



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

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Summary

The economy of Assam is mainly agrarian with agriculture and allied activities contributing about 20 percent to the state's net domestic product and providing livelihood support to about 33.82 million rural poor population of the of the region. Though rice is the dominating crop of the state that occupies around 89.29 % of the gross cropped area, productivity is less than the national average. The BGREI Program has been implemented in state of the Assam with an objective to enhance production and productivity of rice along with the cropping intensity in rice mono cropped areas. Cluster demonstrations, production and distribution of rice seeds, nutrient management and soil ameliorations through micro-nutrients and bio fertilizers and integrated pest management were the major component of BGREI program implemented in Assam. Besides these, assistance has been provided for procurement of farm machineries and implements like rotavator, manual and power operated sprayers, power weeder, tractor driven paddy thresher and power tiller to enhance in productivity of rice in the state and modern compact rice mill to improve post-harvest activities and enhance marketing. Community threshing floor with facilities like thresher machine and drier has been given to help farmers in carrying out post-harvest activities easily and quickly. Line transplanting of rice, system of rice intensification, stress tolerant varieties (Swarna Sub-1 and Sahbhagi Dhan), hybrid rice (Sahydri 4, NPH-924-1, RHR-111, Arize 6444, CRHR-5, VNR 2355, NK 5231 and PNP-24) and rice-pulse cropping system were demonstrated in 47,970.7 ha area of Assam during 2017-18. Demonstration on hybrid varieties recorded the highest 66.17 % increase in yield against the conventional practice (3.80 t ha^{-1}). Other demonstrations like line transplanting, stress tolerant varieties and cropping sequence based demonstration also recorded higher yield as compared to control. The BGREI Program was started in the year 2010-11 and over the years about 14.23% of the total rice cultivated area of the state has been covered under the cluster demonstrations. Rice cultivated area in Assam shown a slightly declining trend from the year 2009-10 to 2017-18 and production and productivity of rice showed an increasing trend during this period. Before implementation of BGREI Program in the state of Assam, the average rice productivity was 1.59 t ha^{-1} and implementing BGREI Program in the state has significantly increased the average rice productivity to 2.03 t ha^{-1} during last three years and recorded the highest productivity of 21.07 q/ha in the year 2017-18. It is felt necessity to create awareness, sensitization, skill improvement and refreshers training courses with latest innovations designed for different levels of Agricultural officers within the state of Assam. Besides, advance planning and timely execution of the program at field level will help in brining green revolution in the state.

1. State background

Assam is an evergreen beautiful state of India. The Brahmaputra and the Barak rivers with 121 small to medium tributaries keep the state fertile. Total geographical area of the state is $78,439 \text{ km}^2$, which is being administrated in 33 districts (Fig. 1). The economy of



Fig. 1. Map of Assam.

Assam is mainly agrarian with agriculture and allied activities contributing about 20% to the state's net domestic product and providing livelihood support to about 75% of the population of the region. Rice is the dominating crop of the state occupying around 90% of the gross cropped area. Among the cash crops, sugarcane and jute occupy a substantial area. In horticulture, banana, pineapple and citrus are the major fruit crops while potato, various cole crops, cucurbits, okra and diverse leafy vegetables are the major vegetable crops. Productivity of the major crops like rice, pulses,

and oilseeds is still much lower in Assam compared to the national average. Agriculture in Assam is characterized by mono-cropping, mostly small holdings low input-low output and subsistence farming systems practiced primarily under rainfed condition.

Assam can be broadly divided into three distinct physiographic units: the plains, the plateau and the hills with the plains of Brahmaputra and Barak valleys being the main area for agricultural development. The typical characteristic feature of Assam soils is its acidity (pH ranging from 4.2 to 5.8). High humidity and seasonal pattern of rainfall and temperature are important features of Assam climate with rainfall being the most important determinant factor for the climate. Rainfall distribution follows a typical monsoon pattern with peak precipitation during monsoon (June-September) and scanty rainfall in winter (December-February). Based on variation in rainfall, physiography and soil characteristics, the state has been divided into following six agro-climatic zones (Table 1).

