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A Revolution Unwanted?

Eastern India Demands a Re-imagining of the 'Green Revolution'

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FOCUS ON THE GLOBAL SOUTH

A Revolution Unwanted?
Eastern India Demands a Re-imagining of the 'Green Revolution'

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Introduction : Launching First Green Revolution

During the 1960s, India was the largest importer of food aid, mainly under the PL-480 programme of the United States of America (USA). In fact, during 1966, over 10 million tonnes of wheat was imported, leading to India being labelled as a nation surviving on a ship-to-mouth basis. India invited Dr. Norman Borlaug who had developed the 'Mexican Dwarf' variety, suitable during the Rabi season in India. The next year, the country also tried out a dwarf variety of rice called IR-8 and with that started India's tryst with the Green Revolution.

These short-stemmed crops solved a basic problem: old-fashioned crops were long and leggy, so when fed with fertilizer they grew too tall and fell over. Borlaug's varieties put out more, heavier seeds instead. Over the next five decades these varieties gained popularity in all parts of the world.[1]

When C. Subramanian became the Minister for Food and Agriculture, Union of India, in July 1964, he lent his support for spreading high-yielding varieties on a large scale, together with irrigation water and mineral fertilizer. In 1968, Indian farmers harvested a record production of wheat, about 17 million tonnes; the earlier highest harvest was about 12 million tonnes in 1964. Such a quantum jump in production and productivity led Indira Gandhi to announce the 'Wheat Revolution' in July 1968.[2]

India was the second country in the world to introduce the Green Revolution. Punjab, Uttar Pradesh and West Bengal were the three States wherein Green Revolution was initially introduced, focusing on; high yielding variety seeds (basically wheat and rice), pesticides and fertilizers. Double cropping was also introduced as a main feature of the green revolution, since India was traditionally a single crop farming country. Up until then, as the Indian agricultural system was mainly dependent on monsoon for irrigation, one crop per year was quite the norm. However, a two-crop system also required additional sources of water other than the monsoon rains, thus increasing the dependency and exploitation of ground water systems.

Use of excessive pesticides to further the yield also contaminated and polluted the ground water. A shift in focus towards high yielding varieties of rice and wheat came at the cost of diversity, eventually turning the peasants away from cultivating millets and other crops rich in proteins and fibers.[3]

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[1] *https://www.economist.com/news/leaders/21601850-technological-breakthroughs-rice-will-boost-harvests-and-cut-poverty-they-deserve-support*

[2] *Swaminathan, M.S., (2012). "Food as People's Right", 3 January 2012, Hindu, New Delhi.*

[3] *http://lctpi.wbcsd.org/wp-content/uploads/2015/12/LCTPi-CSA-Action-Plan-Report.pdf*

The Social Economic and Caste Census of 2011 estimates that, 833 million people continue to live in rural India. A very large proportion of them are either wholly or significantly dependent on farm activity for their livelihood which includes crop agriculture, horticulture, animal husbandry and fisheries.

Yet, inadequate rural infrastructure, lack of effective and inclusive governance, social injustice which has over the years resulted in alarming levels of inequality, climate uncertainties and absence of any meaningful social security measures have all forced the people living in rural India to look at their future with great trepidation and despair. This is happening even as India continues to be one of the world's largest producer of milk, pulses and spices. Makes one wonder, who has the first green revolution actually benefited?[4]

> *The NSSO data also shows that between 1993-94 and 2004-05, the per capita human consumption of cereals increased among the poorest 5.0 per cent of the population, while it fell among the remaining 95.0 per cent. The decline was also sharper in rural areas than in urban ones. However, the demand for cereals used in animal feed is accelerating.*[5]
>
> *The fact is that India has been a net exporter of cereals for most years since 1990. In 2010-11, despite bans on the export of wheat and non-basmati rice, It has exported over 5 million tonnes of cereals comprising 2 million tonnes of basmati rice and 3 million tonnes of corn, while simultaneously adding substantially to stocks of wheat and rice. Also, the balance of evidence suggests that there is enough untapped potential for productivity improvements on Indian farms to enable us to meet cereal demand from domestic production without having to become dependent on food grain imports on a net basis.*[6]

The key to ensuring long-run food security lies in targeting cereals productivity to increase significantly faster than the growth in population[7], so that adequate land becomes available for other agricultural use.[8]

However, the Government of India, as a matter of national priority (from the point of view of food security and sustainability) is swiftly extending 'Green Revolution' to areas of low productivity in the Eastern Region where there is ample ground water. Bringing Green

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[4] *http://ageconsearch.umn.edu/bitstream/204794/2/04-Ashok%20Dalwai.pdf*

[5] *http://ageconsearch.umn.edu/bitstream/204792/2/02-Inaugural%20Address.pdf*

[6] *http://krishi.maharashtra.gov.in/Site/Upload/Pdf/latur_cdap.pdf*

[7] *Shome, Parthasarathi and Sharma, Pooja. (ed.) (2015) "Emerging Economies: Food and Energy Security, and Technology and Innovation, Springer, Page 111*

[8] *https://ageconsearch.umn.edu/bitstream/152078/2/1-Presidentialaddress.pdf*

Revolution in the Eastern India (BGREI) has been introduced as a sub scheme of Rashtray Krishi Vikas Yojna (RKVY) from 2010-11. According to the Government of India, this should be supplemented by investment in infrastructure, particularly in power, logistics and marketing.

If we view the results of BGREI in terms of food grain production we can observe the growth, however, it is not devoid faults and demerits of the Green Revolution in Western India. The rapidly decreasing water level is a great concern for the future; excess use of fertilizers and pesticides has not only affected the consumer, but also contaminates the water, which is hazardous for a large number of population. The effect of BRGEI can be compared with the first Green revolution as well as its impact on social, cultural and economic sphere of the Society.

1. Experience of Punjab : Plateuing of Agriculture Growth

Punjab was Indian agriculture's star performer during the Green Revolution's hey-day. The annual average agricultural-GDP growth of the Punjab was 5.7% between 1972 to 1986, more than twice the all-India average of 2.3% during the same period. But thereafter, the growth rate of Punjab's agriculture fell to 3 per cent between 1987 to 2005 – and during the same period, Indian agriculture also registered a lower growth rate of 2.9 percent.[9] The agriculture sector in Punjab is showing signs of a serious slowdown over the past few years. The sector's growth rate has remained below two per cent in 2009-10, 2010-11, 2011-12 and 2012-13, with growth turning negative in 2009-10 and 2012-13.[10]

Punjab used to have the highest per capita income amongst the 21 large States of India till 2003 but after that it slipped to the seventh position.

Almost 80 per cent of the irrigation is from ground water source. Much of the large power subsidy goes into cultivation of rice, a water intensive crop (producing one kg of rice consuming 3,000 - 5,000 liters of irrigation water). It requires 25 rounds of irrigation in a season. Punjab water table has receded at the rate of 70 cm per year during 2008-2012. Around 110 of the 132 blocks have been declared over exploited. Power subsidy in the State's current budget has crossed Rs.13,000 crore as on 2018.[11] This is the biggest bane of Punjab's agriculture.

For the record, Punjab has in excess of 11.73 lakh tube wells. Farmers in Punjab continue to be heavily indebted. Seventy two per cent of the farm household are heavily indebted, resulting in farmers suicides. Punjab has turned into what is dubbed as 'Cancer Capital'.[12]

Its stellar success notwithstanding, the Green Revolution has been the subject of intense criticism.[13]

The Green Revolution was criticized by social activists on the ground that the high-yield technology involving the use of mineral fertilizers and chemical pesticides is environmentally harmful.[14]

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[9] *http://indianexpress.com/article/opinion/columns/from-plate-to-plough-punjab-agriculture-lessons-for-the-field-green-revolutions-heyday-gdp-growth-4753622/*

[10] *http://www.business-standard.com/article/economy-policy/punjab-economy-to-grow-at-5-3-in-2014-15-survey-115031901254_1.html*

[11] *https://www.hindustantimes.com/punjab/10-of-punjab-s-budget-goes-into-power-subsidy/story-2KZCkCr3ezXaTqRm8L9OIK.html*

[12] *Dheer, Gautam. (2013). "Punjab India's Grain Bowl, Now Reels under Agrarian Crises", 7 June 2013, Deccan Herald, New Delhi.*

[13] *Sambrani, Shreekant. (2014). "Tribute to a Saint who did Miracle with Wheat", 12 September 2014, Business Standard, New Delhi.*

[14] *http://www.thehindu.com/todays-paper/tp-opinion/food-as-peoples-right/article2769860.ece*

Also in August 2013, in an interview to Indian Express, Mr. Sharad Pawar the then Union Agriculture Minister mentioned about the soil fatigue in Punjab, Haryana and Western Uttar Pradesh (UP). He is reported to have said, "Till a few years back, we used to depend on Punjab, Haryana and Western UP. Yes, these are the important States, but the worry was that due to continuous rotation of rice and wheat, the groundwater and soil texture is being affected, resulting in fatigue in the soil. So, introduced the concept of bringing a green revolution to Eastern India - we concentrated on Bihar, Chhattisgarh, Eastern UP. You will be surprised Chhattisgarh is a major producer of rice today. Odisha is also a very important producer of rice.[15]

1.1 Impact of Green Revolution

The Green Revolution may have increased the food stock (wheat and rice) of India several times since its introduction till date. Yet it is far away from turning India self-sufficient in food production. Even today India sometimes suffers from shortfall of the essential food product other than wheat and rice. In 1998, 2006 and 2014 India had to import onions, pulses and sugar for domestic consumption.

Table 1: Production of Major Crops and Allied Activities: (1950-51 to 1996-97)

(Million Tonnes)

Crops	1950 - 51	1970 - 71	1980 - 81	1990 - 91	1996 - 97
Foodgrains	50.8	108.42	129.59	179.39	199.32
Rice	20.58	42.22	53.63	74.29	81.31
Wheat	6.46	23.83	36.31	55.14	69.27
Coarse Cereals	15.38	30.55	29.02	32.70	34.28
Pulses	8.41	11.82	10.63	14.26	14.46
Sugarcane	57.05	126.37	154.25	241.05	277.25
Cotton (million Bales)	3.04	4.76	7.01	9.84	14.25
Nine Oilseeds	5.16	9.63	9.37	18.61	24.96
Milk	17.00	21.00	31.60	53.90	68.60
Fish	0.80	1.80	2.40	3.80	5.35

Source : Agricultural Statistics at a Glance, 1997, Min. of Agriculture, Govt. of India

[15] *Samantha, Pranab Dhal. (2013). "All this is possible only if my Farmers can Produce..., We Must See He Gains", 26 August 2013, Indian Express, New Delhi.*

Table 1 shows the rapid growth in production of cereals like wheat and rice as well as sugar cane, apart from this, we can see there is very less significant growth in production of pulses and oil seeds, which are the main source of protein and fat for medium and lower strata of society. Although, the data reflects the significant growth in food grains, but doesn't provide any number about the growth or reduction in production of fruits and vegetable, which is another major source of vitamins and other useful nutrients.

