Bringing Green Revolution to Eastern India: Experiences and Expectations in Chhattisgarh

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Summary

The BGREI Program in Chhattisgarh includes cluster demonstration of technologies on rice and wheat as well as building assets and irrigation facilities with the objective to increase production and productivity of these crops. In rice 14 % area has been covered by BGREI demonstrations till date. BGREI demonstrations has played a major role in improvement of rice productivity in Chhattisgarh from 1.2 t/ha in 2011-12 to 2.1t/ha in 2016-17. Based on the crop cutting data of 2015-16 and 2016-17, highest yield advantage (63%) has been found in the cropping system based demonstration over the control followed by SRI (31%) and direct seeded rice (25.5%). SRI and hybrid rice technologies have highest impact among BGREI components based on the expansion of area over the period. Site-specific activities especially check dam and small irrigation pond built under BGREI Program brought around 30000 ha area under irrigation. However the area of upland rice in this state is still very high and due to its low productivity, the estimated value of overall rice productivity is comparatively lower than the other BGREI states. Hybrid maize technology is showing increasing adaptation in Chhattisgarh. If some of the upland areas can be replaced by the hybrid maize, mean productivity of rice in the state will be improved. On the other hand, due to water deficiency in BGREI districts the productivity has come down significantly in 2017. A state sponsored program for seed production and distribution of recommended stress tolerant varieties for unfavourable ecology are suggested to increase the productivity of rice in the state.

1. State background

Chhattisgarh is the tenth largest state in India with an area of 135,190 km^2. Chhattisgarh is primarily a rural state with only 20 per cent of population residing in urban areas. Agriculture has major share in economic growth of Chhattisgarh (Table 1). The growth rate of agriculture can be increased by adopting the new technology. The BGREI Program has been launched in the State to enhance rice productivity in the state. Therefore, BGREI was in operation initially in 08 non-NFSM districts and later it was extended to 14 districts of Chhattisgarh (Fig. 1).

Table 1. Particulars of Chhattisgarh state.

Particulars	Status		
Population (crore)	2.56 (male-1.29, female-1.28)		
Population growth (%)	22.61 in 2011		
Farm families (Nos.)	37.46 lakhs (80% small and marginal farmers)		
Forest village	74		
Revenue districts (Nos.)	27		
Block / Janpad Panchayat (Nos.)	146		
Village Panchayat (Nos.)	10971		
Tehsil (Nos.)	150		
Total Village (Nos.)	20273		
KrishiUpaj Mandi (Nos.)	73		
Annual Rainfall (ave.)	1296 mm (september, 2017 µ 877.90 mm)		
Land Use Pattern (Area : Lakh ha)	**Agricultural Land Use**		**(Area-Lakh ha)**
Geographical Area	138	Net sown area	47.75
Cultivable Area	57.28 (41.53%)	Double cropped area	10.47
Forest Area	63.15 (45.80%)	Gross cropped area	65.25
Land under non-agricultural use	10.30 (7.46%)	Kharif area	47.75
Permanent Pastures	5.25 (3.80%)	Rabi area	17.5
Cultivable Wasteland	3.51 (2.55%)	Cropping intensity	137%
Barren and uncultivable land	8.88 (6.43%)		
Current Fallows	2.67 (1.93%)		
Irrigation	**(Area : Lakh ha)**	**Source of irrigation**	**(Area : Lakh ha)**
Net irrigated area	14.68	Canals	9.03 (61.55%)
Gross irrigated area	17.87	Tanks	0.43 (2.93%)
Rainfed area (to cultivable area)	39.41 (69%)	Open wells	0.20 (1.37%)
		Bore wells/ Tube wells	4.28 (29.17%)
		other sources	0.73 (4.98%)
		Total Irrigated Area	14.67
Soil Type			**(Area-Lakh ha)**
Alluvial soil (Kachhar)	1.38 (2.7%)	Inceptisols (Matasi)	13.54 (26.9%)
Entisols (Bhata)	10.02 (20%)	Vertisols (Kanhar)	11.43 (22.8%)
Alfisols (Dorsa)	13.82 (27%)	Land Classif. Total	50.19
Major Agricultural Crops			
Kharif	Paddy, Pigeonpea, Soyabean, Maize, Mung, Urd, Kulthi		
Rabi	Wheat, Gram, Mustard, Safflower, Lathyrus, Field pea, Lentil, Linseed, Groundnut		

(*Source- ENVIS, Center of M.P. State)

2. Major interventions through the BGREI

2.1. Cluster demonstrations

BGREI Program was started in 2010. In the initial years upto 2014-15 the components of cluster demonstration like Rainfed upland rice, Shallow lowland rice, Irrigated variety and Irrigated- hybrid variety has been demonstrated. From 2015-16 the cluster demonstrations like Cropping system based, Direct seeded rice, Hybrid rice, Line transplanting, SRI and Stress tolerance variety has been started.

