an attractant and a funnel to direct lured insects into the insect collecting chamber. Funnel supports three baffles which are joined at the top. A hook has been provided at the top portion to install the light trap in the crop fields. The funnel is connected to a main insect collection chamber. The collection chamber is having two chambers separated by a bigger size mesh to separate the small insects (mostly beneficial insects) and in the bottom cap is provided for opening and closing the chamber. The light trap assembly is provided with sensor which will automatically be lighted in evening and auto off after 4 hours. To segregate the macro and tiny insect a



Alternate Energy Light Trap



Patent Certificate (AELT)

vibrator is provided. Once, the insect touches the main chamber mesh, the vibrator will shake the mesh and the tiny beneficial insects will fall down and collected in the second chamber. The tiny non-target insects mostly natural enemies trapped so can easily be escaped to the crop environment. The facility of escaping of non-target/natural enemies from the main insect collection chamber is a desirable attribute for bio intensive approach of pest management. Farmers can opt any model of light trap based on the availability of their power source i.e., direct electricity, battery or solar energy as per the requirement/situation.

Uses

- Install the light trap @ 1 trap/ ha near or within the field where farmers want to trap the flying insects and keep the light source 60 cm above the crop canopy.
- Secure the poles firmly on the ground
- Mount the lamp or the bulb on the frame, five meters from the ground
- Collect the trapped insect daily morning and escape the beneficial insects to crop environment

Benefits

- Reduces the insects pests population
- Reduces the usages of chemical pesticides
- Durable, ideal for individual or mass usages
- Maintain the balance of agro eco-system
- Effective even during rains
- Harmless to beneficial Insect

Contact Person

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Solar 24 x 7 Insect Trap

Technology in brief

Solar 24 x 7 Insect Trap for mass trapping of phototrophic insect-pests of field, horticultural and plantation crops. Farmers can use this device for insect pest management for early detection of insect pest outbreak and determine their threshold level.

Innovative Solar Insect Trap is a combination of light and sticky trap with unique features that escapes the beneficial insects and kills harmful insects. In day time, the pests will be attracted towards yellow colour/blue colour and in night time the phototrophic insects will be attracted towards the lighting lamp. When the solar panel fixed in the light trap receives sunlight, it converts solar energy to direct electric energy and stores it in a battery for the night. The solar insect trap starts working automatically once the device switch on in evening hour hour. When the light trap LED lamp is turned on at night, phototrophic insect pests like moths, flies, beetles, and hoppers are attracted towards the trap. The insects struck the used baffle and fall on the light trap's base and glued where the adhesive are applied. There are holes in the light trap chamber, where the tiny insects mostly parasitoids entered. The outer cover is detachable and the tiny parasitoids captured in the chamber are released to environment after detaching the cover from main unit.

Uses

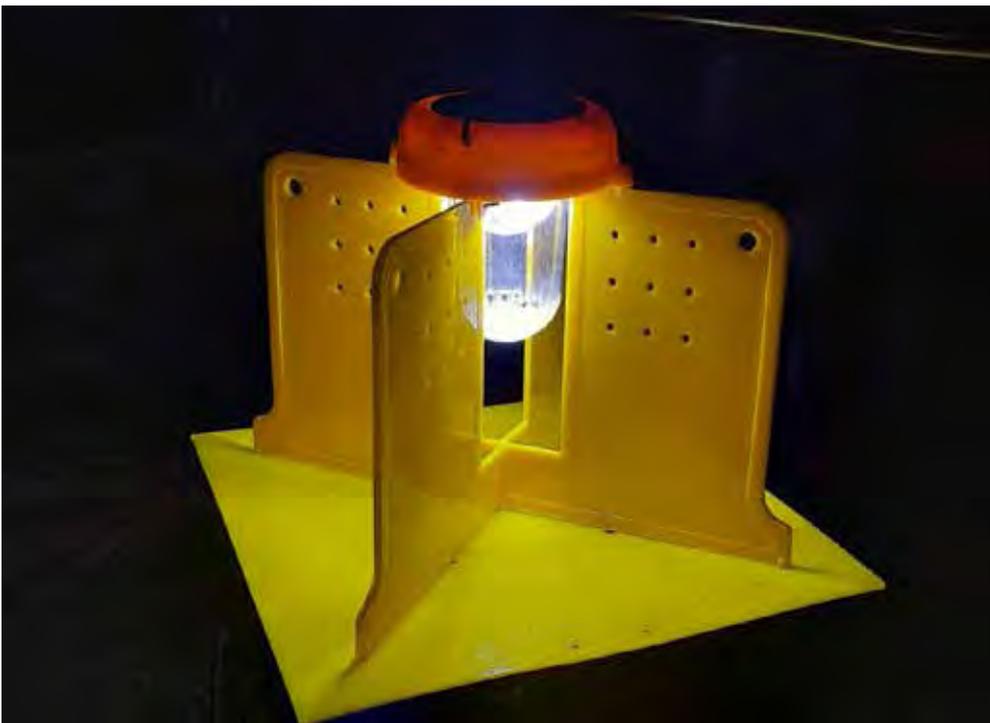
- Install the 24x7 light trap near or within the field where farmers want to trap the flying insects.
- Farmers can identify the target hazardous insects and take early decision regarding the unnecessary use of harmful insecticides

