

High yielding varieties for increasing rice production of rainfed shallow lowlands in Eastern India

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In India, rice is grown in about 43 mha of the land of which 16 million ha area is under rainfed lowland ecology. The vast area of 22 mha representing about 45% of rice area is cultivated as a rainfed crop which produces a very low production. About 92% of rainfed lowland areas are located in the eastern region of the country. Depending upon the water depth and duration of waterlogging in the lowland ecology during the growth period of rice, the lowland rice is classified into rainfed shallow lowland, semi-deep, deep, and very deep water or floating type ecosystem. The rainfed shallow lowland is characterized by water accumulation of 0-50 cm that faces frequent drought and flash flood. Sizeable rice areas of eastern India are existing under shallow lowlands with low production. Impact of the Green Revolution has sidelined the eastern Indian rainfed shallow lowland ecology. However, this neglected ecosystem has tremendous potential to increase the yield and total production as a whole.

Keywords: Eastern India, High yielding variety, Rainfed shallow lowland, Rice

RICE crop faces several challenges when grown under shallow lowland ecology. Many resource poor farmers under rainfed shallow lowlands adopt direct seeding of rice in the recent days, due to scarcity of human power and changing climatic pattern. These direct-seeded fields are poorly leveled before seed sowing. The stagnation of rainwater immediately after sowing led to the rotting of germinating seeds, reduces crop stand in the field, and produces low yield. Further, the presence of stagnant water for more than 10 days period is very common in most areas under this ecology. Thus, anaerobic germination should also be considered as a valuable trait in the varieties chosen for direct seeding. Although by its name, the ecology seems to possess a sufficient amount of water and stagnant water seems to create problems, occasional drought spells are also observed. Besides, the genotypes suitable for shallow lowland ecology have a longer

maturity duration. In the eastern part of the country where these varieties are grown, frequent incidences of untimely rainfall and storms during grain maturity lead to heavy crop loss caused by lodging and pre-harvest germination of seeds. Most parts of Assam including Barak valley, is prone to flash floods during monsoon. Biotic stresses like stem borer, brown plant-hopper, gall midge, leaf folder, bacterial blight, sheath blight, and false smut are significantly affecting rice grain yield. The suitable varieties developed for this ecology from different states are shown in Table 1.

Swarna-Sub1

Swarna-Sub1, a submergence high-yielding rice variety was released in 2009. The variety withstands floods for up to 2 weeks. The variety, Swarna-sub-1 is a flood-tolerant version of the popular mega variety Swarna (MTU7029) for eastern India (Fig. 1). Plant height of the variety is 100 cm, medium grain, and

maturity duration is about 140-145 days. Average yield of the variety is about 5,500 kg/ha. It is suitable for shallow lowland areas of the eastern region where Swarna is popular.

Ranjit-Sub1

Ranjit-Sub1 variety is an improved version of the Ranjit variety developed to get better yields under submerged conditions mainly in Barak Valley. Most parts of Assam including Barak valley is prone to periodical flash floods, particularly during the monsoon. Ranjit variety is a high-yielding popular variety of Assam developed by Agricultural University. The Ranjit Sub 1 retains all the traits of the Ranjit variety and is tolerant to submergence for 2 weeks. Ranjit-Sub1 can be regenerated again in case damaged by the flood, hence ensure maximum productivity.