2.2. Asset building and site-specific activities

The Asset building intervention includes assistance for farm machineries & implements like manual/power sprayer, drum seeder, seed drill/zero-till seed drill, power weeder, self propelled paddy transplanter, rotavator, multi crop thresher irrigation pipes and pump set. The component of Site Specific Activities has been provided to induce flexibility in the program to take up the activities not covered under other components of the program, which contribute in productivity of rice and wheat. Assistance for activities that would help in enhanced procurement, creation of storage facility, marketing and value addition is also included. These activities include promotion/creation of primary processing facilities (drying, grading, par-boiling of paddy and bagging etc) including farm level storage, institution building, linkage for procurement operations/ marketing. A total 1707 number of check dam which have the potentiality to irrigate 22657 ha area and 287 small irrigated ponds which have the potentiality to irrigate 7155 ha land have been constructed under BGREI Program in the state (Table 2).

Table 2. Site-specific activity specially check dam and small irrigated pond under BGREI (from 2011 to 2018).

Year	Check Dam		Small irrigated pond	
	No.	Irrigated land (ha)	No.	Irrigated land (ha)
2010-11	224	2972	100	2500
2011-12	158	2097	32	800
2012-13	273	3625	103	2575
2013-14	236	3131	20	500
2014-15	359	4777	8	200
2015-16	268	3550	15	375
2016-17	111	1470	5	125
2017-18	78	1035	4	80
Total	1707	22657	287	7155

3. Areas of demonstrations

In Chhattisgarh 14 % area under rice has been covered by BGREI demonstration till date. The details of the year-wise demonstration area are presented in Table 3. In last three years (2015-2018) around 2 lakh ha area in the state was demonstrated with different components under BGREI Program (Table 4).

Table 3. Area under BGREI demonstration in Chhattisgarh.

Total rice area	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	BGREI demo area
37.73	0.39	0.87	1.14	1.07	0.70	0.74	0.49	5.40

Table 4. Demonstration area (ha) under different components in the BGREI program.

Different components	Year		
	2015-16	2016-17	2017-18
Direct Seeded Rice	5000	5000	1000
Line Transplanting	5000	5000	1000
SRI	5000	5001	2000
Stress Tolerant Varieties	21860	21266	15000
Hybrid Rice	18412	25000	15000
Cropping System Based	14900	13000	15136
Sub Total Rice	70172	74267	49136

4. Trends area, productivity, production of rice and wheat since 2009-10

The trends of rice area and production are described in (Fig 2). The rice area in Chhattisgarh state varied in the range of 3671-3830 thousand hectares for the period 2009-10 to 2017-18. However, there is wide variation in the production which ranged from 4.11 Mt in 2010-11 to 8.05 Mt in 2016-17. As there was less variation in the area, higher production is mainly due to the increase in the productivity, which ranged from 1.12 t ha^{-1} in 2009-10 to 2.10 t ha^{-1} in 2016-17 (Table 5).

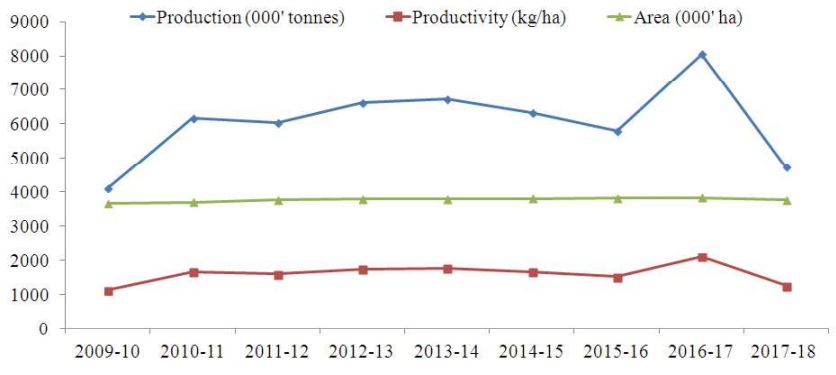

Fig. 2. Trends of area, production and productivity of rice in Chhattisgarh.

5. Effects of BGREI interventions

The BGREI Program started in 2010-11. Until 2014-15 the components of rice demonstration were rainfed upland rice, shallow lowland rice, irrigated variety and irrigated hybrid. The average yield advantage based on crop cutting data from 2012 -13 to 2014-15 is presented in Table 6. The average yield advantage of all these components was around 20-21%. Since 2015-16 BGREI demonstration components were revised. The average crop cutting data of 2015-16 and 2016-17 revealed that the highest yield advantage was achieved in cropping system based demonstrations (67%) followed by SRI demonstration (31%) and direct seeded rice (25.5%) (Table 7).