Benefits

- Reduces the cost of spraying pesticides and insecticide
- Reduces the insect pests population
- Best insect control tool for organic farming
- 2-3 units to be installed per acre for best results
- It is all weather proof and lasts for many years
- Attracts insects in day by the color and in night by the light.

Contact Person

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Eco-friendly light trap harmless to beneficial insects

Technology in brief

The Eco-friendly light trap harmless to beneficial insects developed are based on solar, electric and battery operating modes. These will eliminate the restrictions on usages of solar light Trap during continuous rains or during insufficient sun light incident over solar panel. The light traps so developed increase the usage but also decrease the cost of newly evolved Light Trap which will assist in popularizing the technology among farmers as economic version and also its application will increase in field leading to mass trapping of harmful insects. The trap has head, body, baffles and collection chamber. Collection Chamber has cylindrical shape, which gives aesthetic value to device with Zic-Zak format. This prevents crawling back and escape of harmful insect pests. The collection chamber has two opening. One is in proximal end of collection chamber and other in the distal end of chamber for removal of trapped insects. The provision for beneficial insects has been made in the upper wall of collection chamber. There is porous cylindrical collection jar which collects only beneficial insects and jar has inbuilt light source which is detachable from the main collection chamber. The cylindrical porous partition is designed in such a way that tiny insects mostly parasitoids can through them. It is facilitated with a light source which orients the beneficial insects to reach in and stay till further escape and whereas remaining harmful pest insects remain outside the porous chamber into the major part of collection chamber. These harmful insects have separate escape route from which they can be taken out and killed in kerosinized water.

Uses

- Install the light trap near or within the field where farmers want to trap the flying insects and keep the light source 60 cm above the crop canopy.
- Secure the poles firmly on the ground
- Mount the lamp or the bulb on the frame, five meters from the ground
- Collect the trapped insect daily morning and escape the beneficial insects to crop environment

Benefits

- Reduces the insects pests population
- Reduces the usages of Chemical Pesticides
- Durable, ideal for individual or mass usages
- Maintain the balance of eco-system
- Effective even during rains.
- Harmless to Beneficial Insect

Contact Person

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Trichoderma spp: Bio-formulations to improve crop health

The CRRI-T3 (*Trichoderma atroviride*) has been isolated from the tree bark of *Cassia tora* of 42 Mouja (Barala) of Cuttack District (GPS Location: 86058'E, 20045'N). The ITS sequence has been deposited in NCBI (KR014408.1). Deposited to Microbial Type Culture Collection (MTCC), IMTech, Chandigarh (MTCC-12246). After testing the growth inhibition of different pathogens, the talc-based formulation (10^{10} cfu/g) was tested in the net house against sheath blight



Fig 1. (a)Effect of *Trichoderma* spp on rice plant under field conditions (10-25% yield advantage) (b) Root and shoot growth of *Trichoderma* treated seedlings (15 days) (Ctl=Control, T2=NRRI2, T3= NRRI T3).



Fig-2. Effect of *Trichoderma* seed treatment on panicle length and grain nos/panicle of 3 rice varieties (MTU 1061, MTU7029 and Pooja respectively).

and blast disease. The formulation was able to control sheath blight and blast disease. The beauty of the product is it can replace the chemical fungicides as seed treatment. The formulation was tested in AICRIP for continuous three years 2019-2021. All the three years it was able to manage all the rice diseases at different combination like seed treatment, Seed treatment-foliar spray-foliar spray or seed treatment-foliar spray-foliar spray with fungicide. This product is not only able to manage the rice diseases but also excellent growth promoter which is realized in terms of higher yield. Also effective against many other crops like millets, black and green gram, groundnut, maize, lentil etc.