Bahadur-Sub1

Bahadur-Sub1 is the improved

Table 1. Rice varieties developed for this rainfed shallow lowland ecology

Name of the variety	Duration (days)	Recommended state	Avg. yield (t/ha)	Remark
Swarna-Sub1	145	Odisha, Uttar Pradesh	5.2	Submergence tolerance for 14 days
Ranjit-Sub1	155	Assam	4.8	Submergence tolerance for 2 weeks
Bahadur-Sub1	155	Assam	5.0	Submergence tolerance for 2 weeks
CR Dhan 800	140	Odisha	5.75	Moderately resistant to bacterial leaf blight and sheath blight
CR Dhan 801	140	Odisha, West Bengal, Andhra Pradesh, Telangana, Uttar Pradesh	6.3	Multiple stress tolerant. Drought tolerant, submergence tolerance for 2 weeks. Moderately resistant to leaf blast, neck blast, bacterial blight, stem borer (both dead heart and white ear heads), and leaf folder
CR Dhan 802 (Subhas)	142	Bihar, Madhya Pradesh	6.5	Multiple stress tolerant. Drought tolerant, submergence tolerance for 2 weeks. 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
CR Dhan 409 (Pradhandhan)	160-165	Odisha	5.0	LS grain, height:130-140 cm, moderately resistant to blast, neck blast, sheath blight, sheath rot, stem borer, and leaf folder
Pooja	150	Odisha, Madhya Pradesh, Assam, Tripura, West Bengal	4.5	Resistant to bacterial blight, Field tol. to major pests and diseases
CR Dhan 410 (Mahamani)	160-165	Odisha	7	Moderately resistant to stem borer, leaf folder, neck blast, bacterial blight, sheath rot, and brown spot
Sumit	145	Odisha	5.2	Resistant to stem borer and leaf blight
CR Dhan 401(Reeta)	150	Odisha, West Bengal, Andhra Pradesh, Tamil Nadu	5.5	Resistant to leaf blight, moderately resistant to 110 cm, R to Leaf blast; MR-Neck Blast, sheath blight, and sheath rot
CR Dhan 408 (Chaka Akhi)	165	Odisha	4.8	Moderately resistant to neck blast, bacterial leaf blight, sheath rot, stem borer, leaf folder
CR Dhan 407	150	Odisha, West Bengal	5	Moderately resistant to neck blast and leaf blight
Savitri	150-155	Odisha, Tamil Nadu	3.8	Moderately resistant to bacterial blight and sheath blight
Gayatri	155	Odisha	5.0	SB grain; Semi-dwarf, MR to BB, MR-Blast, and GM
Luna Suvarna (CR 403)	150	Odisha	3.5-4.0	Suitable for saline Dhan shallow lowlands, R to blast, tolerant to brown planthopper and sheath blight
Luna Sampad	140	Odisha	4.0	Resistant to blast, tolerant to SB, BPH, LF
CR Dhan 907 (aromatic)	150	Chhatisgarh, Odisha, Andhra Pradesh, Gujarat	4.5	MS grain, resistant to neck blast, gall midge, MR to sheath rot, and stem borer
CR Dhan 908	145	Odisha, West Bengal, and Uttar Pradesh	5.0	Height-95 cm, MR-Leaf blast, Neck Blast, Bacterial Leaf Blight, Brown Spot, Stem Borer, Leaf folder, and WBPH.
CR Dhan 909	140	Assam, Bihar, Uttar Pradesh, Maharastra	5.0	Moderately tolerant to Leaf blast, Neck Blast, Bacterial Leaf Blight, Brown Spot, Stem Borer, Leaf folder, and WBPH.
CR Dhan 910		Odisha	4.4	Height-101cm, MR to BL, NBI, ShR, RTV, SB, LF &WBPH

version of popular variety, Bahadur which is suitable for the flood-prone areas of Assam. Bahadur variety is a semi-tall statured type suitable for rainfed shallow lowland ecology which produces an average yield of about 5.0–5.5 t/ha. Bahadur variety was released by Assam release committee in the year, 1991. Popular variety Swarna-Sub1 was the donor parent for Bahadur-Sub1. The Bahadur-Sub 1 produces the same yield as Bahadur and is tolerant to

submergence for 2 weeks without losing any of the traits of Bahadur,

CR Dhan 800

CR Dhan 800 is released for Odisha by SVRC, Odisha during 2016. The variety is resistant to bacterial blight of rice. CR Dhan 800 was developed by pyramiding of *xa5*, *xa13*, and *Xa2* bacterial blight resistance genes in the popular variety, Swarna. It is developed through a marker-assisted breeding

approach at the National Rice Research Institute, Cuttack. This variety is medium slender grain, intermediate alkali spreading value, and amylose content identical to the parent, Swarna. The variety is suitable for bacterial blight endemic areas in Odisha.