Table 2: Agricultural Investment (at 1980-81 constant prices)

(Rs. In Crore)

Year	Total GCF in Agriculture	Public (GCF)	Private (GCF)	% Share	
				Public	Private
1960-61	1668	589	1079	35.3	64.7
1970-71	2758	789	1969	28.6	71.4
1980-81	4636	1796	2840	38.7	61.3
1990-91	4594	1154	3440	25.1	74.9
1991-92	4729	1002	3727	21.2	78.8
1992-93	5372	1061	4311	19.7	80.3
1993-94	5031	1153	3878	22.9	77.1
1994-95	6256	1316	4940	21.0	79.0
1995-96	6961	1268	5693	18.2	81.8
1996-97 (Q)	6999	1132	5867	16.2	83.8

Q: Quick Estimates; GCF: Gross Capital Formation;

Source : http://indiabudget.nic.in/es97-98/chap83.pdf

Table 2 informs us about the trend in agricultural investment from 1991 to 1997. Public investment has gradually decreased while private investments went up. It is therefore evident that the claims of heavy subsidy on agricultural product, such as fertilizers, pesticide and other agricultural instrument notwithstanding, government's share in agricultural investment has actually gone down forcing the farmers to invest more in order to achieve the target production of government. Post liberalization of Indian economy in 1991, this claim of a 'burden of subsidy' is therefore not consistent with the data available, where we see that in the period of 1991 to 1997, when green revolution was being pushed through with full force, the actual Government expenditure in agriculture fell from 21.2% to 16.2%.

Table 3 : Eighth Plan Targets and Production Performance of Crop (in Million Tonnes/ Millions Bales of 170 Kg each of Cotton)						
Crops	8th Plan Targets	1992-93	1993-94	1994-95	1995-96	1996-97
		ACHIEVEMENTS				
Rice	88.0	72.86	80.30	81.81	76.98	81.31
Wheat	66.0	57.21	59.84	65.77	62.10	69.27
Coarse Cereals	39.0	36.59	30.81	29.88	29.03	34.28
Pulses	17.0	12.82	13.31	14.04	12.31	14.46
Foodgrains	210.0	179.48	184.26	191.50	180.42	199.32
Nine Oilseeds	23.0	20.11	21.50	21.34	22.10	24.96
Sugarcane	275.0	228.03	229.66	275.54	281.10	277.25
Cotton	14.0	11.40	10.74	11.89	12.86	14.25
Source: Planning Commission of India / Ministry of Agriculture, Govt. of India						

If we compare Table 1 and Table 3, we see that the initial spike in production of Rice, Wheat and Coarse cereals tapered out towards the period 1991-1997 and falling well below the target in some years. In the case of rice production, the 8th Five-Year Plan target was 88 million tons, while we achieved much lesser, despite the thrust of 'Green Revolution'.

The same trend of shortfall can be seen in the case of wheat, pulses, oil seeds, sugar cane and cotton.

This near stagnation in food production after 1991 is significant and offers an important lesson, particularly at a time when there is renewed efforts to push through Green Revolution in Eastern India. The experience from last century tells us that Green Revolution is not the solution to neither bring about self-sufficiency nor sufficient nutritional guarantee. This is apart from the severe adversary ecological impacts that the first leg of this 'revolution' brought about.

1.2 Impact on Diversity of Crops:

Since the beginning of the history of farming in India, generation to generation, Indian farmers persistently improved and adapted the various genetic varieties of crops available to them from nature. The diversity of crops is neither purely natural nor accidental.[16] The diversity is the outcome of efforts and innovation of thousands of years. Crop selection, cross breeding and other techniques were involved over the period of time to secure the suitable crops according to

[16] *https://www.grain.org/article/entries/514-reviving-diversity-in-india-s-agriculture*

their environment. Adaptation to local environment was the main reason for diversification of crops. In fact, a single species of rice collected from the wild sometime in the distant past, have diversified into 50,000 varieties as a result of the ingenuity and innovative skills of farming communities (a fact that the modern seed industry always conveniently sidesteps, and that the non-discerning consumer is ignorant of).[17] Survival is the basic feature of these crops, thus some time in a same village single species has different varieties of crops, according to their nutrition, water, land and fertilizers. Many tribal villages in the hills of northeast India, with paddy cultivation similar to the Southeast Asian region, have been known to get over 20 rice varieties within a single year in their terraced fields.

The Green Revolution in North India, led to extinction or even replacement of several of these species by a handful of specific profitable species.[18] In other words, inter cropping was replaced by mono-cropping. Profit became the primary focus in crop selection instead of an extensive diversity of local species of crops. In this process, the great genetic diversity of crops were replaced by a narrow genetic range of crops. Local varieties of rice plant were replaced by new rice plant known as IR8, with a promise of 3-4 times more production per hectare. The majority of indigenous crop varieties, which had a special tendency to survive in adverse conditions due to low production, are no longer grown.

The constancy of a bio-diverse agriculture is possibly its most important characteristic, as recorded from many regions of the globe. This is marvellously exemplified by a formerly - common pattern of the Garhwal Himalaya, the *Baranage*.

> *Literally meaning '12 grains', this practice involves the sowing of a mixture of crops into a single plot of land. Rajma (beans, Phaseolus vulgaris), urad (black gram, Phaseolus mungo), mung (green gram, Phaseolus aureus), kulth (horsegram), marsha or ramdana (Amaranthus frumentaceous), mandua (finger millet, Eleusine coracana), jhangora (barnyard millet, Oplismenus frumentaceus), bhat (soyabean, Glycine soja), lobiya (Vigna catiang), and other crops are grown in a jumbled profusion which at first glance would appear a mess, but which is probably a carefully considered way of obtaining optimal and sustained yields. Since maturity periods of these crops vary, different crops are harvested at different times, helping to retain soil moisture, and providing a constant supply of food. Fertility is continuously recharged by the use of leguminous plants like pulses. In addition, bunds along the fields support trees like bhimal (Grewia spp.), used for making rope, soap, baskets, and for fodder. According to some assessments, Baranaja gives a higher overall productivity (apart from meeting diverse*

[17] *ibid*

[18] *https://www.researchgate.net/publication/239599293_Agro-biodiversity_The_future_of_India's_agriculture*

needs) than if the field was to be converted into a soyabean monoculture, which is being propagated by official agricultural agencies in the region.[19]

1.3 Impact of Mechanization:

In general terms, mechanization is equated with the modernization in most of the developing countries. In the field of farming, the perception is same in India. Without analysing the impact of mechanization of agriculture, we have blindly followed the practices of Western countries, wherein heavy mechanization is relied upon to modernize the farming technique. With the implementation of heavy machines and technological advancement, the production structure of Indian agriculture has been altered, from stable, traditional agriculture structure to a highly-risky modern agricultural structure.

The disparity in the income and holding of land has shown the different impact on various categories of farmers. Small and marginal farmers form over two-thirds of India's farm dependent population. Unfortunately for these farmers, the cost of machinery is not affordable and even the maintenance cost of this machinery is too much.

Tenant farmers in particular are unable to bear the high cot of heavy machinery, seeds and fertilisers.

Increase in mechanization, also leads to loss of livelihood. A tractor, for instance, can result in lesser employment opportunities for farm workers who are then forced to migrate out of their villages in search of daily wage work. While it may be argued that mechanization, if properly implemented, can create non-farm labour opportunities within a locality, such cases are far and few in between.

Adapting to new technologies and heavy machines have further increased the debt burden on the small farmers and tenant farmers, leading to increased vulnerabilities and suicides, especially in states like Punjab and Maharashtra.

Unplanned mechanization therefore disturbs the equilibrium of rural economy and can result in a chain of complex technical, economical, social, cultural and institutional effects that are neither easily predictable nor necessarily consistent with the aims of rural development.

1.4 Impact on Water:

The green revolution initially focused on the high yielding variety (HYV) of crops which required more water than the indigenous varieties of crops. To meet this requirement, new irrigation schemes were implemented. New irrigation policy was comparatively expensive as well as

[19] *http://pubs.iied.org/pdfs/6119IIED.pdf*

inappropriate irrigation schemes turned into the problem of salinization of water. To fulfil the required water for HYV seeds, construction of big dams came as an alternative, since many areas of India have usually low rainfall and less connectivity of rivers. However, the construction of big dams resulted in the flooding of very fertile land and ecological system, with a heavy displacement of local people without appropriate compensation.

Water logging is another problem associated with new irrigation schemes. In canal system of irrigation, water logging is a serious problem, which not only destroys the cultivated land but also generates the serious ecological problems. The Indira Gandhi canal, one of the largest canal projects starting from Punjab to Rajasthan, is a striking example, where water logging became a multidimensional problem. In several districts of Rajasthan, including Jaisalmer, Ganga Nagar and Bikaner, several thousand acres of fertile agricultural and pastures have become waterlogged. With the help of irrigation from Indira Gandhi Canal command area, many farmers are growing, wheat, rice and cotton instead of pastures. On the one hand, it increased the production of crops, but on the other hand, intensive irrigation of these crops generated soil depletion and water logging problems.[20]

Presently, water resources are scarce and expensive in India. Large farms benefit because they can afford canal irrigation, whereas small farmers are dependent on monsoon or they borrow money with high interest rates to irrigate their fields.[21]

1.5 Impact on Underground Water:

To increase the production of crops, the adaptation of High Yielding Variety crops was introduced, which require lots more water than traditional crops. The areas where canal system is not well-connected or low rainfall areas are basically dependent on ground water to irrigate the HYV crops to maintain the moisture. Under the package program, the area of wheat and rice has increased significantly. Rice has been introduced in the areas of Rajasthan, Punjab and Haryana where rainfall is below 50 cm during the rainy season. In these areas, the farmers transplant their paddy crop with the help of irrigation in the month of June when the mean maximum and minimum temperature read around 42° C and 30° C respectively. Rice is water relishing crop and generally needs 100 cm of rainfall.[22]

In places that are heavily dependent on irrigated water, ground water levels are rapidly falling. In half of Punjab, the water level from the surface level has gone down from 15 meters to 30 meters. Even the Punjab Irrigation Department's latest report on subsoil water says that the

[20] *http://www.yourarticlelibrary.com/green-revolution/ecological-problems-emerged-out-of-the-green-revolution-in-india/44554*

[22] *http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1027&context=envstudtheses*

[22] *http://www.yourarticlelibrary.com/green-revolution/ecological-problems-emerged-out-of-the-green-revolution-in-india/44554*

average fall in water table in central Punjab was 20 cm per annum from 1980 to 1900, 25 cm from 1990 to 2000, 75 cm from 2005 to 2008, 45 cm from 2008-2013 and 70 cm in 2014-15.[23] Unnatural demands on the ground water levels would eventually lead to absolute scarcity of this resource creating serious ecological impacts.

There are also instances where areas that are well connected by canals and are extensively used to irrigate the crops, see a rapid and unnatural increase in the ground water levels. This is also not good for the soil, since the rise of underground water results in capillary action and heavy evaporation of water through capillaries makes the soil saline and alkaline, which affects the quality of soil and vegetation.

1.6 Impact on Health:

The implementation of the Green revolution, led to the use of High Yielding varieties of wheat and rice and, as we discussed before, these HYV crops need large amounts of water for irrigation, as well as an adequate amount of chemical fertilizers and other crop protection chemicals. Adequate water and fertilizer, which is necessary for the fast growth of HYVs are highly suitable for the growth of insects and pests also. This leads to an increased demand for chemical pesticides, fungicides and insecticides- all posing serious health risks to the one who farm as well as the one who consumes.

Plant protection chemicals are artificially produced compounds to increase the production of the beneficial crop by eliminating the harmful weeds. These chemicals are poisonous and harmful to humans and animals. However, to increase the production (and thereby profit) these chemicals are used by the farmers, not only on the crops but also on the vegetable and fruits like, guava, apples, oranges and litchis.