Table 1. Agro-climatic zones of Assam.

Agro-climatic zones	Districts
North Bank Plains Zone	Darrang, Dhemaji, Lakhimpur, Sonitpur, Biswanath, Udalguri
Upper Brahmaputra Valley Zone	Dibrugarh, Tinsukia, Sivsagar, Charaideo, Jorhat, Majuli, Golaghat
Lower Brahmaputra Valley Zone	Kamrup Metro, Kamrup (Rural), Nalbari, Baksa, Barpeta, Bongaigaon, Chirang, Kokrajhar, Goalpara, South Salmara, Dhubri
Central Brahmaputra Valley Zone	Marigaon, Nowgaon, Hojai
Hill Zone	KarbiAnglong East, KarbiAnglong West, Dima Hassao
Barak Valley Zone	Cachar, Hailakandi, Karimganj

There is a slight variation of climate from region to region within the State. The Lower Brahmaputra Valley Zone of Assam is characterized by plentiful rains and foggy winter. The cold season in this region is from December to February and this is followed by the sandstorms and thunderstorms from March to May. The rainy season, as in rest of Assam begins in late June and continues up to late September. October and November constitute the post-monsoon period. In Lower Brahmaputra Valley Zone of Assam, the day temperatures in April and May are nearly the same as in the monsoon months. The climate of the Barak Valley districts is characterized by abundant rainfall, moderate temperatures and high humidity. The climate of the Central Brahmaputra Valley and North Bank Plain Zone are characterized by the absence of a dry hot summer season, the highest temperature being experienced during the period of south west monsoon along with abundant rains and a humid atmosphere throughout the year. The climate of the Upper Brahmaputra Valley is somewhat identical to North Bank Plains Zone of eastern Assam.

2. Major interventions through BGREI

2.1.1 Cluster demonstrations: Cluster demonstrations, production and distribution of rice seeds, nutrient management and soil ameliorations through micro-nutrients and biofertilizers and integrated pests management were major component of the BGREI Program implemented in state of the Assam to enhance production and productivity of rice. Demonstration on Line transplanting, system of rice intensification, stress tolerant varieties (Swarna Sub-1 and Sahbhagi Dhan), hybrid rice (Sahydri 4, NPH-924-1, RHR-111, Arize 6444, CRHR-5, VNR 2355, NK 5231 and PNPB-24) and rice - pulse cropping system were the major interventions in the state to enhance production and productivity of rice along with the cropping intensity in rice mono-cultured areas.

Asset building and site-specific interventions: Asset building intervention includes assistance for procurement of farm machineries & implements like rotavators, manual and power operated sprayers, power weeder, tractor driven paddy thresher and power tiller. Assistance has been provided for procurement of Power tiller (8 BHP and above) under the component of Site Specific Activities to SC, ST, small and marginal and women farmers of Assam with the objective of enhancing the productivity of rice in the state. Modern compact rice mill with a milling capacity of 300-500 kg/hour (7-10 HP motor) has been provided with a financial assistance of 60% of the cost limited to 1.5 lakh to improve post-harvest activities and enhance marketing. Community threshing floor with facilities like thresher machine and drier has been created to help farmers in carrying out post-harvest activities easily and quickly.

3. Areas of demonstrations

The BGREI Program was started in the year 2010-11 and over the years about 14.23% of the total rice cultivated area of the state has been covered under the cluster demonstration activity.



Table 2. Rice area of Assam State vis-à-vis area covered in the BGREI.