Table 6. Yield advantage of BGREI demonstrations based on the average value of the years, 2012-22013, 2013-14, 2014-15.

Components	Yield of demonstration plot ($t\ ha^{-1}$)	Yield in control plot ($t\ ha^{-1}$)	Yield increase (%)
Rainfed upland rice	4.21	3.49	20.10
Shallow low land rice	4.46	3.72	20.08
Irrigated traditional variety	5.10	4.21	21.28
Irrigated hybrid	5.41	4.50	20.20

Table 7. Average yield of demonstration plot, control plot and yield advantage over the control plot (Based on crop cutting data of 2015-16 and 2016-17).

Demonstration	Area (ha)	Cluster (Nos.)	Crop cutting result (Demonstration plot)		Crop cutting result (Control plot)		Yield advantage (%)
			No. of cutting (total)	Production (q/ha)	No. of cuttng (total)	Production (q/ha)	
Cropping System Based	22310	261	7162	56.46	7139	34.47	63.80
Direct Seeded Rice	8800	114	2439	33.33	2422	26.55	25.51
Hybrid	38299	474	12559	53.59	11990.67	44.25	21.11
Line Transplanting	9700	115	2872	39.75	2818	33.14	19.94
SRI	9501	120	3091	43.57	2851	33.21	31.19
Stress Tolerance	38234	502	11751	37.40	11283	31.18	19.96

The overall impact of BGREI Program in Chhattisgarh state as realized from the percent of area increased under different technologies (Table 8) can be summarized as follows.

SRI and hybrid rice technologies have higher impact. The area can be increased under such technology to get better productivity

Application of herbicide & line sowing in direct seeded rice should be higher to get better productivity in upland and medium land areas

Upland rice is low productive. If some of the area is replaced with hybrid maize, the mean productivity of rice can be improved for the state

Seed treatment package and regular training to farmers can reduce crop loss and increase productivity

Some new rice varieties including stress tolerance varieties and hybrid are adopted in the state (Table 9, Fig. 4)

Table 8. Impact of technologies under BGREI Program in increasing area

Transfer of technology	Area (ha)		Increase (%)
	2012	2017	
SRI	20944	54200	159
Seed treatment	2374131	2920382	23
Line sowing	226660	275392	22
Intercropping	173353	184913	7
Bund farming (Pigeon pea/sesame)	219953	223788	2
Hybrid rice	157486	433370	175
Hybrid maize	62108	161285	160
Weedicide	879806	1152917	31

Table 9. Varieties adopted under rice demonstration in 2017 in Chhattisgarh

Rice demonstration in different ecosystem	Variety under demonstration	Area under demonstration (ha)
Direct Seeded	Chandrahasini, Rajeshwari, Maheshwari	5000
Line Transplanting	Durgeshwari, PKV HMT, Pusa 5, HMT, Samleshwari	5000
SRI	PKV HMT, Durgeshwari, Maheshwari, Swarna Sub-1	5000
Stress Tolerent Variety	Swarna Sub 1, Karmamasuri, Rajeshwari, OP Bio-226, IGKVR-1	24860
Hybrid Rice	US-382, JKRH-401, CORH-3, K-371, VNR-2245	18173
Cropping system based	Durgeshwari, DRH-775, Chandrahasini, Karma Masuri, CORH-3, US-382, K-371, Arize Tej, DRRH-02	14900

Fig. 4. Under BGREI, Hybrid paddy (cv. US-382) demonstration in Kondagaon district was monitored by national level monitoring team in 2018.

6. Production and Productivity Comparison of BGREI and Pre-BGREI Years

There has been a significant increase in the production of rice from 4110 thousand tonnes (2009-10) to an average 6187 thousand tonnes in last three years (2015-18). Despite low production in previous year due to rainfall deficiency there has been significant increment in the productivity from an average of 1.1 t/ha in pre-BGREI year (2009-10) to an average of 1.6 t/ha during last three years (2015-2018) (Fig. 5).

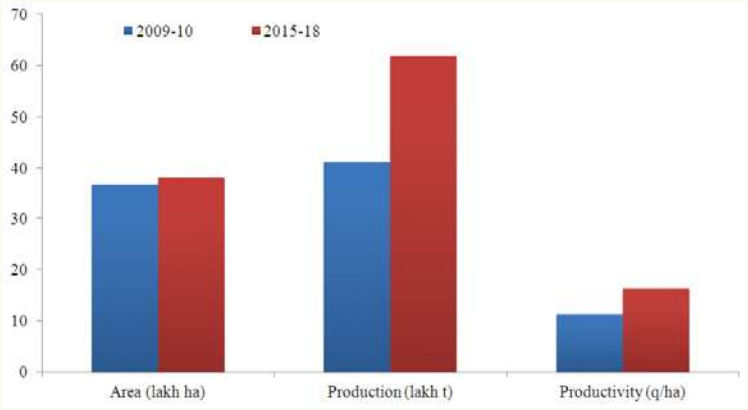

Fig. 5. Comparison of pre-BGREI and BGREI years in terms of area, production and productivity of rice in Chhattisgarh.