The Indian Council of Medical Research (ICMR) conducted a survey and revealed the existence of excessive residues of DDT and other pesticides in bovine milk. Traces of lead, copper, zinc, cadmium and arsenic were also detected in rice, wheat, maize, mustard, cotton, sesame, fruits and vegetables.[24]

Uses of toxic chemicals, such as gano-chlorine, gamyxicne and DDT had major effects on human beings and wildlife. Fungicides and herbicides have changed the balance of fungi and weed population in order to increase the production invited several other problems of imbalance ecology.[25]

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[23] *http://www.tribuneindia.com/news/nation/north-india-running-out-of-water-confirms-nasa/120110.html*

[24] *http://www.yourarticlelibrary.com/green-revolution/ecological-problems-emerged-out-of-the-green-revolution-in-india/44554/*

[25] *http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1027&context=envstudtheses*

2. Bringing 'Green Revolution in Eastern India'

It is by now clear that the first leg of Green Revolution, even if had increased the yield of foodgrains significantly in the initial decades before tapering off, has not delivered on its promise of food self-sufficiency, notwithstanding the damage inflicted on soil and environment. In regional terms, only the states of Haryana and Punjab have shown the significant results in foodgrain output after the implementation of Green revolution. The eastern region of India, spread over the Gangetic plain, Eastern UP, Bihar and West Bengal has not shown the impressive results.

Instead of benefiting, the Green Revolution has created several problems; mainly it affects the labour and works dynamics, which led to the mass migration towards the metropolitan and other big cities, and adverse impacts on the environment in Eastern India. The increasing use of agrochemical-based pest and weed control in some crops has affected the surrounding environment as well as human health. An increase in the area under irrigation has led to rising salinity of the land. Despite the purported advantages, high yielding varieties have led to significant genetic erosion.

The Eastern region, which was one of the most developed and prosperous regions of the country prior to independence, is presently prone to a number of biophysical, institutional and socio-economic constraints. This has resulted in a peculiar subsistence agriculture with low input, low yield, low risk technology. Average farm size, irrigation coverage, average fertilizer consumption and power consumption in agriculture are all below the national average and in comparison to Punjab, Haryana and Western UP it is very low. Average fertilizer consumption in Odisha and Bihar is the lowest of any Indian state, since, most of the farmers rely heavily on traditional farming and use the traditional practices to cultivate the crop as well as to fulfil their basic needs without depending on the market.

Ironically, it must be noted that the climatic and soil conditions of these state are congenial for production of different types of vegetables. Despite lacking in basic infrastructure for storage, packaging, transportation, organized marketing system and post harvest handling facilities, Bihar ranks 3rd in vegetable production in the country (16325.7MT), and produces a variety of traditional and non-traditional vegetables without using synthetic fertilizers, pesticides, herbicides, and heavy machinery. Even the top two producers of vegetables in India, West Bengal (25466.8MT) and Uttar Pradesh (19571.6 MT) depend on traditional farming and horticulture.

Except Western Uttar Pradesh, most of the region of Eastern Uttar Pradesh horticulture depends on traditional methods of cultivation or very limited use of synthetic fertilizers but almost no use of heavy machinery and technology.

Now if we compare these states with Punjab and Haryana, which were the backyard of the green revolution experiment, both these states don't even feature in the top 10 Vegetable producing states in India. It is commendable that the farmers of Bihar and UP are able to deliver consistently despite the lack of any meaningful State support and by solely relying on traditional methods, where the input cost is very low, and they grow vegetables according to season and climatic conditions by using seeds from the previous harvest.

This method of agriculture also provides a social stability as well as fulfils the nutrient value of the food. Exchange of food items such as cereals to the vegetable and fruits build a social fabric which is most required in any traditional society. At the same time low input cost makes the farmers less vulnerable towards the crop failure. Unlike the farmers of Punjab and Maharashtra where the input cost is very high, forcing farmers to take a loan on high interest rate from local lenders, in Eastern India, most of the framers invest their savings and procured seeds. We can see the significant difference in the number of suicides in Eastern India in comparison to Punjab and Maharashtra.

In the production of spices these states are ahead of Punjab, Haryana and Maharashtra. Uttar Pradesh is the one of the largest producer of the mustard oil, Bihar is the second largest producer of mustard oil, and Andhra Pradesh is in the third position. We know, mustard oil is one of the most favourite cooking oil and basic source of fat in North India and Western India, since most of the population of the region cannot afford butter and ghee in required quantities. Even in turmeric production West Bengal, Uttar Pradesh and Bihar is in top 15 list. West Bengal is the fifth largest producer of turmeric and Bihar and Uttar Pradesh is placed at 9th and 10th place respectively. The medicinal value of turmeric and their use as spices is well known and documented. Turmeric is one of the best natural antibiotic and used in other medicines, since it has a great medicinal component.

In garlic production Uttar Pradesh is placed 5th largest and Bihar takes the 10th position. Garlic too has great medicinal values and form an integral part of the daily food ingredients. In chilly production, if we leave South India and Gujarat, Uttar Pradesh, West Bengal and Bihar feature among the top producers

A variety of spices are produced in Bihar. According to government reports, at present Bihar produces about 20 thousand tonnes of spices annually from an area of nearly 15,081 ha. The important spices are Ginger, Turmeric, Chilly, Coriander, and Garlic. Chilly accounts for 47.6% of the area under spices and 39.5% of the production followed by turmeric, which occupies 26.3 per cent of the area under spices and accounts for 36.4% of the production in the state.

The moot point therefore is the rationale in introducing Green Revolution, which has no evidence to offer in its ability to increase vegetable, cereal or spice production, in states that have traditionally been doing well thanks to its dependence on sustainable farming methods!

The programme, Bringing Green Revolution in Eastern India (BGREI) was first initiated in 2010-11. The programme was based on the report of a task force formed in 2009 to analyze and assess the present scenario of food production, water resource, its management and utilization in North West and Eastern India. The Task Force focused on the problems of over exploitation of water resources in the states where the policy of Green Revolution has been implemented, and its outcome has been significantly measured, like Haryana, Punjab and Western Uttar Pradesh.

BGREI started with the recommendations of this task force in 2010-11 in seven eastern Indian states, namely, Assam, Bihar, Chhattisgarh, Jharkhand, Eastern Uttar Pradesh, Odisha and West Bengal. The main recommendations of this task force were to harness the water potential in the region to increase the production of rice, which was still underutilised and to promote the latest crop production technologies by which the production and productivity of rice and wheat can be increased.

The main objective of BGREI:[26]

1) To increase production and productivity of rice and wheat by adopting latest crop production technologies;
2) To promote the cultivation in the rice fallow area to increase cropping intensity and the income of the farmers;
3) To create water harvesting structure and efficient utilization of water potential; and
4) To promote post harvest technology and marketing support.

To implement these objectives on the ground, the Central Government allocates the funds for various interventions such as[27]

1) Block /Cluster Demonstration 40%;
2) Seed Distribution (HYVs/Hybrids) 10%;
3) Seed Production (HYVs/Hybrids) 05 %;
4) Need Based inputs 10%;
    a) Micro–nutrients and Soil ameliorants 05%;
    b) Plant protection chemicals 04%;
    c) Cropping system based training 01%;
5) Asset Building (farm machine and implements, irrigation devices) 200%;
6) Site Specific Activities 10%;
7) Marketing support including Post Harvest management 05%.

[26] *http://krishikosh.egranth.ac.in/bitstream/1/5810029612/1/Rajeeb%20M.Sc.%20Thesis.pdf*

[27] *http://nfsm.gov.in/State_Action_Plans/2016-17/preparation%20of%20Action%20Plan%20-%20BGREI%20-%2028.04.2016.pdf*

3. Prevailing Agriculture Scenario in Eastern India

3.1 Major Crops

Eastern States are the most important rice-growing about 63.3% of India's rice area in India. Although 35% of the people live in this region, their demand is about 49% of the rice grown in the country. The annual per capita rice consumption in this region is 133 kg versus 37 kg in the western region, 39 kg in the northern region and 113 kg in the southern region. In 2011-12, the average rice yield in the six of seven Easter States is 1.7 tonnes per hectare.

Out of 26.8 million hectare of rice area under rainfed ecosystems, Eastern India occupies 21.1 million hectare amounting to 78.7% of its total rice area. A modest increase by half a tonne per hectare in rice yield in the rainfed ecosystem can add about 10 million tonnes extra rice from Eastern India the major crops in the region.[28]

Following are the major crops of this region:

● Rice ● Maize ● Pulses ● Mustard and Other Edible Oil ● Potato ● Jute ● Sugarcane

Currently rice along with maize is the main focus to be promoted under Second Green Revolution.

3.2 Water Utilization

In spite of good rainfall, abundant surface, and ground water resources and plentiful of labour, land use, crop diversification, crop yield, incomes from farmland are dwindling. Rainwater is not efficiently utilized due to inadequate provision of irrigation structures such as canals, gully-plugs, check dams and irrigation projects.[29] As a result, water resources in monsoon season are unevenly spread or controlled leading to floods and there is little water in dry seasons, leading to drought.

In spite of several development programmes in the Eastern region such as Command Area Development Programme, Drought Prone Area Development Programme, and Comprehensive Area Development Programme, most of these government programmes fail to offer satisfactory results due to leakages, improper planning, inadequate monitoring, ineffective implementation and control.

While ground water exploitation in some States in the North and West have reached saturation level, utilization levels are only 8% in Odisha, 24% in West Bengal, 25% in Bihar and 32% in Eastern Uttar Pradesh.

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[28] *IRRI. (2002). "Constraints in Rainfed Rice Farming in Eastern India", Report on Rainfed Rice, International Rice Research Institute (IRRI), Philippines, 2002.*

[29] *Ghosh, Madhusudan. Sarkar, Debashis. Roy, Bidhan Chandra (ed.) (2015). "Diversification of Agriculture in Eastern India". Springer, 2015*

Water is a key ingredient in deciding cropping pattern and use of modern inputs. As shown by Table 4 the average rainfall received in the Eastern region at 837.53 mm in 6.66% more than that of all India level. But the average deviation from normal rainfall in the Eastern region is (-)16.36% as against (-)1.56 at all India level.[30]

Table 4: Details of annual rainfall, irrigation potential, fertilizer use and credit available during 2005-2006

Sl. No.	Particulars	Eastern India	All India	Eastern region as a % of all India
1	Annual Rainfall (mm)			
(a)	Actual	837.53	879.0	106.66
(b)	Normal	1120.86	893.0	125.52
(c)	Deviation from normal (%)	(-)16.36	(-)1.57	-
2	Irrigation potential (million ha)			
(a)	Targeted	1.73	10.92	15.85
(b)	Exploited	0.83	5.16	16.18
(c)	To be exploited	51.71	52.71	-
3	**Fertilizer consumption (kg/ha)**	121.27	105.50	114.95
4	**Credit to farmers (Rs./ha)**	3946.87	9131.00	43.22

Source : Centre for Monitoring Indian Economy (CMIE), Various Issues, Directorate of Economics & Statistics, Various State Governments

3.3 Credit Availability

However, it is disturbing that in spite of a large number of financial institutions in the region and an array of financial reforms, credit availability per hectare in the Eastern region is only Rs. 3946.87 as against the all India average of Rs. 9131.[31] At the disaggregate level, the situation is quite alarming as the average credit available in Bihar, Chhattisgarh, and Jharkhand have not even reached to Rs. 3,000 per ha during 2005-2006. Table 4 presents the rainfall, irrigation potential, fertilizer use, and credit availability in Eastern region vis-a-vis all India during 2005-2006.

[30] *Karmakar, K.G. and Sahoo, B.B. (2015). "Green Revolution in Eastern India", in the edited book by M. Ghosh, D. Sarkar and B.C. Roy, "Diversification of Agriculture in Eastern India", Springer, 2015.*

[31] *http://www.springer.com/cda/content/document/cda_downloaddocument/9788132219965-c1.pdf?SGWID=0-0-45-1474905-p176821639*

3.4 Land Use Pattern

Out of the total 166.07 million ha of the cultivable land in the country, 24.18 million ha (14.56%) have remained fallow. When 82.62 million ha (42.86% of Gross Cropped Area-GCA) is under irrigation, second crop is cultivated in 50.91 million ha (35.88% of net sown area).[32]

However, in the Eastern region, fallow land constitutes 14.21% of the total cultivable area, and irrigation facility is available to 47.76% of the GCA. When the cultivable land in the Eastern region constitutes 22.32% of the total cultivable land in the country, those of net sown area, rabi-cropped area, gross irrigated area, and cropping intensity in the Eastern region are higher.