CR Dhan 801

The variety, CR Dhan 801 is recommended for cultivation in Odisha, West Bengal, Andhra



Fig. 1. Field view and panicles of Swarna-sub1.

Pradesh, Telangana, and Uttar Pradesh. It is first multiple abiotic stress tolerant rice variety and developed from the cross of IR81896-B-B-195/2 * Swarna-Sub1// IR91659-54-35 by the marker-assisted breeding method (Fig. 2). The variety has tolerance to submergence and drought conditions. The variety is weakly photosensitive with an average maturity duration of 140-145 days with a plant height of 100cm. 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.

CR Dhan 802 (Subhas)

The variety, CR Dhan 802 (Subhas) was developed from the breeding materials of cross Swarna-Sub1*4 / IR81896-B-B-195 is recommended for cultivation in Bihar and Madhya Pradesh. Selection, evaluation, and testing of the NILs were done at ICAR-National Rice Research Institute, Cuttack, Odisha to breed high-yielding variety with tolerance to submergence and drought conditions. CR Dhan 802 was released in 2019. Average yield of

the variety is 6,508 kg/ha under normal conditions and 2,344 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, planthopper, 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.

CR Dhan 409 (Pradhan Dhan)

CR Dhan 409 (Pradhan Dhan) is a good grain type shallow lowland variety released by the SVRC, Odisha during 2016. Average yield of the variety in Odisha is around 5t/ha. Maturity duration of the variety is



Fig. 2. Field view of CR Dhan 801.

160-165 days with semi-tall plant type (130-135cm). It possesses long slender grain, more panicles/m² (250-300) with 135-140 days to 50% flowering, high tillering (12-20), long panicle with moderate test weight (22.5g). It is moderately resistant to leaf blast, neck blast, sheath blight, sheath rot, stem borer (both dead heart and white ear heads), and leaf folder. CR Dhan 409 has good hulling, milling, and head rice recovery. It possesses intermediate amylose content, long slender grain, and other desirable grain quality parameters (Fig. 3).

CR Dhan 401 (Reeta)

CR Dhan 401 (Reeta) was released in 2010 by CVRC. The selection and evaluation work was carried out at National Rice Research Institute, Cuttack, Odisha. The variety is moderately tolerant to neck blast, brown spot, sheath blight, sheath rot, green leafhopper, stem borer, leaf folder, and gall midge biotype4. CR Dhan 401 has good hulling, milling, and head rice recovery. The maturity duration of the culture is 145-150 days, semi-dwarf plant type, non-lodging genotype, suitable for shallow lowland / irrigated late maturity group in the states of Odisha, West Bengal, Tamil Nadu, and Andhra Pradesh. It produces medium slender grain, 250-300 panicles per m² with 120-125 days to 50% flowering, moderate tillering (7-10), extra-long panicle (28-31 cm) with a seed test weight of 30.5 gm. The variety produces 5.4 t/ha under the rainfed shallow lowlands of India. The variety possesses desirable cooking and eating grain characteristics. The plant height of CR Dhan 401 is 110 cm. It is weakly photosensitive, Semi-dwarf (110 cm), long panicle, medium slender grain with the white kernel, broad and upright flag leaf, and thick leaf.

CR Dhan 408 (Chakaakhi)

CR Dhan 408 was released by SVRC, Odisha for the shallow lowlands in 2014. Average yield of the cultivar in Odisha is 4.8 t/ha. The variety is strongly photosensitive and it flowers in the 1st week of November. The plant height is 130-

140cm. It has a long bold grain, 250-300 panicle per m², moderate tillering (7-10), and having seed test weight of 25.6g. The base of the variety is purple and the seed is apiculous. The cultivar can tolerate one-week submergence. CR Dhan 408 possesses desirable quality characters like high head rice (60%), high milling (68%), intermediate amylose content (23.03%), and good for wet rice preparation. The variety is moderately resistant against the stem borer, leaf folder, white-backed planthopper, and rice whorl maggot attack. It is also moderately tolerant to Leaf blast, neck blast, bacterial blight, and sheath rot diseases.