Trichoderma erinaceum has been isolated from *Cassia tora* tree bark and tested for its growth promotion and induction of resistance against different seed and soil borne diseases of rice in NRRI farms for consecutive 6 years against. The *T. erinaceum*, when used as seed bio priming reduces the germination time, promotes the plant growth as evident from root and shoot growth and it enhances the yield in rice. The biopriming of *T. erinaceum* (CRRI-T2) also protects the crop from seed and soil borne diseases. So, it can be an excellent component for organic cultivation.

Advantages:

- (a) Efficacy:**
1. Rice grain yield advantage: 10-25%
 2. Green gram yield advantage >10%
 3. Small millet yield advantage >10%
4. Rice-AICRIP data (effective against leaf blast, neck blast, sheath blight and sheath rot)

(b) Novelty: The present technological innovation concentrates on preparation of *Trichoderma* formulation to fill the gap with *Trichoderma* strains from novel habitats tree bark capable of both biocontrol and growth promotion. In India many formulations are commercially being used as biocontrol agents against large number of pathogens across several crops. However, there appears to be a limited effort to develop effective commercial formulation of *Trichoderma* spp. capable of controlling rice diseases as well as for plant growth promotion. Additionally, such products are safe to handle and cost effective. These provide invaluable input in the present-day organic agriculture. The formulation was tested in AICRIP trials for three years and was observed to control all rice diseases and able to enhance the yield upto 25%.

Patent granted “Mukherjee AK, Adak T, Swain H, Behera SP, Dhua U, Jena M, Bagchi TB, Bhattacharyya P, Kumar A, Dangar TK. 2015. Multi-Use Composition for biocontrol of plant pathogen infestation, growth enhancement and uses thereof. Indian Patent No. 383679” granted on 3rd Dec 2021

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NRRI Bracon card (B.h) for management of rice leaf folder

Summary of the product/Technology: *Bracon hebetor* (= *Habrobracon hebetor*) is an important larval parasitoid of lepidopteran pests of rice. Although chemical insecticides are being widely, usage of bioagents *Habrobracon hebetor* has tremendous potential. These parasitoids are mass produced in the mass production facility and are made available to different stakeholders in the form of cards. Eight bracon cards (consisting of ~4000-4500 pupae) per hectare are recommended. Card should be placed in the field before expected adult emergence date mentioned on the card. Take out each strip and staple on the lower surface of the leaf, if weather conditions are normal or else each strip has been provided with hole at one end and they can be tied to a stick through inverted plastic cup to avoid rain water. Card may be installed in morning hours to avoid predation.

Proposed stakeholders:

- Farmers
- State agriculture universities/ICAR institutes for mother cultures



Process of mass production of NRRI Bracon card (B.h)

- Entrepreneurs who involved in biocontrol agents business
- Commercial mass production labs abroad

Commercial potential:

- The product is an alternative to chemical insecticides
- Presently, the product is being produced and sold in the institute @ Rs. 70/- per card.

- Till now, **634 number of cards** have been prepared and sold commercially to different stakeholders and **generated revenue of Rs. 44, 380/-** to the institute.
- Digital payment and purchase platform has been created for smooth purchase of bio-agents.

Publications:

Management of Rice Leaf Folder using NRRI Bracon card (B.h). ICAR Krishi technology code 201610451663503



NRRI Tricho card (Tc) for management of rice leaf folder

Details of the Technology: *Trichogramma chilonis* is an important egg parasitoid of rice leaf folder, *Cnaphalocrosis medinalis*. Three tricho cards (consisting of ~60000 parasitized eggs) per hectare are applied once moth activity is noticed. Five such releases are made at every 7-10 days' interval till egg masses or moth activity is not seen, whichever is earlier. Card should be placed in the field before expected adult emergence date mentioned on the card. Farmers should refrain from using pesticides in the field where *Trichogramma* are released. Card should be placed in the field before expected adult emergence date mentioned on the card. Take out each strip and staple on the lower surface of the leaf, if weather conditions are normal or else each strip has been provided with hole at one end and they can be tied to a stick through inverted plastic cup to avoid rain water. Card may be installed in morning hours to avoid predation.

Proposed stakeholders:

- Farmers
- State agriculture universities/ICAR institutes for mother cultures
- Entrepreneurs who involved in biocontrol agents business
- Commercial mass production labs abroad

Commercial potential:

- The product is an alternative to chemical insecticides
- Presently, the product is being produced and sold in the institute @ Rs. 60/- per card.
- Till now, **3110 number of cards** have been prepared and sold commercially to different stakeholders and **generated revenue of Rs. 1, 86, 600/-** to the institute.
- Digital payment and purchase platform has been created for smooth purchase of bio-agents.