However, among the Eastern States, the maximum fallow land is found in Jharkhand (53.4%) followed by Odisha (13.0%). Similarly, the cropping intensity in the Eastern region ranges between 102.74% (Eastern Uttar Pradesh) and 180.04% (West Bengal).

Table 5 presents the land use pattern in Eastern India vis-a-vis all India

Table 5: Patterns of land use in the Eastern region and all India during 2005-2006

Sl. No.	Particulars	Eastern India	All India	Eastern region as a % of all India
1	Cultivable land	37.07	166.07	22.32
2	Net sown area	31.80	141.89	22.41
3	Fallow land	5.27	24.18	21.79
4	Fallow land to cultivable land (%)	14.21	14.56	-
5	Rabi cropped area	12.07	50.90	23.71
6	Net irrigated area	14.15	60.20	23.50
7	Gross irrigated area	20.13	82.62	24.36
8	Cropping intensity (%)	137.95	135.87	-
9	Irrigated area to gross sown area (%)	47.46	42.86	-

Source: Centre for Monitoring India Economy (CMIE), Various Issues, Directorate of Economics & Statistics, Various State Governments

[32] *Ghosh, Madhusudan. Sarkar, Debashis. Roy, Bidhan Chandra (ed.) (2015). "Diversification of Agriculture in Eastern India". Springer, 2015*

3.5 Crop Yields

Table 6 presents the crop yields in the Eastern region vis-a-vis all India during the year 2005-2006. In almost all crops, Eastern region falls behind all India average in crop yield. Only in the case of potato production, the Eastern region gets an edge over the all India average.[33] It is disturbing to note that in spite of the dominance of the Eastern region over the all India scenario in terms of cropping intensity, irrigation, rainfall, and fertilizer use; crop yields of rice, wheat, oilseeds, sugarcane, ginger, turmeric and garlic are lower than all India average.

Table 6: Yields of selected crops in the Eastern region and All India during 2005-2006 (q/ha)

Sl. No.	Particulars	Eastern India	All India
1. Food Grain crops			
(i)	Cereals	17.75	19.92
(ii)	Rice	18.74	21.03
(iii)	Wheat	17.25	26.19
2. Non-food Grain crops			
(i)	Oilseeds	7.44	10.04
(ii)	Sugarcane	540.81	669.28
(iii)	Potato	197.68	185.92
(iv)	Ginger	18.39	35.37
(v)	Turmeric	21.92	49.52
(vi)	Garlic	28.98	44.34

Source : Centre for Monitoring India Economy (CMIE), Various Issues, Directorate of Economics & Statistics, Various State Governments

There exists a large yield gap in major crops produced in the country. It is evident from the 2003-2005 data of the Planning Commission that the yield gaps in wheat ranged between 6% (Punjab); rice over 100% in Assam, Bihar, Chhattisgarh, and Uttar Pradesh; maize between 7% (Gujarat) and 300% (Assam); jowar between 13% (Madhya Pradesh) and 200% (Karnataka); mustard between 5% (Haryana) and 150% (Chhattisgarh); soybean between 7% (Rajasthan) and 185% (Karnataka), and sugarcane between 16% (Andhra Pradesh) and 167% (Madhya Pradesh).[34]

[33] *http://www.springer.com/cda/content/document/cda_downloaddocument/9788132219965-c1.pdf?SGWID=0-0-45-1474905-p176821639*

[34] *Karmakar, K.G. and Sahoo, B.B. (2015). "Green Revolution in Eastern India", in the edited book by M. Ghosh, D. Sarkar and B.C. Roy, "Diversification of Agriculture in Eastern India", Springer, 2015.*

4. Popularization of Hybrids Seeds in Eastern States

4.1 Hybrid Rice Popularization

Seed is the first link in the food chain and embodies millennia of evolution and thousands of years of farmers breeding as well as freely saving and sharing of indigenous seeds.[35]

The varietal diversity of cultivated rice in India can be considered to be the richest in the world with the total number of varieties estimated to be around 200,000.[36]

State-wise area coverage, production and yield of rice are given in Table 7. In 2011-12 while Uttar Pradesh achieved highest productivity of 2358 kg per hectare, Punjab recorded the highest productivity with 3741 kg per hectare.

Table 7: Area, Production and Yield of Rice for the year 2010-11 and 2011-12

(Area: Lakh Hectares; Production: Lakh Tonnes; Yield - Kg/Hectare)

	2010--11			2011-12			2012-13			2013-14		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Andhra Pradesh	47.51	144.18	3035	40.96	128.95	3146	36.3	115.1	3173	43.6	127.2	2920
Assam	25.704	47.366	1843	25.37	45.163	1780	24.9	51.3	2061	24.5	49.3	2012
Bihar	28.325	31.02	1095	33.24	71.626	2155	33.0	75.3	2282	31.3	55.1	1759
Chhattisgarh	37.025	61.59	1663	37.738	60.284	1597	37.8	66.1	1746	38.0	67.2	1767
Gujarat	8.08	14.966	1852	8.36	17.9	2141	7.0	15.4	2198	7.9	16.4	2076
Haryana	12.45	34.72	2789	12.35	37.59	3044	12.2	39.8	3272	12.3	40.0	3256
Jharkhand	7.203	11.1	1541	14.69	31.306	2131	14.1	31.6	2238	12.6	28.1	2239
Karnataka	15.4	41.88	2719	14.16	39.55	2793	12.8	33.6	2632	13.4	35.7	2664
Kerala	2.132	5.228	2452	2.082	5.69	2733	2.0	5.1	2577	2.0	5.1	2558
Madhya Pradesh	16.029	17.721	1106	16.62	22.273	1340	18.8	27.7	1474	19.3	28.4	1474
Maharashtra	15.18	26.96	1776	15.41	28.41	1841	15.6	30.6	1963	16.1	31.2	1938
Odisha	42.257	68.277	1616	40.045	58.07	1450	40.2	73.0	1814	41.8	76.1	1821
Punjab	28.31	108.37	3828	28.18	105.42	3741	28.5	113.7	3998	28.5	112.7	3953
Tamil Nadu	19.057	57.924	3040	19.038	74.587	3918	14.9	40.5	2712	17.3	53.5	3101
Uttar Pradesh	56.57	119.92	2120	59.47	140.22	2358	58.6	144.2	2460	59.8	146.4	2447
West Bengal	49.442	130.459	2639	54.337	146.058	2688	54.4	150.2	2760	55.1	153.7	2788
Others	11.13	24.88	-	11.13	24.90	-	16.4	39.2	-	18.0	40.6	-
All India	428.625	959.797	2239	440.068	1053.122	2393	427.5	1052.4	2462	441.4	1066.5	2416

Source: Agricultural Statistics at a Glance 2012, 2013, 2014 and 2015

[35] *https://www.navdanyainternational.it/en/publications-navdanya-international/the-law-of-the-seed*

[36] *Sahai, Suman. (2014). "Custodian Farmers are the Real Seed Saviours", The Hindu Survey of Indian Agriculture, 2014.*

Table 7 shows that except West Bengal, the productivity of rice in all other major Eastern States i.e. Bihar, Assam, Jharkhand and Odisha is lower than the national average.

Rice is grown in about 4.20 million hectare in Odisha. During kharif season the area covered under Rice is about 39.33 lakh hectare whereas the coverage in Rabi is 2.93 lakh hectare. The productivity of rice in 2013-14 was 1.821 tonne/hectare, far below the national average of 2.416 tonnes/hectare.

From the funds of Rashtray Krishi Vikas Yojana (RKVY), the thrust is to step up rice yields along with the pulses, and corn in the States of Odisha, Bihar, Jharkhand, Chhattisgarh, West Bengal and Eastern Uttar Pradesh.

Allocation of funds has increased from Rs.1475 crore in 2007-08 to more than Rs.9000 crore in 2012-2013. During the same period allocation of Odisha and Bihar also increased from Rs. 47 crore and Rs. 64 crore to Rs. 503 crore and Rs. 724 crore respectively.

In order to popularize hybrid rice cultivation, private seed companies and multinational seed companies were invited to participate through advertisement in newspapers. The Directorate of Agriculture acted as the nodal agency and the ATMAs (Agriculture Technology Management Agencies) of the concerned districts operated as the implementing agency in association with some pro-corporate NGOs (Non Governmental Organisations) and seed companies. NGOs prepared the list of the farmers who were selected for the distribution of seeds. Appendix 1 lists the major Rice hybrid Seed Companies and their seed varieties.[37]

Finally following three companies DevGen Seeds Pvt. Ltd., J.K. Agri Genetics Ltd., {UPL - Advanta Ltd. (Table 8)} and their brands, which were approved for the distribution among farmers.

Table 8 : Selected Seed Companies and their Brands (Final List)

Sl. No.	Company	Name of the Hybrid
1.	DevGen Seeds Pvt. Ltd.	PRH-122 (Ganga)
2.	J.K. Agri Genetics Ltd.	JKRH-401 & DRRH-3
3.	UPL-Advanta Ltd.	PAC-853

Source : Directorate of Agriculture and Food Production, Odisha, Bhubaneswar

The scheme to popularize hybrid rice shares Rs.8232 per hectare. Hybrid seed cost of about Rs.2000 per hectare is not included in the scheme share. Also the cost of irrigation is not there.

[37] *Living Farm, "www.livingfarm.org"*

Rice in India is the staple food for nearly 65% of the total population of the country and India is the second largest producer and consumer of rice in the world. Rice production in the country crossed the mark of 100 million tons in 2011-12. The productivity of rice has increased from 1984 kg per hectare in 2004-05 to 2416 kg per hectare in 2013-14.

4.2 Why Hybrid Rice is not practical in Eastern States

In India the area under hybrid rice is only 3.5% whereas in China it is 60%.[38] This is principally because the current generation of hybrid rice varieties does not provide sufficient yield increase over elite non-hybrid varieties and lack grain quality, a desirable taste, milling quality and other agronomic properties such as drought tolerance.

There are several other constraints causing poor adoption of Hybrid rice in India, particularly in Eastern States.

- Hybrid rice may give some extra yield, but it should not be the only criterion since it derails the sustainability of rice production system.
- Farmers do not see main benefit in using hybrids as there are issues relating to quality and availability of seeds.
- The ultimate realization per unit area in hybrid rice is very low.
- The large scale transition to hybrid rice in the country particularly in Odisha and Bihar is not practical since the input costs are too high.
- The input cost, especially for seeds is too high in Hybrid rice production, hence quite unaffordable for small farmers.
- Besides Hybrid rice requires better irrigation which is not possible everywhere in the region.
- The focus of the BGREI is to promote seed production through participatory/ PPP (Public Private Partnership) model as well as producing and distributing truthfully labelled seeds but the PPP model of scheme will not be farmers friendly and it will not promote seed sovereignty because it will force farmers to buy hybrid seeds every year from the market which will make them dependent for seeds.
- Promotion of hybrid rice from PPP Model only helps the private seed companies to build the monopoly on the seed market. Once the seed companies develop monopoly they can even arm-twist the government.

[38] *Devgen. (2011). "Devgen's Strategy: Build the Next Generation of Hybrid Rice", Devgen Annual Report, 2011, Belgium.*

- PPP model favours the seed companies. If there is poor yield or crop failure or any other deficiency, there is nothing in the scheme to protect the farmers.
- While sacrificing the interest of small farmers, government officials of the concerned departments are providing free extension services to the private seed companies to promote hybrid rice seeds.