Rice area (lakh ha)	Area covered under BGREI demonstration (lakh ha)							Cumulative BGREI demonstration area (lakh ha)	Area covered under BGREI demonstra- tion (%)
	2011- 12	2012- 13	2013- 14	2014- 15	2015- 16	2016- 17	2017- 18		
24.51	0.41	0.56	0.38	0.72	0.41	0.53	0.48	3.49	14.23

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

Rice cultivated area in Assam has shown a slightly declining trend from the year 2009-10 to 2017-18 (Fig. 2). Production of rice in the state showed an incremental trend during this period. Rice productivity of the state was 1.74 t ha⁻¹ in 2009-10 and showed an increasing trend in the successive years and recorded the highest productivity of 2.11 t ha⁻¹ in the year 2017-18

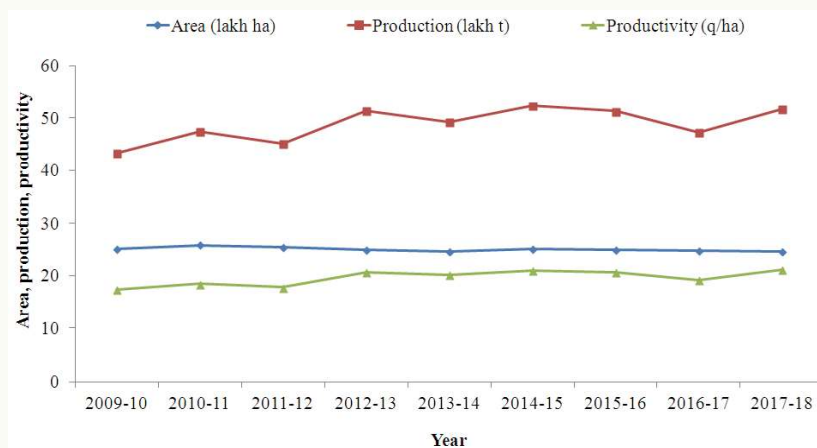


Fig. 2. Trend in area, production and productivity of rice from 2009-10 to 2017-18.

5. Effects of the BGREI interventions

Interventions *viz.*, line transplanting, SRI, stress tolerant varieties, hybrid varieties and productive cropping systems were demonstrated in 47,970.7 ha area under BGREI in Assam during 2017-18. Effects of the technologies on the yield of the rice crop were evaluated through crop cuttings in the demonstration and control plots under the



conventional practice in the farmer's fields. Demonstration on hybrid varieties recorded the highest 66.17 % increase in yield against the conventional practice (3.80 t ha^{-1}) (Table 3). Other demonstrations like line transplanting, stress tolerant varieties and productive cropping systems also recorded higher yield compared to control.



Table 3. Performance of interventions in Assam (2017-18).

Name of the demonstration	Area covered (ha)	Yield in demonstration plot (q/ha)	Yield in control plot (q/ha)	Increase in yield (%)
Line transplanting	3682	49.99	41.39	20.77
SRI	1413	-	-	-
Stress tolerant varieties	16153	51.78	40.96	26.39
Hybrids	6069	63.13	37.99	66.17
Cropping system based interventions	20654	48.58	43.00	12.99

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

Before implementation of BGREI Program in the state of Assam the average rice productivity was 15.93 q/ha and implementing BGREI Program in the state has significantly increased the average rice productivity to 20.28 q/ha during last three years.

Table 4. Area, production and productivity of rice in Assam during Non-BGREI and BGREI years.

Parameters	Non-BGREI years (2007-08 to 2009-10)	BGREI years (2015-16 to 2017-18)
Area ('000 ha)	2434.3	2467.7
Production ('000 t)	3887.3	5005.4
Productivity (t ha^{-1})	1.59	2.03

Assam receives around 1500 mm of annual rainfall and rainy season mark the most of the months of a year (Table 5). Rain showers erratically in the summer months between March and June. However, the state witnesses exceptionally higher monthly rainfall of 437.4 mm in the month of April in the year 2017 (Fig. 5). Monsoon arrives in the later part of June month and the intensity of rainfall usually crosses the extent and leads to natural catastrophes like floods in the state. Such heavy precipitation lasts till the month of September. From late-October to late-February, winter season exists in the state marked by low temperature and scanty rainfall. Spring and autumn seasons continue to carry moderate temperatures and less rainfall in Assam.