Publications: Management of Rice Leaf Folder Using NRRI Tricho card (T.C). ICAR Krishi technology code 201609939450883



NRRI Tricho card (Tj) for management of rice yellow stem borer

Details of the product/Technology: *Trichogramma japonicum* (egg parasitoid) is recommended for yellow stem borer (YSB) of rice. Three tricho cards (60000 parasitized eggs/ha) are applied usually from 30th day after transplantation. Five such releases are made at every 7-10 days interval till egg masses or moth activity is not seen, whichever is earlier. Card should be placed in the field before expected adult emergence date mentioned on the card. Take out each strip and staple on the lower surface of the leaf, if weather conditions are normal or else each strip has been provided with hole at one end and they can be tied to a stick through inverted plastic cup to avoid rain water. Card may be installed in morning hours to avoid predation.



Process of mass production of NRRI Tricho card (Tj)

Proposed stakeholders:

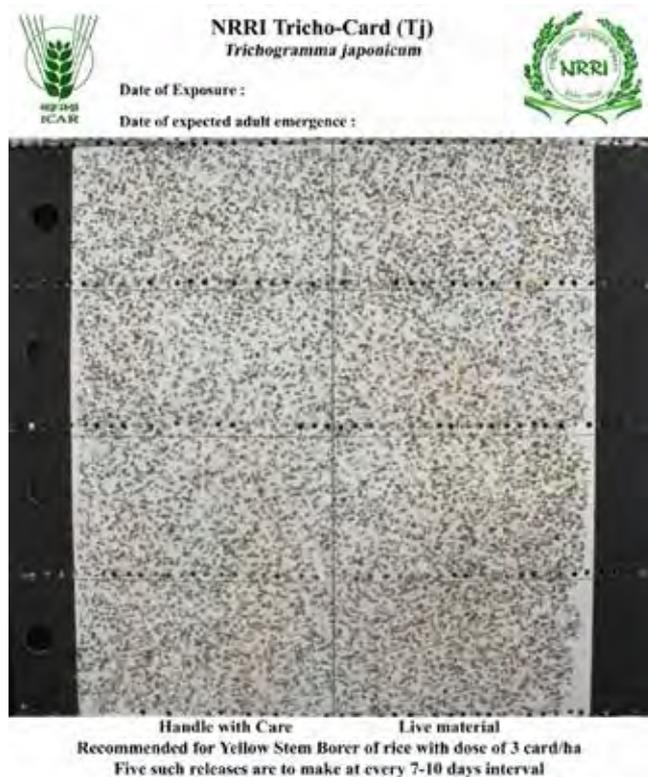
- Farmers
- State agriculture universities/ICAR institutes for mother cultures
- Entrepreneurs who involved in biocontrol agents business
- Commercial mass production labs abroad

Commercial potential:

- Presently, the product is being produced and sold in the institute @ Rs. 60/- per card.
- Till now, 3756 number of cards have been prepared and sold commercially to different stakeholders and generated revenue of Rs. 2,25,360/- to the institute.
- Digital payment and purchase platform has been created for smooth purchase of bio-agents.

Publications: NRRI tricho card (Tj) for the management of yellow stem borer in rice.

ICAR Krishi technology code: 201609939450883



Insecticide induced hormesis to improve fitness of egg parasitoid, *Trichogramma chilonis*

Details of the Technology: Hormesis for the intractable pests can be dreadful, but for natural enemies of pests, it is a puissant strategy in optimizing their mass rearing. We report multigenerational stimulatory effects of widely used insecticide, imidacloprid, on the demographic traits of an important egg parasitoid *Trichogramma chilonis* Ishii. The study investigated the consequences of sublethal (LC_5), low lethal (LC_{30}), and median lethal (LC_{50}) concentrations, as well as a control, for five continuous generations (F_1 to F_5). Further, there was a significant enhancement in the adult longevity as well as oviposition days of the F_5 individuals at both these concentrations. Considering the population traits, along with gross reproductive rate (GRR), net reproductive rate (R_0) was also enhanced by both LC_5 and LC_{30} in F_5 individuals than F_1 ; whereas the intrinsic rate of increase (r) and finite rate of increase (λ) were enhanced only at LC_{30} upon comparing with control. On the other hand, LC_{50} exposure to *T. chilonis* did not result in notable differences in biological or population traits when compared across generations (F_1 and F_5). Low and sublethal concentrations of imidacloprid did not have a major influence on demographic traits of *T. chilonis* at initial generations of exposure but can induce hormetic effects in the subsequent generations. Overall, imidacloprid-induced hormesis stimulating the development of *T. chilonis* might be helpful under circumstances of mild exposure of imidacloprid in fields and could be leveraged for its mass rearing