4.3 Popularization of Hybrid Maize in Odisha

Maize is grown on around 2.50 lakh hectares in Odisha. Kharif maize alone accounts for about 90% of the total acreage. It is cultivated mostly in Ganjam, Gajapati, Keonjhar, Koraput, Nabarangpur, Mayaurbhanj and Kalahandi districts.

According to the Directorate of Agriculture of Odisha, there are three major advantages of growing maize. First, as staple crop that requires less water, second, it can be used as food and feed. Third, it is a crop; that has less input costs and gives more profits. One of the objectives of special maize scheme through PPP model under RKVY is to wean farmers away from rice cultivation and hook them to maize. Maize in India is slowly expanding its presence due to incessant promotion by private companies and animal feed market, to the extent that it is now contributing close to 7% of the national "foodgrain" basket.

In order to improve the maize cultivation practices, the Government of Odisha took some measures and one of them was to tie up with the seed companies to ensure uninterrupted supply of hybrid maize to the farmers. In 2010, under the BGREI programme, the government entered into PPP (Public Private Partnership) with leading seed companies of the country and allotted 21 districts to them to avoid conflict of interests. During the Kharif season of 2010, Odisha undertook 'Project Golden Days' in 30,000 hectares in the state and partnered with Monsanto India Ltd. (MIL) for the tribal districts of Bolangir, Kalahandi, Nayagarh, Nuapada and Khurdah covering 8,000 hectares. Another 9,000 hectare of area covered by the Pioneer Seeds in the districts of Gajapati, Rayagada, Ganjam, Mayurbhanj, Sambalpur, Bargarh. By means of the project, farmers had access to the high yielding hybrid maize seeds and training on improved agronomic practices.[39] Under the Union Government RKVY scheme, Odisha Government started the programme for production of Hybrid seeds in Odisha and seeds companies were given the chance to produce hybrid seeds in the State and the State Government provided subsidies to farmers who took part in the scheme.[40] Under the PPP model, the government bought seeds from the following companies listed in Table 9 and supplied them free of cost to the farmers but later farmers had to pay for the seeds.

[39] *http://www.apraca.org/upload/book/79/India=2013-3a.pdf*

[40] *https://nsai.co.in/news/64-odisha-approves-plan-for-hybrid-rice-maize-seed-production*

Table 9: Selected Companies & Maize Hybrids[41]		
Sr. No.	Company	Name of Hybrid
1.	Ganga Kaveri Seeds (P) Ltd.	GK 3059
2.	J.K. Agri Genetics Ltd.	Jk-502, JK-2492, JK 175, JK 1701
3.	Kaveri Seeds Company Ltd.	Kaveri - 3696, Ekka - 2288, KS-244+
4.	Mahyco	MRM-3838
5.	Monsanto India Ltd.	Double, Prable, 900 M-Gold
6.	Nirmal Seeds Pvt. Ltd.	N 51
7.	Nuziveedu Seeds Pvt. Ltd.	Ajaya, Sunny, HM-9
8.	PHI Seeds (P) Ltd.	30 R-77
9.	Sansar Agropol Pvt. Ltd.	HQPM-1
10.	UPL-Advanta Ltd.	PAC-740
11.	Sriram Bio-Seeds Genetics	TX-369
12.	Sriram Fertiliser & Chemicals	Bio-9637
13.	Raasi Seeds Pvt. Ltd.	Tiptop

Hundreds of crore of public money went into these PPPs. For the seed and agri-chemical companies hybrid maize is a major market driver. When the shift to hybrid seed happens, the demand for pesticides and fertilisers goes up which ensures two markets for the agribusiness companies, that of herbicides and also of the hybrid seeds. Only 25 percent of the maize crop is consumed as food; the rest goes into poultry feed, animal feed, industrial use, etc.

A fact finding team by Alliance for Holistic and Sustainable Agriculture (ASHA) in Odisha revealed that at least three factors come in the way of hybrid maize actually enhancing food security of the farmers and tribals. (i) They don't like consuming hybrid maize and are gradually moving away from maize consumption once hybrids enter the picture — they report that the taste is not good and that they can't digest it easily (even their animals don't like hybrid maize fodder, they report); (ii) Hybrid maize is grown as a mono-crop that eliminates many other nutritious crops that used to go with their own maize varieties and (iii) In some places, since hybrid maize duration is longer, a second crop is no longer possible, which usually was a vegetable crop. It is apparent that hybrid maize is not about food security in any direct way. They also found negative net returns for farmers who undertook hybrid maize cultivation.[42]

[41] *Department of Agriculture, Government of Odisha*

[42] *http://agrariancrisis.in/tag/maize/*

4.4 Why Hybrid Maize is not Suitable for Odisha and Eastern States

a) No projected yield

Yield increase or the productivity of maize is nowhere near to the projected yield. The State Government and the companies reported that the yield would be around 12 quintals per acre whereas the actual yield is 3 to 5 quintals per acre, thus the return is not as expected.

b) Negative returns without subsidy or free input

Simple calculation shows that the farmers will get negative return if subsidy or free inputs are not provided under RKVY.

c) No additional income to the farmers

According to experts, "Conventional maize may give yield equal to hybrid if same amount of inputs are provided to conventional maize and hence there is no additional income to the farmers in growing hybrid seeds.

d) No concern for seed sovereignty

First aim of the scheme should be Seed Sovereignty, i.e. non-dependence of farmers over market for seeds. However the programme has shown no concern for seed sovereignty while promoting the hybrid seeds of private companies. Farmers cannot save the hybrid seeds for the next season, as they have been doing for generations in the case of conventional/desi/ open pollinated varieties.

e) Hybrid maize, no contribution to food security

Unfortunately hybrid maize in the country is promoted as a solution to food security which is not true. It is an industrial crop which is largely supplied to poultry, animal feed, starch industry and also exported to Far-East Nations, Indonesia, Malaysia, Korea, Bangladesh, Iran and other countries and thus hybrid maize makes no contribution to food security.

f) Hybrid maize is not 'tasty, sweet or soft' like conventional maize'

People in the Eastern States and elsewhere in the country do not prefer hybrid maize because taste of conventional maize is much better than hybrid maize. Almost entire hybrid maize is sold in the market and it is mainly used for animal feed.

g) Building market monopoly

Experience of Bt Cotton has shown that the Private Companies destroy the conventional seeds and build total monopoly on the seed market, forcing the farmers to be dependent

on them, resulting in indebtedness and ultimately suicides. Same situation shall arise, if Hybrid Maize is promoted.

h) **Higher seed cost**

In Odisha the retail price of traditional maize seeds is Rs. 30 per kilo, while the public sector seed is around Rs. 60 per kilo. And under RKVY farmers buy the seed at Rs. 110 per kg. On another front, the retail prices of hybrid maize seed are a cause of concern for viability of cultivation. The ASHA fact-finding team collected information on MRPs of different hybrid maize brands of Monsanto and found that a product like Pinnacle costs Rs. 1043/- per packet of 3.5 kilos of seed. The price differential in that sense is around 5-fold, between the public sector seed and one brand of Monsanto.

I) **Promote intensive use of chemicals**

Hybrid maize also promotes intensive use of fertilizers and the pesticide. Very often the seed and pesticide companies are same.

j) **Less stress tolerant in hybrid maize**

Less 'Stress Tolerance' is found in hybrid seeds as compared to local variety/desi maize seeds. It has to be remembered that Odisha is very disaster-prone (droughts and cyclones being a regular feature), that most of Odisha's farmers are smallholders and that most of Odisha's agriculture is rainfed, including its maize cultivation. In the era of climate change, it is obvious that smallholders need resilient systems for better adaptation. In such a situation, it is important to have stress tolerant traditional maize than the non-stress tolerant hybrid maize which can create major food security concern during a natural disaster.

k) **Hybrids promote monoculture**

In several States such as Uttar Pradesh, Conventional Maize is grown as mixed-crop with *Urad, Moong* and Vegetable whereas hybrid maize is cultivated as monocrop and this eliminates the nutritious crops i.e. pulses and vegetables. Besides, cultivation of hybrids, maize as monocrop is more risky than growing conventional maize as mixed crop.

l) **No safeguard for the farmers**

There is no safeguard to protect the interest of the farmers in case of crop failure, deformity or poor germination. The companies are under no obligation other than to replace seed in case of failure of germination. They are obviously in a position where their marketing departments are becoming redundant (which means further savings for the corporation on marketing costs) and the State government was doing the job of

marketing for these companies! It is unclear why this should be called a "partnership" rather than "public expenditure for private markets".

m) **Hybrid maize fetch less price**

As compared to '*Desi*' maize, Hybrid maize fetch less market price. There is no reason, why Open Pollinated Varieties (OPVs) cannot be promoted. It is not difficult to get yields of 3 tonnes per hectare even with OPVs. The spread GM maize has always been proceed to the aggressive promotion of hybrid maize itself so that farmers once trapped, can be easily moved to GM maize.

4.5 Failure of Monsanto's Hybrid Maize in Bihar

In Bihar, an Eastern State, maize is grown in all three seasons and the State has registered the growth more than wheat and rice. The share of Bihar is about 7% in the total maize production in the country. The State cultivates maize in around seven lakh hectares and grows it in all three seasons of Autumn, Rabi and Summer using both traditional and hybrid seeds. Almost 80%[43] of the maize seeds being used in Bihar is hybrid.

In Bihar, a maize crop is to the farmers of Kosi region what cotton was for the farmers of Vidarbha region in Maharashtra. However due to failure of maize (900 M Gold, 9081 and Pinnacle varieties of hybrid maize) in Kosi region in 2010, several farmers suffered heavy losses and many attempted suicide.[44]

In the region, which is often ravaged by floods, maize can be grown with just two cycles of irrigation. Though Bihar Government is not promoting maize through PPP model, however, besides Monsanto, which is in the State for almost 15 years, other companies like Syngenta, Pioneer, Kaveri, Seed-Tech and Pinnacle are also in the market. Seed rate vary from Rs. 750 to Rs. 1000 for 5 kg. Farmers complain why they have to buy fresh packets of costly seeds every year. Once they grow a new variety, they should be able to use it for next year, but that is not possible with the hybrid varieties.[45]

In the event of crop failure, farmers have to look at the Government for compensation. Bihar had bitter experience of private hybrids in maize in December 2009-10 on account of non-formation of grains. Around 50,000 of the 3.75 lakh hectares of land under maize cultivation in the State had been damaged.[46] When farm-saved corn seed was displaced by Monsanto's

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[43] *http://ficci.in/spdocument/20386/India-Maize-2014_v2.pdf*

[44] *Jha, Aditya. (2010). "Maize Failures Drives Kosi Farmers around the Blend", 12 March 2010, Hindustan Times, Patna Edition.*

[45] *Directorate of Statistics and Evaluation. (2013). "Hybrid Maize in Bihar", Government of Bihar.*

[46] *http://www.thehindu.com/news/national/other-states/Farmerrsquos-suicide-not-due-to-failure-of-maize-crop-Nitish/article16576993.ece*

hybrid corn, the entire crop failed creating Rs. 4 billion losses and hence increased poverty for desperately poor farmers. But the private companies including Monsanto had disowned their responsibility and the State had to step in to provide assistance taking an extra burden of Rs. 61 crore.[47] Moreover, there are no liability clauses in the MoUs signed with the seed companies to ensure farmers' rights and protection from seed failure.

The problem of non-setting of grains was not observed in public sector hybrids. Even though Bihar had not seen farmers' suicide but with the failure of hybrid maize seeds, several maize growers committed suicide. Interestingly, instead of being penalized and prosecuted for selling spurious seeds, the industry sought more benefits in the name of making improved seed available to farmers as well as demanded to introduce crop insurance for hybrid maize seed crops.

