Invited Review

Rice in Eastern India: Causes for Low Productivity and Available Options[1]

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Eastern India, comprising of the states of Assam, Bihar, Jharkhand, Chhattisgarh, eastern Uttar Pradesh and West Bengal, is the largest rice growing region of the country. Accounting for 58% of the total rice area, share of eastern region to the national rice production is less than 48%. Yield level of this region also remains below the national average. Impressive yield growth achieved in the non-traditional rice growing areas of the north and the traditional rice-growing southern regions during the last three decades enabled the country to achieve and sustain self-sufficiency in rice. Although, it is widely believed that the key to India's sustained food security lies in the eastern India, general understanding of the problems restricting the yield level and development efforts to remedy these are still elusive. The present review addresses some of the related issues.

The area under rice accounts for about 22 per cent (44.6million ha) of the total cropped land, 34 per cent of the food crop area and 42 per cent – of the area under cereals. The nation's rice output level of 87.8 million tones in 2004-2005 is about 6 per cent less than the all time high of 93.08 million tones achieved in 2001-2002. Production during 2008-09 is expected to touch 100 million tons.

The rice ecosystem is broadly classified into two categories viz., irrigated and rainfed (Fig. 1). Coastal saline and hill rice smaller bust distinct ecosystems.

Of India's total rice cultivated area of 45.16 million ha, only 23.34 million ha (about 54 %) is irrigated (Table 1). About 70 per cent of the annual rice production of 87 million tones comes from the irrigated area. The remaining 30 per cent comes from the areas that are rainfed. Rainfed areas are

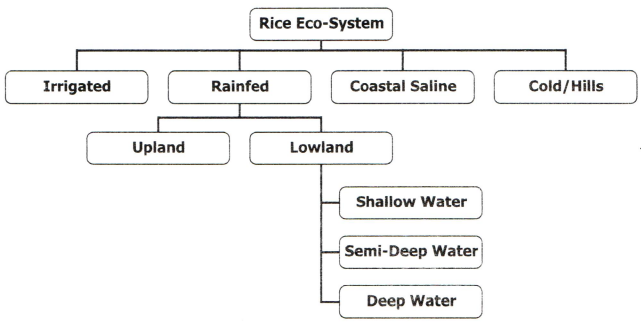

Fig. 1 : Rice ecosystems

vulnerable to the vagaries of rain and therefore, the fluctuations in their output. The average rice productivity on irrigated land is 2.3 to 3.5 tonnes ha^{-1}. The productivity from rainfed ecology is low and fluctuates between 0.5 to 1.6 tones ha^{-1}.

Table 1: Rice area in India under different ecologies (2002-03)

Rice ecosystem	Area (M ha)	% of Area
Irrigated	24.34	53.9
Rainfed	12.24	27.1
Flood prone	2.71	6.0
Upland	5.87	13.0
Total	**45.16***	**100.0**

Rainfed Rice in Eastern India

Rice is grown in Eastern India mainly in the basins of *Ganga* and Mahanadi rivers and has the highest intensity of rice cultivation in the country. This region receives heavy rainfall and rice is grown mainly under rainfed conditions. Rice area under different rainfed rice ecosystems in the states of eastern India is presented in Table 2.

1. **Upland:** upland rice areas lie in eastern zones comprising of Assam, Bihar, Madhya Pradesh, Orissa, Eastern Uttar Pradesh and West Bengal and North Eastern Hill regions. In the rainfed

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Table 2 : Rice area under different rainfed rice ecosystem in the eastern states

RGE	Rice Growing Environments (%) in different eastern Indian States							Total
	Assam	Bihar	Orissa	Chhattisgarh	Eastern UP	WB	%	M. ha
Irrigated	9	29	23	13	28	24	21	5.7
Upland	9	10	15	29	8	16	16	4.4
Rainfed lowland (RL)	39	32	38	60	40	31	39	10.6
RL Medium deep (25-50 cm)	21	9	11	2	6	9	8	2.2
Deep water (50-100 cm)	17	7	9	-	5	7	7	1.8
Floating Rice (> 100 cm)	4	13	3	-	12	12	8	2.2
Total area (m ha)	2.3	5.4	4.5	4.0	2.9	5.5	30	24.6

upland rice, there is no standing water in the field after few hours of cessation of rain. The total area under upland rainfed rice in the country is about 6.00 million ha. which amounts to 13.0% of the total area under rice crop in the country. The productivity of upland rice is very low. As against the present national average productivity of about 2.1 tones ha^{-1} the average yield of rice in upland areas in the country is only1.0 tones/ ha.