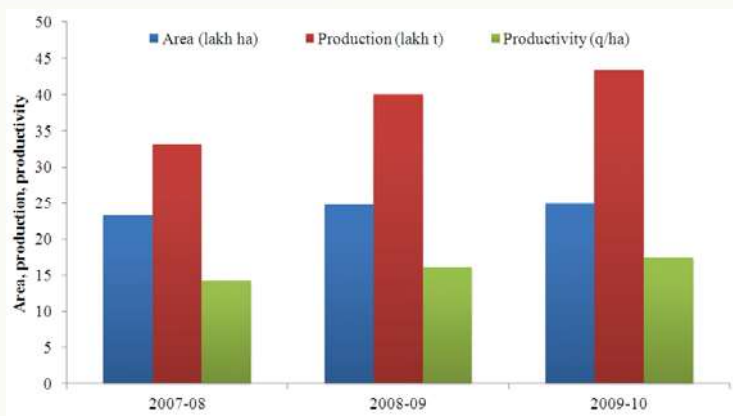


Fig. 3. Area, production and productivity of rice in Assam in pre-BGREI period.

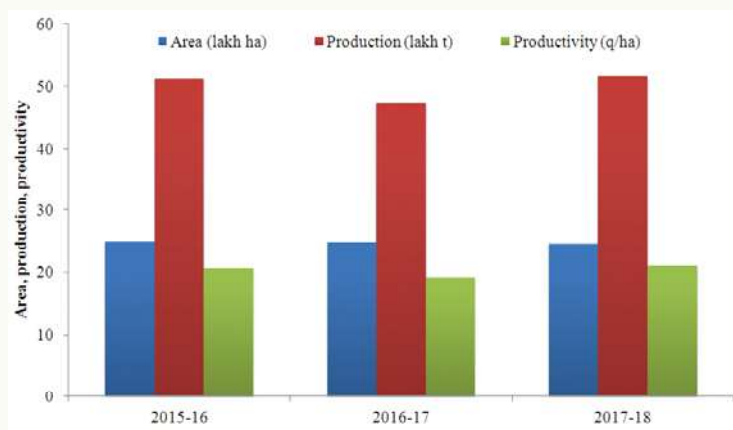


Fig. 4. Area, production and productivity of rice in Assam during BGREI period.

Table 5. Rainfall pattern of Assam during the last ten years.

Month	Rainfall (mm)	Rainy days (No.)
January	6.70	1
February	13.44	1
March	56.66	4
April	229.88	11
May	251.71	13
June	317.05	11
July	182.73	10
August	209.21	9
September	165.11	7
October	58.99	2
November	3.82	0
December	4.51	1
Total	1499.81	70



7. Suggestions

- Proper planning and timely formulation of action plan and its implementation.
- Seeds should be distributed well ahead of the season. Late receipt of seed resulted in less adoption of demonstration.
- Varieties for demonstration should be selected as for land situation based on State Seed Sub Committee recommended. Swarna sub-1 should not be grown in all ecologies.
- Measures need to be taken for utilization of perennial water streams for irrigation in *rabi* rice.
- In villages three phase electricity connection is rare, hence in place of electrical rice mill diesel operated mill may be provided.
- Awareness, sensitization, skill improvement of agricultural officers through refresher training courses with latest innovations should be designed within the state.

Average productivity of rice was 1.60 t ha^{-1} before implementation of the BGREI Program in the state of Assam but significantly increased to 2.02 t ha^{-1} (latest three years) on implementation of the BGREI Program. Demonstration on hybrid varieties recorded the highest (66.17%) increase in yield against the conventional practice (3.70 t ha^{-1}) in the state. Seeds should be distributed well ahead of the season as rainfall starts early in the state. Further, as three phase electricity connection is rare in the villages, in place of electricity, diesel operated mill may be provided through the program.