The failure of hybrid Maize in Bihar in 2010 was the second such tragedy with maize farmers because the first one had happened in 2002-3 when the maize crop failed in an area of around 20,000 acres in Vaishali, East Champaran, West Champaran, Khagaria and a few other districts, where Monsanto's Cargill maize seeds worth Rs 30 crore was planted.[48] The Bihar Government has ordered a probe into the failure of the Monsanto's 'Kargil 900 M' maize crop, which was cultivated over 1.4 lakh hectares in the state. After the probe, the Bihar government has suspended the licence of Monsanto India Ltd and its dealers in the state for supplying allegedly substandard or contaminated hybrid maize to the farmers, which turned hundreds of them to penury.[49]

4.6. Lessons for Eastern States

Despite the bad experiences with hybrid seeds, the governments didn't learn any lessons. Rather it allowed agribusiness companies to unleash more of their Hybrids seeds in the country as well as allowed field trials of GM seeds. When the shift to hybrid seed happens in the crop, the demand for pesticides and fertilizers goes up. The agribusiness giants such as Monsanto are already penetrating into rural hinterland in many States with their hybrid seeds. This replaces the age old self reliant, multi-cropping cultivation system, being replaced by the monoculture industrial model of farming with high chemical inputs. Ironically, in a majority of cases thousands of crores of rupees of the Central Government funds under Rashtray Krishi Vikas Yojana is being used to spread hybrid seed.

Infact, hybrid seeds are being promoted to pave the way for GM seeds. Hybrids have always

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[47] *http://indianexpress.com/article/news-archive/web/seed-of-contention/*

[48] *http://www.indiaenvironmentportal.org.in/content/41884/seeds-of-justice-in-bihar/*

[49] *http://www.rediff.com/money/2003/apr/03maize.htm*

been a precursor to the release of genetically modified (GM) version of the crop. In the case of maize, several herbicide-tolerant transgenic crops (referred to as HT GM crops) are in various stages of trials. There are four multinational agribusiness companies who are developing GM maize in India. Monsanto India Ltd. is way ahead with its insect–resistant and herbicide-tolerant maize. Three other companies are Pioneer Overseas Corporation, Dow Agro-sciences and Syngenta Biosciences, are also in the race and there is a huge push to commercialise HT GM crops in India.

Herbicide-tolerant GM crops will allow farmers to spray herbicides on a standing crop and destroy weeds. It has to be noted that this technology is of herbicide-tolerance and not herbicide-resistance, which means that the HT GM plant develops the capability of withstanding/assimilating the herbicide without getting destroyed. For instance, in Roundup Ready GM crops (the brand name for Monsanto's trait of herbicide tolerance, for a plant to withstand Monsanto's brand of glyphosate), a gene from an agrobacterium strain CP4 (CP4 EPSPS), that is resistant to glyphosate is inserted. The biotechnology industry claims that use of herbicide tolerant GM crops would reduce the overall chemical use in agriculture and would particularly decrease the use of the older generation, 'more toxic' herbicides but the truth is it will intensify the use of herbicides. And its impacts will lead to loss of farmland biodiversity, increased herbicide residues in food and animal feed and water courses, spread of herbicide tolerant genes to related weed species and neighboring crops, weeds developing resistance to the herbicide etc. The Genetic Engineering Appraisal Committee (GEAC) had already approved the field trials of two transgenic corn hybrids with brand names 900M Gold and HiShell in 2010-11.[50]

A field survey by the author indicates that the farmers who grow hybrid maize also plant local variety of maize which are more suitable under stressed situation like – flood and water logging situation, compared to the hybrid. Secondly, we also observed that negligible consumption of hybrid maize as food is also a key reason for continued practice to plant local varieties of maize during Rabi season.

[50] *http://indiagminfo.org/wp-content/uploads/2011/09/herbicide-tolerant-crops-briefing-paper.pdf*

5. Farm Mechanisation in Eastern States

Traditionally, Indian farmers relied on equipments which were simple and could be easily fabricated by village crafts men, blacksmith and carpenter such as Khurpi, Spade, Sickle, Plough, Row marker, Persian wheel, Wooden leveller, etc. which, now has been replaced by farm mechanization.

Mechanization of farm indicates the use of machines for conducting agricultural operations replacing the traditional methods which involve human and animal labour. Thus, mechanization is a process of replacing biological sources of energy involving animal and human labour to mechanized sources of energy which includes various machines like tractors, threshers, harvesters, pump sets, etc.

In brief, farm mechanization may be viewed as package of technology to ensure timely field operations, increased productivity, reduced crop losses and improved quality of grain or product.

Farm mechanization includes tractor, power tiller, zero till seed, fertilizer-drill, raised-bed planter, sugarcane-cutter planter, potato planter, potato digger, tractor driven reaper, seed cleaner-cum-grader, mobile foot harvester, power weeder, power thresher, winnower, cono-weeder irrigation pipe, sprinkler, pump set (diesel/electric driven), rotavator, combine harvester, wheel-ho, multi-row seed drill, sprayer duster, and other power driven agricultural implements, machines, etc.[51]

Farm productivity is positively correlated with the farm power coupled with the efficient implements and their judicious utilization. However, farm mechanization also causes adverse impact on the employment of labour and their livelihood.

Strong argument depicting comparative backwardness of any State in regard to agricultural mechanization can be its low KW/hectare use of machinery. The same for Bihar was 1.0 Kilo Watt/hectare. It was much lower than Punjab (3.75 KW/ha i.e., the highest in India and even lower than the national average (1.5 KW/ha). The level of agricultural mechanization was meant for the period 2009-10. As per the execution guidelines of the Agricultural Mechanization Programme/Scheme 2009-10 it was to be launched in all the districts of Bihar to facilitate the 'Second Green Revolution' in the country.[52]

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[51] *Tewari, V.K. et.al. (2012). "Farm Mechanisation Status of West Bengal in India", Vol. 1, Issue 6, December 2012, Basic Research Journal of Agricultural Science and Review.*

[52] *Verma, Mrinal and Tripathi, Ashok. (2015). "Perspective of Agricultural Mechanisation in Supaul District of North Bihar - A Research", Vol. 8, Issue 8, August 2015, Journal of Agriculture and Veterinary Science.*

Mechanization is capital intensive and substantial sums have been invested in our country. In the absence of good planning and direction investment on mechanization may not yield the expected results.

5.1 National Mission on Agriculture Mechanization (NMAM)

As far as efforts of the government to promote and strengthen mechanization in agricultural sector are concerned, since the year 2009-10 of the 11th Five Year Plan (i.e. 2007-08 to 2011-12) the following six schemes/ programmes were undertaken:

1. Macro-mode Management of Agriculture (MMA).
2. Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize (ISOPOM).
3. Jute Technology Mini Mission-II.
4. National Food Security Mission (NFSM).
5. Rashtriya Krishi Vikas Yojana (RKVY).
6. State Plan on Power Tiller Promotion Scheme (SPPTPS).

Under the above schemes, agricultural machines, tools and equipments are made available to farmers on subsidized prices.

Tractor is the basic machine on which most of the farm mechanization depends. Power tiller was introduced in the country in the sixties, but could not gain popularity like tractor due to its limitation in the field and on the road.

Contribution of different power sources in Indian agriculture is given in Table 10.

Table 10: Percentage contribution of different power sources in Indian Agriculture (2005-06)[53]

Power Source	Percent contribution	Remark
Agricultural worker	6	Average farm power = 1.5 kW/ha
Draught animals	8	
Tractor	47	
Power tiller	01	
Diesel engine	18	
Electric motors	20	

[53] *http://un-csam.org/Activities%20Files/A0711/02in.pdf*

National Mission on Agriculture Mechanization (NMAM) has envisaged a special provision for extending financial assistance and subsidies to small and marginal farmers directly or through co-operative in Eastern States for buying farm machines. We fear that indiscriminate promotion of expensive farm mechanization in Eastern States will render small and marginal farmers in the vicious circle of indebtedness and suicides, which is already happening in Punjab, Vidarbha, Marathwada and Bundelkhand.

(a) Subsidies by Odisha Government for farm mechanization

Odisha Government in 2013 adopted the State Agriculture Policy that gives huge subsidies to farmers who adopt mechanization. Odisha has a very high provision of funds to popularize farm mechanization. The State Plan alone provides Rs. 240 crore as subsidies for farm mechanization, which is probably the highest among all the States. The State's total budget for the farm mechanization subsidy is around Rs. 300 crore.[54]

To promote mechanization, Odisha also launched 'Farmers Club'. In 2014-15, State had 11,648 farmers clubs. These are supported by 'National Agricultural and Rural Development Bank (NABARD) and the public banks. Under the programme, NBBARD provides the financial support to the clubs for the first three years. The bank sponsoring the club may provide the support for another two years. Balasore district alone has over 1000 farmers club.

(b) Assam on the highway of farm mechanization

Similarly, Assam is on the highway of mechanization and in the process, 5772 tractors and 20,777 power tillers have already been provided to farmers till 2012.

Table 11: Present Farm Power Level of Assam State[55]

Implement	Total Numbers
Tractor	5,772
Power tiller	20,777
Power paddy thresher	43
Rotavator	111
Self propelled reaper	20
Small implements	99,884

[54] *Thakur, Purusttam and Sahoo, Samarjit et.al. (2015). "Finding Answers to the 34 Million Questions", Vol. 24, No. 15, 1-15 December 2015, Down To Earth, New Delhi.*

[55] *Mandal, S. (2014). "Road Map for Farm Mechanization in Assam State", Vol. 27, Issue 1, June 2014, Indian Journal of Hill Farming.*

Within few years, Assam will require 37,616 numbers of tractors and 43,886 numbers of power tillers which will take the State to higher level than national average of tractors and power tiller density per thousand hectare. There will also be necessity of 29,257, 42,839, 52,245 and 4,180 numbers of mould board plough, cultivators, paddy transplanter, combine harvester respectively and many other agricultural implements and machinery.[56]

(c) Farm mechanization expensive for West Bengal farmers

In a study in West Bengal, about 26% of the farmers consider tractor operated plough as expensive to purchase, while another 14% considered that it is expensive even to hire tractor operated plough. Further, about 26% of the farmers responded that tractor operated plough is not readily available for hire at a time when it is actually needed the most. Similar observations are made in case of other expensive machines like electric/diesel tubewells or pumps, tractor trolleys, seed drill, etc. In case of thresher machines, apart from being expensive to purchase, the major problem turns out to be maintenance costs involved.[57]

Same study also observes, "More importantly, the cost of machinery grew faster than the growth in value of production over the period 1996-97 to 2009-10. This holds true for paddy, mustard and especially wheat, where cost of machinery grew by 38.73% as compared to 11.48 growth of value of production".

5.2 Farm Mechanization: Not Suitable for Eastern States

Though, it is generally believed that mechanization is good and always advantageous for farming, it has its drawback. It has more disadvantages in the backward area like Eastern India, which comprises an underdeveloped region of Uttar Pradesh, Bihar and West Bengal, since it requires the heavy initial investment in capital goods. There are also other problems associated with the use of machinery in farming like maintenance of the machines, availability of parts, etc.