2. **Lowland:** Lowland rice area is mostly located in the eastern region comprising of Assam, Bihar, Madhya Pradesh, Orissa, Eastern Uttar Pradesh and West Bengal. Lowland rice area is about 14.4 million ha which accounts 32.4 per cent of the total area under the rice crop of the country. The average rice productivity of lowland area ranges from 1.0 to 1.2 tones/ha.

The lowland rice may be further classified into three categories depending upon the standing depth of water in the field as:

Shallow Water : The standing depth of water in the field is generally below 50 cm. the shallow rice area is located in the eastern states *viz.* Assam, Bihar, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal.

Semi-deep water : The standing depth of water in the field varies between 50-100 cm. These areas are lying in eastern states *viz.* Assam, Bihar, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal.

Deep water : The standing depth of water is more than 100 cm in the field. Such deep water rice areas are mostly situated in the eastern states *viz.*, Assam, Bihar, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal. These areas are subjected to flood occurrence and duration of flooding varies from year to year.

Constraints for Productivity in Eastern India

The key production constraints in the rainfed lowlands of eastern India, are:

i) Physical

Abiotic stresses commonly limit rice productivity in eastern estates. Major abiotic stresses are:

Drought : The irregularities in south-west monsoons do result in moderate to sever droughts in rainfed rice growing areas especially in eastern India. Such moisture stresses with varying durations may occur during any stage (vegetative, flowering and terminal) of the crop growth in uplands, whereas, seedling stage drought generally

occur in lowland. Effects at initial and terminal stage depends on sowing time and growth duration of the varieties. Even short duration varieties possessing escape mechanism, takes heavy toll of the crop due to poor water holding capacity. Bihar plateau & Hazaribagh are prone to drought. Impact of drought during 2002-03 on rice area, production and productivity in the eastern states in comparison to a normal year (2001-02) is presented in Table 3.

Table 3 : Impact of drought during 2002-03 on rice area, production and productivity of eastern states in comparison to all India

State	Area ('000 ha)			Production (000 tons)			Yield (Kg/ha)		
	2001-02	2002-03	Change (%)	2001-02	2002-03	Change (%)	2001-02	2002-03	Change (%)
Assam	2528.5	2540.7	0.5	3849.5	3737.9	-2.9	1524	1471	-3.5
Bihar	3568.8	3591.2	0.6	5280	4978.3	-5.7	1480	1386	-6.4
MP	1755.4	1451.6	17.3	1660	899.6	-45.8	948	620	-34.6
Orissa	4500	4273.5	-5.0	7144.5	3243.6	-54.6	1589	759	-52.2
UP	5876.8	4416.9	-24.8	12460	8108.6	-34.9	2120	1836	13.4
WB	6069.1	5842.2	-3.7	15260	14389	-5.7	2514	2463	-2.0
Total (ES)	24299	22116	-8.9	45654	35357	-22.55	1696	1423	-16.09
India	44904	40279	-10.3	93340	72653	-22.2	2079	1804	-13.2

Utilization of ground water in high rainfall areas in eastern India for bringing more area under productive 'Boro' (winter) rice is not being exploited in Bihar, Chhattisgarh and Orissa. But in West Bengal inadequate power/fuel supply has left hundreds of shallow wells under utilized.

Flood/Submergence : Flood/submergence are critical constrains to rice production in lowland & deep water areas. Eastern India account for about 62 per cent of the total flood prone area in the country. Most part of deep water areas are subjected to submergence. Traditional & adapted varieties are very low yielders. Most varieties can neither elongate fast nor survive inundation, however they suffer with lodging when water recedes. Most varieties are not adapted to flash flood submergences. Almost all low land & deep water areas are prone to temporary inundation. Orissa has flood prone area of about 3,80,000 ha.

Lowlight : Predominantly low incident solar radiation coupled with fluctuating light intensity. due to over cast sky during the wet season is a major constrains for realizing the high productivity in eastern and north eastern India. The reproductive stage is the most sensitive stage to low light stress. Early and medium duration genotypes are highly affected as their reproductive stage coincides with the low availability of light. High tiller mortality at vegetative stage, reduction in spikelet number at reproductive stage, dry matter production after flowering thus reducing mobilization of pre-flowering reserve carbohydrate from shoot to panicle are important features drastically affected.

Weather related constraints, poor drainage and adverse soils are also other important physical constraints in this region.

Weather related constraints

Sali (Assam) & *Aman* rice (WB) exposed to low solar radiation & thereby suffer low photosynthetic efficiency.

Late *Sali, Aman* rice and hill rice (WB) often suffer from sterility (low temperature at flowering)

Boro rice (Assam, WB & Bihar) suffers from cold injury during the early vegetative growth stage.