CR Dhan 404 (Sumit)

CR Dhan 404 (Sumit) recommended for the rainfed shallow lowlands of Odisha CR Dhan 404 was released by SVRC, Odisha in 2016. Its maturity duration is 150 days, semi-dwarf (108-115 cm), non-lodging genotype, suitable for shallow lowland/irrigated late-maturing rice-growing areas of the state. It produces long bold grain, 260-300 panicles per m² with 120-125 days to 50% flowering, moderate tillering (6-8), extra-long and heavy panicle (29-31 cm). The variety is resistant to leaf blast, stem borer, leaf folder, glume discolouration, and GRH. It is resistant to both dead heart and white ear head stem borer insects. It is moderately tolerant to neck blast, brown spot, bacterial leaf blight, sheath blight, sheath rot, green leafhopper, gall midge biotypes 1, 5, 6, rice thrips, and EHB. Culture tolerates flash flood submergence for one week and has good regeneration ability after natural de-submergence. It has 6.26 mm of grain length, 2.45 mm of kernel length, 3.68 L/B ratios, 70.3% of milling recovery, 62.2% of head-rice recovery, 4.0-5.0 alkali value, and 24.03% amylose content. Average yield of the variety is 5.2 t/ha.

CR Dhan 403

CR Dhan 403 (Luna Suvarna) is released by SVRC, Odisha in 2010.



Fig 3. CR Dhan 409 (Pradhan Dhan).

It is a salt-tolerant, tall, long-duration rice variety suitable for coastal saline areas with resistance to major pests and diseases. The plant height of Luna Suvarna is 130 cm. It is photosensitive, medium tall, dense having fully exerted long panicles. It is a medium slender golden colour grain. The days to maturity of Luna Suvarna is 145-150 days. It has resistance against blast and moderate resistance against sheath blight and brown spot disease. The variety has tolerance to salinity (5.0-8.0 dsM-1) and standing water up to 45cm depth. Average yield is about 3,500-4,000 kg/ha. It has resistance against blast and sheath blight, and moderate resistance for the brown spot.

CR Dhan 407

The CR Dhan 407 is recommended for the rain-fed shallow lowland ecosystem of Odisha and West Bengal. It has a plant height of 102 cm, duration of 150 days, and well-exerted compact panicles, with



Fig. 4. CR Dhan 410 (Mahamani) at dough stage of the crop.

an average yield of around 5 t ha⁻¹. It showed moderate resistance to bacterial blight, leaf blast, white-backed plant-hopper, and whorl maggot. It produces desirable grain quality features with long grain, high head rice recovery-HRR (63.6%), intermediate amylose content (23.475%), and intermediate gel consistency - GC.

CR Dhan 410 (Mahamani)

The variety CR Dhan 410 (Mahamani) is a premium quality shallow lowland variety released by SVRC, Odisha in 2019. Mean yield in Odisha is found to be 4,353 kg/ha. The genotype is strongly photosensitive with average maturity duration of 155 days. It possesses long slender grain with a long heavy panicle having moderate test weight (24g) (Fig. 4). It is resistant to stem borer (both dead heart and white ear heads) and leaf folder while moderately resistant to neck blast, bacterial blight, sheath rot, and brown spot diseases. CR Dhan 410 has good hulling, milling, and head rice recovery. It possesses intermediate amylose content, long slender grain, and other desirable grain quality parameters.

CR Sugandh Dhan 910

The CR Sugandh Dhan 910 is a short-grained aromatic rice variety released for Odisha during 2015. Average grain yield of the variety is 4385 kg/ha. Maturity duration of the variety is 142-145 days and the plant type is semi-dwarf. The variety has 263-277 panicles/m². It is moderately resistant to blast, neck blast, sheath rot, rice tungro virus, stem sorer, leaf folder, and white-backed plant-hopper. The medium slender grains, test weight of 17.3g with no kernel chalkiness, and HRR of 68.8%. It possesses soft GC, intermediate amylose content, and ASV.

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