Rainfall pattern in 2016-17 and 2017-18 is presented below. In 2017-18, in most of the BGREI districts rainfall was deficit (Table 10). Therefore, the productivity in the state that was steadily going up over the years came down to 1.2 t ha^{-1}.

Table 10. Rainfall deficiency in 2017 as compared to 2016.

Name of district	Rainfall (cm)(June to November)		Deficit/Excess
	2016	2017	
Gariyaband	141.67	102.42	-11%
Mahasamund	135.76	100.66	-8%
Dhamtari	155.34	89.13	-19%
Durg	141.04	69.09	-36%
Bemetara	105.62	75.3	-29%
Balod	154.99	101.27	-6%
Janjgir	144.51	83.67	-33%
Sarguja	136.52	116	-13%
Surajpur	141.49	107.79	-9%
Balrampur	211.19	152.2	27%
Kanker	222.65	111.9	-10%
Narayanpur	191.46	109.28	-17%
Jagdalpur	204.44	149.2	16%
Kondagaon	199.64	130.13	3%

7. Suggestions

- Inclusion of preferred high yielding varieties/hybrids of the farmers in this program.
- Giving seed indent for seed production of the newly released high yielding stress tolerant and nutrient rich varieties. New rice varieties with their suitability in the context of food and nutritional security and changing scenario are suggested as follows.
- High yielding varieties with high nutrient (Protein, Fe, Zn) content is required to cultivate in large scale to achieve the food and nutritional security. Presently high yielding varieties with high nutrient content are available. CR Dhan 310 (with high protein content), DRR Dhan 45 (with high Zn content) and Chattrisgarh Zinc rice 1 (with high Zn content) can be incorporated under BGREI Program.
- Rainfall deficiency is becoming a frequent event in many BGREI districts under changing climatic scenario. Therefore, drought tolerant variety in IR 64 background, DRR Dhan 42 (IR 64 Drt 1), another rice variety DRR Dhan 44 with drought tolerance and CR Dhan 801 in Swarna background is suggested to incorporate in BGREI Program. Apart from this many aerobic rice varieties have been released as a part of the water saving technology. Long slender grain aerobic rice varieties such as CR Dhan 203 and CR Dhan 201 also can also be adapted in BGREI demonstrations.
- Varieties are being grown since long are subjected to high incidence of insect-pests and diseases. Samba Mahsuri is one of the popular varieties are being cultivated in Chattrisgarh for its good grain quality. But this variety has been notified more than 10 years and susceptible to pest and diseases such as bacterial blight. This can be replaced by Improved Samba Mahsuri (RP Bio-226), a high yielding rice variety with major bacterial blight resistance genes Xa21, xa13 and xa5. CR Dhan 800 (CRMAS 2232-85) in 'Swarna' background showed ssignificantly higher level of Bacterial blight resistance than Swarna. This variety also can be taken in Chhattisgarh for this Program.
- Cluster demonstrations using more than one rice varieties in catchment areas of check dam, build under BGREI Program.
- Regular monitoring of BGREI cluster demonstrations and submission of reports to the Nodal officers from NRRI, Cuttack and IGKV on quarterly basis.
- Non Supply/ Poor supply of quality seeds of paddy, including the varieties and hybrids by the state seed corporation is another major area of concern, needing immediate attention of State govt. Indent of breeder seeds of new recommended varieties (by NRRI, IGKV) by state agricultural department is required for adaption of new rice varieties with high yield, quality and stress tolerance.
- Delayed/incomplete supply of inputs under *cafeteria* needs immediate attention of the State nodal agency i.e., SSC or an alternate mechanism such as decentralized supply of inputs may be decided at level of state headquarters.

The BGREI demonstration and other intervention helped in improvement of rice productivity in Chhattisgarh from 1.2 t ha^{-1} in 2011-12 to 2.1 t ha^{-1} in 2016-17. However, the productivity was very poor in 2017 due to moisture deficiency in most of the rice growing districts as well as the BGREI districts. More interventions of climate change adaptation and mitigation technologies are required in future for getting sustainable production and profitability of rice cultivation. Line transplanting can be incorporated under SRI, hybrid rice and cropping system-based research and area can be increased for getting better productivity. A state-program for seed production and distribution of stress tolerant varieties for unfavourable ecology can increase the productivity of rice in the state.