Harvest of *Boro* and *Ahu* rice (Assam) coincides with onset of monsoon.

Continuous rain during harvest causes grain germination (lack of seed dormancy in HYV).

Incomplete drying and high humidity affect the grain quality.

Poor drainage

Considerable area in Bihar lacks proper drainage facilities.

Poor drainage hinders efficient use of inputs.

Orissa also suffers with the same.

Adverse soils

Acid soil deficient in N, P, Zn, Bo and organic matter content.

Continuous rice cropping and low inputs depleted important macro and micro nutrients.

Large area in Orissa, Southern Bihar, WB and Assam has acidic soil characterized with coarse texture, low water holding capacity, low organic matter and base saturation.

Few areas of eastern India have alkali/saline soil.

ii) **Biological**

Diseases

- Leaf and panicle blast major disease in upland ecosystem.
- Bacterial blight and rice Tungro Diseases complex become major problems
- Brown spot more prevalent in rainfed upland areas.
- Endemic diseases for drought prone uplands may not found in flood prone areas and *vice* versa.

Insect Pest

- High humidity and temporary characteristic facilitate the pest population.
- No variety truly resistant to yellow stem borer (20 per cent yield loss).
- Gall midge: major damage during early growth stage.
- Green leaf hoppers (vector of tungro virus) are potential enough to cause greater yield losses.

Weed

Grasses predominate weed flora in the initial stages of crop growth in rainfed uplands followed by docotyledons in the later stage.

iii) Technological

Lack of ideal high yielding varieties and slow adoption of improved varieties, non availability/ inadequate supply of high quality seeds, low to very low fertilizer use in agricultural operation, poor crop emergence and crop stand leading to the thinner plant population, slow and ineffective transfer of technology are the constraints in the rainfed areas. Low input management vis-à-vis risks of crop losses dissuade farmers from high input management in rainfed ecologies. More than lack of awareness, poverty coupled with justifiable apprehension on crop success is attributable to the low use of fertilizer and other monetary inputs including quality seed in rainfed eastern states.

iv) Socioeconomic

Almost 65 per cent farmers have small and fragmented holdings scattered at different places. Average holding size is around 1.4 ha except Madhya Pradesh. Unfavorable land tenure system causes lack of interest. Non availability of inputs likes pesticides, fertilizers, and labour in peak period leads to low production. Majority of the farmers are extremely poor having limited resources and low literacy rate, fail to perceive the HYV and technologies.

v) Institutional (Infrastructure, Credit & Marketing)

Poor infrastructure such as irrigation, drainage, roads, transport and communications system influence marketing and input flow. Poor marketing facilities, non availability of inputs, including credit facility at proper time. Poor extension reach agencies, lack of coordination between agriculture and allied departments and proper facilities for skill

upgrading for formers on risk management are the important institutional factors which affect the awareness and skill fullness of farmers.

Improvement of rice production technology

While the constrains in increasing the productivity of rice in eastern India have been listed above, the remedy also lies in addressing them in order of priority. The weather related constrains remaining the most influencing factors, effort should be focused in tackling them through specific variety development program that can withstand the demands of drought as well as submergences. Central Rice Research Institute has developed several rice varieties and released them with the help of AICRIP for cultivation in various handicapped ecologies. Extremely low seed replacement rate (SRR) remains one of the hindrances in introducing the high-yielding varieties in this region. In fact, Orissa remains the state with the lowest SRR in the entire region and need to be tacked on an emergent basis.

Hybrid rice remains the focus of National Food Security Mission and CRRI has been in the forefront to develop hybrid rice varieties for growing in shallow lowlands. Hybrid rice varieties like Ajaya and Rajlakshmi had been instantly popular with other hybrid cultivars that can quantitatively increase the rice yield.

Tackling the soil related constraints through judicious management options to solve the problem of soil acidity, nutrient Imbalance and low fertility. Thus resource analysis and improving sustainability remains the most important action in the field of natural resource management. Development of integrated nutrient management involving use of organic and inorganic sources ensures higher fertilizer use efficiency and maintenance of soil fertility. Incorporation of 'dhaincha' (*Sesbania aculeate*), *Azolla* or FYM in combination with urea fertilizer in a specific ratio would help increasing the fertility level.

Conclusion

Obviously, eastern India remains the elusive golden horizon in increasing the rice yield for the country and in that process add to the food security of the country. While all the regions are showing a lower compounded agricultural growth rate (CAGR) for rice productivity, eastern region still maintains the rate suggesting it has the potential to increase. It is essential that a concerted look is devoted in this direction to reach the goal