Proposed stakeholders:

- Farmers
- State agriculture universities/ICAR institutes for mother cultures
- Entrepreneurs who involved in biocontrol agents business
- Commercial mass production labs abroad

Commercial potential:

- The product is an alternative to chemical insecticides
- Improved strain would be commercialized to harness greater benefit

Efficient Portable Insect Collector with Automated Counter

Details of the product/Technology: The rice meal moth, *Corcyra cephalonica* Stainton is one of the important factitious hosts for laboratory rearing of number of parasitoids such as trichogrammatids, chrysopids and braconids. In order to have large scale mass rearing of these parasitoids, large scale production of the host insects is must. As the host insect *C. cephalonica* is basically a moth and as it is reared in concealed room, while handling this insect especially at the adult stage emits huge number of scales and there is every chance that personnel involved in handling may inhale. Presently moths are being collected through manual methods in test tubes and release them in the oviposition cages and which consume lots of time. Also, it goes difficult for the worker to count the moths at each collection unit for record keeping, which would consume his/her energy and time.

It is an insect collector, and more specifically, relates to a back-mountable battery-operated insect collection system. A compact lightweight apparatus with minimum accessories that enables the collection and counting of insects. It is a portable apparatus that consumes less energy and time. Much helpful in insect mass production facilities and field collection of insects anywhere and anytime. This system eliminates the labor-intensive process and a cost-effective solution. It Safeguards the health of the worker involved while collecting the moths in mass production facility which otherwise would lead to respiratory problems.

Proposed stakeholders:

- Biocontrol laboratories:
- State agriculture universities/ICAR institutes
- Entrepreneurs who involved in biocontrol agents business
- Commercial mass production labs abroad

Commercial potential:

Anticipated revenue/margin

Number of Biocontrol labs in India: 361
(Source: Directorate of Plant Protection Quarantine & Storage, Ministry of Agriculture and farmer's welfare Directorate of Plant Protection Quarantine & Storage: <http://ppqs.gov.in/divisions/integrated-pest-management/bio-control-labs>).

Approximate selling price (through commercialization): Rs. 20000/- (It would be better price as the lower model without sensor & counter, without battery and non-portable unit costing Rs. 16000/- <https://www.accoindia.com/productDetail/insect-handling-device.html>)



Portable Insect Collector with Automated Counter

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Procedure for Commercializing ICAR-NRRI technologies

ICAR-NRRI has been at the forefront in developing high-yielding rice varieties suitable for diverse agro-climatic conditions. Through the dedicated efforts of scientists from various disciplines, the institute has also innovated numerous production and protection technologies to enhance productivity, quality, resilience and profitability of the rice crop. Some of the commercially viable, important technologies are hybrids, climate-resilient/smart varieties, specialty /biofortified rice with rich contents of zinc, protein and aroma, customized leaf colour chart (CLCC) for efficient nitrogen application, light trap technologies for insect pest management, Trichoderma-based formulations (biostimulants), eco-friendly Irrigation Alert System, NRRI Tech Decomposer, Methanotroph formulations, and many more. The detailed list of the technologies is available at [National Rice Research Institute – Cuttack, Odisha \(icar-nrri.in\)](http://NationalRiceResearchInstitute-Cuttack.Odisha(icar-nrri.in))

- In case you are interested to exploit the commercially potential NRRI technologies (also called TechNRRI), you can send your express of interest (EOI) in writing to Director, ICAR- National Rice Research Institute, Cuttack.
- Your request will be placed before the Institute Technology Management Committee (ITMC) for consideration. Once approved, you will be communicated to this effect.
- Thereafter, both the parties shall sign a Memorandum of Understanding or Agreement, as the case may be with mutually agreed terms and conditions on non-exclusive basis.
- After completing all the necessary formalities, the final MoU/agreement for the commercialization of NRRI-developed technologies is signed by both the parties on Rs. 100 non-judicial stamp papers. This ensures a legally binding commitment between the institute and the firm regarding the commercialization and utilization of the technology.
- Upon payment of License fee, the technology will be transferred in terms of knowledge/ material or both as the case may be. Subsequently, hands on training is provided as per requirement on payment basis.
- The MoU/MoA can be extended /renewed after its expiry based on mutual understanding.



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