According to a Study[58] coordinated by C.S.C Sekhaar and Yogesh Bhatt of Institute of Economic Growth (University of Delhi), of a survey of Bihar and West Bengal, the farmers were asked questions regarding various problems associated with the use of machinery, in different

[56] *http://www.kiran.nic.in/pdf/IJHF/Vol27_1/6_Road_Map_Farm_Mechanization.pdf*

[57] *Sarkar, Debashis et.al. (2013). "Effect of Farm Mechanisation on Agricultural Growth and Comparative Economics of Labour and Machinery in West Bengal", Study No. 175, Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India, Krishi Bhawan.*

[58] *http://www.iegindia.org/ardl/2014-5-s.pdf*

farming operations, which enables us to detect the constraints in way of mechanization of agriculture in general. It is observed that according to the perceptions of the farmers, about 10 percent of the farmers find animal operated plough expensive to purchase, while about 14 percent opined that it is not readily available for hire services. The rest 76 percent of the farmers preferred not to answer this particular question as they do not have any other major problems with an animal operated plough. In the case of ploughing activities, about 26 percent of the farmers consider tractor operated plough quite expensive to purchase, while another 14 percent considered that it is expensive even to hire tractor operated plough. Further, about 26 percent of the farmers responded that tractor operated plough is not readily available for hire at a time when it is actually needed the most. As such, it comes out that in the case of animal operated plough, there are much fewer problems as perceived by the farmers as compared to tractor operated plough. The major difference between the two comes out to be the fact that tractor operated plough involves much higher costs as compared to animal operated plough, though it can perform the similar task much quicker and more efficiently.

Unlike other agriculture sector, farm mechanization in Eastern States has far more complex structural composition. Land size, cropping pattern, market price of the crop farm machinery of appropriate size, and the availability of financial assistance/support from banks are some of the major factors which decide the farm mechanization.[59]

a) Due to 'small Size' of land holding in Eastern India, it is difficult for the farmers to own machinery. As a result, the benefits of mechanization are enjoyed by only a section of the farmers who have large farm holdings.

b) Matching equipment for tractors, power tillers and other prime movers are either not available or farmers make inappropriate selection in the absence of proper guidance, resulting in fuel wastage and high cost of production.

   Almost 90% of tractors are sold in India with the assistance of some financial institution. Sale of farm machinery is driven by factors like financial support, and the applicant's profile which decide the credibility of loanee/farmers. Very often it happens that the loanee/farmers are not able to pay the installments and the tractors are auctioned by the bank or financial institutions, causing great shame and humiliation to the farmer.

c) The high cost and energy efficient farm machinery are capital intensive and majority of Indian farmers particularly in Eastern States are not able to acquire these assets due to shortage of capital with them.

d) The quality of farm implements and machinery manufactured by small scale industries in

[59] *Verma, Mrinal and Tripathi, Ashok. (2015). "Perspective of Agricultural Mechanisation in Supaul District of North Bihar - A Research", Vol. 8, Issue 8, August 2015, Journal of Agriculture and Veterinary Science.*

the country is generally not of desired standard resulting in poor-quality work, low output and high operational cost. The quality of equipment has to be improved.

e) The after sales service of farm machinery is the other concern in Eastern States. There are inadequate service centers for proper upkeep of the machinery.

f) Lack of proper knowledge of farmer to purchase farm machinery, operate and maintain it properly leads to wrong choice, makes it uneconomical and risky too.

g) There is shortage of diesel in the country as a whole. Thus, to use so extensive oil based farm machinery is not desirable.

h) The lack of repair and replacement facilities especially in the remote rural areas is another hindrance in efficient small farm mechanization.

i) Due to seasonal nature of the agriculture, the farm machinery remains idle for much of the time.

In India 85% farmers are small and marginal with less than 2 hectares. Similar is the case in Eastern States. A tractor, which is main farm machinery, is economical for large farmers with more than 10 hectares of land.[60]

Mechanized farm in Eastern States will render a huge number of existing cattle population surplus and unnecessary. Considering the huge size of population in the region mechanization will displace a large number of labourers.

In the Eastern region, farmers are neither aware of any assistance programme or subsidy for increasing mechanization. Only a few large farmers reap benefit from such programme, leaving rural masses deprived for such schemes.

There is a need to revive age-old tradition that reduce the dependency on contractual labourers. For example, farmers in Odisha's Sambalpur, Bargarh, Debagarh and Sundargarh districts have traditionally followed the Pancha system, where men from all farming families come together and work at farms. If a farmer remains absent, he has to hire a labourer and send him as a substitute. The traditional system, which is prevalent in tribal pockets, could be a deterrent to rising wage cost. But community trust has been steadily eroding.

Tribals in southern Odisha follow a community farming practice called Kutumb Bada where all the villagers work together on paddy fields. The interesting feature of Kutumb Bada is that the farm owner has to make a nominal contribution, which can be as low as Rs. 20 per person, to a collective fund that is used for community development.

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[60] *Mehta, C.R. (2013). "Agricultural Mechanization Strategies in India, Central Institute of Agricultural Engineering", Bhopal, ICAR, Regional Forum 2013 (http://www.ciae.nic.in).*

6. Re-imagining the 2nd Green Revolution - Alternate & Farmer Friendly Strategies

6.1 Expansion of Crop Land and Crop Diversification

In order to promote 2nd Green Revolution, the foremost strategy was to increase the net sown area and double-cropped areas, which implies planting two crops per year on the same agriculture land. Double crop area can be increased by increasing irrigation facilities, conserving monsoon water through rain water harvesting structures, using water efficient sprinkler irrigation system, and using suitable kharif area for seasonal vegetable, roots, and tuber crops.

When the cropping pattern in Eastern region vis-a-vis all India scenario is observed during the last one and a half decades, it is found that cropping pattern in the Eastern region has hardly changed over these years. This is evident from the fact that food grain crops constitute 78.83% of the total cropped area of 41.41 million ha in the Eastern region as against 63.07% (192.80 million ha) at the all India level.[61] Therefore in order to keep the soil healthy and improve crop yield besides increasing farm profitability, it was decided to change the cropping pattern in the Eastern region. Location-specific crop-mix in accordance with soil, climate and rainfall and irrigation facility needs were put in place.

6.2 Enhance the Role of Krishi Vigyan Kendras (KVK)

Krishi Vigyan Kendra's (KVK), run at the district level with the support of Ministry of Agriculture, Government of India, are vital links for disseminating new agriculture technologies and cultivation practices from government research institutions to the farming community. The country has 642 KVKs - at least one in every district - working under various State agricultural universities, with full funding support from the Indian Council of Agricultural Research (ICAR).[62]

It is also significant that in the Eastern States, particularly in Bihar and Odisha, multinational seed companies such as Monsanto, DuPont, Syngenta and Bayer Crop Science are doing brisk business. The expansion of the private sector in a space increasingly vacated by the State agencies tells a story in itself. *Krishak Mitras* (Farm Friends) may also play great role. *Krishak Mitras* play mediators' role between the agriculture department and farmers. They inform and educate farmers about availability and variety of government seeds, new technique of farming schemes and crop insurance.

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[61] *Karmakar, K.G. and Sahoo, B.B. (2015). "Green Revolution in Eastern India", in the edited book by M. Ghosh, D. Sarkar and B.C. Roy, "Diversification of Agriculture in Eastern India", Springer, 2015.*

[62] *http://indianexpress.com/article/india/india-news-india/at-this-kvk-50-acres-and-2-scientists-who-double-up-as-accountants-administrators/*

6.3 Popularize System of Rice Intensification (SRI)

A revolution in rice production can occur by producing better seeds or through better cultivation results. The System of Rice Intensification (SRI) has demonstrated in several States the ability to save water in rice production but at the same time increase yield in a cost-effective manner. About 60% of the country's rice area is irrigated, accounting for 75% of production, but by guzzling disproportionately large volumes of water.

For small and marginal farmers, SRI can be a game changer. The spirit of SRI - "more from less" - is best expressed by the catchy slogan on a billboard in Tripura *Beej kam, saar kam, jal kam, aushadh kam, kharcha kam, phalan bishi, aay bishi* (lesser inputs in seed, fertilizer, water, pesticides, costs, but with increased output and incomes).[63]

It was in Madagascar in Latin America, some 30 years ago, that the SRI technique was developed by a Jesuit priest, Henri de Laulanie. It is estimated that globally over five million farmers have already adopted SRI cultivation. In the 50 countries where SRI has been tried, 30-40% saving of water has been demonstrated.[64]

SRI has shown an ability to raise rice yields to about eight tonnes per hectare (the current national average is 2.1 tonnes) without requiring new varieties, and with significantly reduced fertilizers and agrochemicals, while using only about half the water in business-as-usual irrigated rice. With the use of best practices, SRI yields of about 15-20 tonnes per hectare have also been achieved.[65]

In Tripura, from just 44 farmers using the methods in 2002, the number has increased to about 3,50,000 on 1,00,000 hectares, nearing half of the State's rice area.[66]

Bihar started it with only a few hundred farmers, in 2007; four years later, the area under SRI was supposed to be about 10% of the State's rice area.[67]

SRI referred to as the new "green grassroots revolution", is not dependent on purchased inputs, but on certain ideas and changes in practice that can be explained and justified in scientific terms. It is an assemblage of good agronomic practices which might vary across different agro-ecological and cropping system conditions, but earmarked to benefit farmers through higher yields and lower cultivation costs.

Under SRI, farmers transplant young, single seedlings, spacing them widely in a grid pattern,

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[63] *Sharma, Rita. (2014). "More Rice from Less Water", 7 July, 2014, The Hindu, New Delhi.*

[64] *Gopalakrishnan, R. (2014). "For A Second Rice Revolution", 5 September 2014, Business Standard, New Delhi.*

[65] *http://www.thehindu.com/opinion/op-ed/more-rice-from-less-water/article6183223.ece*

[66] *ibid*

[67] *Vidal, John. (2013). "India's Rice Revolution", 16 February 2013, Guardian, U.K.*

while keeping soil moist and fertile, but not flooded. Soil aeration is ensured by regular weeding both manually and by specially designed Cono-Weeders, Compost and other sources of organic nutrients are preferred over fertilizers to enrich soil biota

Advantages of SRI

Main advantages are savings in water and seed with higher yields.

- **Higher grain yields** - 20-50%,
- **Water saving** - 30-50% reduced irrigation,
- **Cost of Production** - 10-20% lower,
- **Net farmer incomes** - 50-100% higher or more,
- **Biotic Resistance** - Greater resistance to pests and diseases,
- **Climate resilient** - More tolerant to drought, storm damage, extreme temperature,
- **Climate smart** - Reduced greenhouse gas emissions,
- Total farming area under SRI in India - 1.7 million hectares.

Under SRI, rice seedlings are transplanted in 8-12 days (or 2-3 leaf stage), instead of 25-30 days old seedling in traditional method of rice cultivation. It results in achieving maximum yield potential.

In practice, SRI

- Sparingly use of water to keep the soil moist, but do not flood the field continuously.
- Use organic compost/vermi compost for better yield.
- Wider spacing at 25cm × 25 cm in square rather than in rows.

First Green Revolution of the mid-1960s, which focused on improving yields through breeding new traits, using agrochemicals to enhance soil nutrients and providing assured irrigation. That resulted in adverse ecological effects. In 21st Century, with water becoming an important cost and constraint, with soil degradation and shrinking land resources and climate change adverse impacts, SRI offers millions of disadvantaged farming households better opportunities. There are no patents, royalties or licensing fees in SRI – the few modern technologies being promoted under BGREI which would only benefit the farmers.

6.4 Promote Organic Cultivation

Organic products still constitute in niche in the overall Indian agriculture market, making up for 1% of total agricultural production. However, the market shows a growth rate of around 100%

or more as the domestic demand highly increased in the last years.[68]

In practical terms, organic agriculture means that the use of synthetic fertilizers, pesticides and chemical medication is avoided. Potential of Eastern States in this sector is big since the traditional cultivation practices are more or less in line with the organic standards. Therefore, the knowledge is already present and a conversion easily manageable.

Additionally, another competitive advantage lies in the structure of the Eastern States in agriculture sector characterized by small production sites. Indeed, those are proved to be more productive in organic farming.

After turning Sikkim into a fully organic state, India is now looking at a "cluster" approach to increase area under chemical-free farming in other States.

The Centre's overall plan is to develop 10,000 clusters (one cluster of 20 hectare each) across the country for promoting organic farming to cater to growing domestic demand and the high export potential of such crops.[69]

Under this plan, 50 or more farmers can form a cluster. Every farmer will be provided Rs. 20,000 per acre in three years for seed, harvesting of crops and transporting produce to the market under the '*Paramparagat Krishi Vikas Yojana*' (traditional agriculture development plan) of the agriculture ministry.

The organic food that is marketed through direct sales by the original producer or producer organisation to the end consumer is exempt from the need of verification of compliance and this compliance does not apply to processed organic food products.

However, the ground level reality is that the organic farmers over the country face great hurdles for 'Certification' of their produce.

Like Sikkim, Eastern States should facilitate the certification process to promote organic farming. The climate, growing conditions, untapped production potential, vast human resources, least use of chemical fertilizers/pesticides, and a strong traditional farming system are some other advantages for organic crop production. The potential areas for the growth of organic farming are rain-fed, tribal and hilly regions. To popularize organic practices and reap the benefits of organic farming, experts should investigate how the small and marginal farmers could benefit from such farming, and wastelands could be used for such farming.

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[68] *Duval, Marion and Claudia, Wiehfer. "Organic Food Labelling Practice in the EU - An Option for the Domestic Market in India", Indo-German Programme On Consumer Policy, and Consumer Protection (CPP), GIZ, New Delhi.*

[69] *Mohan, Vishwa. (2016). "Maha, MP Lead in Earmarking Special Organic Farming Zone", 10 July 2016, Times of India, New Delhi.*

6.5 Promote Indigenous/ Conventional Rice Seeds

Farmers in Eastern States can produce 8-9 tonnes per hectare of rice, which is better than the hybrid varieties of Indian Rice Research Institute (IRRI). The kind of yield was achieved by Dr. R.C. Richharia simply by low input conditions. Dr. Richharia was one of the leading experts on rice in India. He documented and collected an amazing 19,000 rice varieties during his career. As per his estimation, India was home to 2,00,000 varieties of rice.[70]

These varieties have resistance against various biotic stresses, particularly against bacterial blight, gall midge and brown plant hopper, all pests which affect the rice plant. Many of the varieties are being used as parents in rice variety crossing programmes.[71]

To promote indigenous rice varieties Dr. Debal Deb, an ecologist with the Centre for Interdisciplinary Studies in Kolkata, has helped set up a Seed Bank for indigenous rice varieties in Odisha and now more than 5000 farmers have been shifted to using these varieties because of availability of indigenous seed.

According to Dr. Debal, before 1970, about 5,600 varieties of rice flourished in Bengal but not more than 500 may be left today. Dr. Deb has documented 340 varieties in a book. In 1998, he established *Vrihi* which is the name of the *Atharva Veda* for rice, to facilitate a free exchange of local crop varieties among farmers.[72]

In Eastern region, there are large numbers of indigenous rice varieties developed by farmers through non-formal science. The region boasts of an impressive range of rice varieties - from flavoured, fine and coarse to high-protein, scented and varieties with medicinal properties - that can be harvested between 60 and 150 days. The unique varieties, developed by local farmers over centuries, include the smallest (*Jag Phool*; 4 mm long), the longest (*Dokra, Dokri*; 14 mm long) and the boldest (*Hathi Panjara*; having two grains in one floret).[73]

Bhimsen has the largest width; there is variety called *udan pakheru* - because of its long, featherlike structure. One of his many books, Dr. Richharia speaks of a variety called *Chikko* in the tribal area of Bastar which is preferred because it can be ground into soft flour which can be rolled out to make chapattis. Another variety called khowa was popular because it tasted like milk after it was boiled. There are super long varieties which are popular for making puffed rice and bold varieties which are used to make flattened rice *(poha)*. Many varieties are high-yielding and resistant to pests.

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[70] *Alvares, Claude. (1986). "Dr. Richharia's Story - Crushed, but not Defeated", 23 March 1986, Illustrated Weekly of India, Bombay.*

[71] *Menon, Meena. (2001). "The Grain Story", 2 July 2001, Business Line, New Delhi.*

[72] *ibid*

[73] *Krishna Kumar, Asha. (2003). "The Raipur Collection", Vol. 20, Issue 02, 18-25 January 2003, Frontline, Chennai.*

There are special rice types such as the Tulsi Manjari from Bihar, which are used to make kheer and some are eaten to relieve joint pains or headaches.

In the Jagannath Temple at Puri in Odisha, freshly harvested rice is presented to the deity everyday, and various varieties of rice, placed in pots, one on top of the other, with a single flame beneath the lowermost, still cook simultaneously.

6.6 Recommendations/ Suggestions to Promote Green Revolution in Eastern States

Since the promotion of BGREI in last five years, several civil society groups are actively working in the region to help farmers understand the real meaning of the BGREI which could lead to similar catastrophic results in terms of environmental and health hazards as seen during and after the first Green revolution. The Alliance for Sustainable and Holistic Agriculture (ASHA), a nationwide alliance of progressive farmers groups, said in its Third Kisan Swaraj Sammelan (held in Hyderabad in April 2016) Declaration that "introducing Green Revolution paradigm in Eastern India is unacceptable to us, and BGREI investments should be diverted to promotion of ecological agriculture".

Therefore enough caution must be made to stop the farmers from blindly adopting the BGREI technologies where there is over emphasis on input intensive technologies, excessive and imbalanced use of chemical fertilizers which would lead to micro nutrient deficiencies, over dependence on chemical based pest control, and last but not the least, excessive exploitation of ground water. Therefore the civil society groups from Eastern India make the following recommendations for specific crops being promoted under BGREI.

(a) Recommendation/suggestion to promote rice

- Introduce some mechanism to safeguard the interest of the farmers, in case of crop failure or poor germination.
- Promote Indigenous rice varieties as explained earlier.
- Adopt Dr. Richharia's Model for Rice Cultivation (Appendix 2).
- Popularize SRI methods for higher yield with less water.
- Usher the 'green revolution' in Eastern States based on the principle of sustainability, soil heath and environmental protection.
- Maintain the seed sovereignty by growing seeds saved from the previous year.
- Multiply indigenous climate resilient rice seeds.
- Collaborate with Directorate of Rice and State Agriculture Universities to improve the yield and quality of indigenous seeds.
- Ensure the availability of indigenous rice seeds.

- Involve 'Extension Agencies' such as Krishi Vigyan Kendras and Krishak Mitras (Farmer Friend) to play greater role in creating awareness about the advantages of cultivating indigenous rice.
- Innovate the extension approaches to promote indigenous rice.

(b) **Recommendations/suggestions for maize**

- Promote 'desi', local / traditional, Open pollinated or conventional maize varieties which would make contribution to food security, as hybrid maize is primarily grown for industrial use.
- Develop seed banks in the villages to ensure seed sovereignty.
- Conserve and multiply indigenous, climate resilient seeds.
- Revive the government seed corporations and empower them to be able to conserve and multiply Open Pollinated Seed Varieties.
- Request the agriculture Universities and encourage them to find climate resilient seeds and improve their quality and insure the availability.
- Encourage seed exchange programme among farmers.
- Promote maize with mixed cropping.
- If one must absolutely promote maize, there is no reason why OPVs cannot be encouraged. The directorate of Maize Research has released more than hundred OPVs. If the same kind of investment is used as in the PPPs, productivity is bound to increase.
- Monsanto and other seed companies have cashed in on the deficiencies of the agriculture departments in almost every state. It is not very difficult to get yields of three tonnes per hectare even with OPVs. All that's needed is an understanding of how to pick the best seeds and the same set of good management practices, hybrids may give better yields initially but soon their yields will stagnate.

c) **Recommendations/suggestions for judicious farm mechanization**

- Promote Custom Hiring Services (CHSs) for use of Tractors, power tillers and other implements to ensure timelines of operation.
- Establish 'Farm Machinery Banks' for machines and supply to users and consumers.
- Small hand tools and equipments are most necessary tools for small land holders and for inter-culture operations where power operated machinery can't be operated. These equipments are suitable for inter row operation like weeding, side dressing etc. These could be given to farmers in the packages of implements.
- Consider forming user's cooperative to purchase expensive farm equipments and ensuring effective maintenance of equipments.

7. Overall Assessment of Bringing Green Revolution in Eastern India (BGREI):

There are many flaws in the implementation of the program as well as in an understanding of the region and its ecology. We can compare the official data to assess the results of BGREI and its implications on other aspects of society in the region.

Table 12: Percent Operational Agricultural Holdings by Major Size of Groups in BGREI States

Eastern States	Marginal (<1ha)	Small (1 - 2 ha)	Semi medium (>2 - 4 ha)	Medium (>4 - 10 ha)	Large (> 10 ha)
Assam	62.65	20.69	12.98	3.54	0.18
Bihar	84.18	9.24	5.09	1.42	0.08
Chhattisgarh	53.67	22.00	15.61	7.53	1.20
Jharkhand	69.1	13.5	11.3	5.4	0.7
Odisha	56.43	27.39	12.32	3.57	0.32
Eastern UP	69.00	18.10	9.46	3.12	0.32
West Bengal	80.44	14.86	4.17	0.52	0.01
BGREI States	67.73	18.71	9.94	3.28	0.35
All India	62.88	18.92	11.69	5.48	1.02

Source: Agriculture at a Glance, 2009

The data in Table 12 shows that out of the seven States of Eastern India where BGREI has been implemented as a notion of second green revolution in India, in two major States - West Bengal and Bihar - 80 percent farmers have less than 1 hectare of agriculture land holdings. And if we take in account those farmers with less than 2 hectare of agricultural land holding, all other States except Chhattisgarh, fall in this category as well. Even in the category of medium farmers (land holding between 4 to 10 hectare), only Chhattisgarh and Jharkhand have crossed the threshold of 5 percent, rest all the States have less than 5 percent of medium scale farmers.

Given these figures, we find a very nominal or almost non-significant growth in the first two year of the implementation of BGREI, even after the heavy investment by the Central and State governments, which has benefitted the small and marginal farmers in this region. However the

use of new technologies in the form of HYVs and hybrid seeds and heavy mechanization will serious impact the livelihood of small and marginal farmers which constitute the majority of farm population in eastern India.

7.1 The Production of Rice, Wheat and Pulses | Trends show only nominal growth

If we compare the production of major crops like rice, wheat and pulses from previous year, it seems that there is a nominal growth in the production of these crops. However, the Table 13 data shows that only Bihar has shown the significant positive growth in rice production, which is more than 10 percent. The total increase in rice production in the year 2010-11 was only 0.3 percent in all seven States, and in the year 2011-12, it has increased by 2.3 percent

Table 13 : Production matrix of Rice during QE: 2009-10, QE: 2010-11 & QE: 2011-12 (4th Advance estimates) in BGREI States vis-a-vis All India

State	Production ('000 tons)			% Change	
	QE: 2009-10	QE: 2010-11	QE: 2011-12	In QE: 2010-11 over QE: 2009-10	In QE: 2011-12 over QE: 20010-11
Assam	3626.4	3863.2	4081.8	6.5	5.7
Bihar	4418.5	4339.8	4782.2	-1.8	10.2
Chhattisgarh	4794.4	5025.8	5223.2	4.8	3.9
Jharkhand	2564.2	2474.6	2564.6	-3.5	3.6
Odisha	6990.9	6984.7	6782.8	-0.1	-2.9
Eastern UP	6049.0	6160.8	6558.2	1.8	6.5
West Bengal	14670.8	14377.8	14399.3	-2.0	0.1
Total BGREI States	43116.2	43226.7	44346.1	0.3	2.6
All India	94023.4	94860.68	97054.02	0.9	2.3
% BGREI to All India	46	46	46	-	-

Source: Source: DES, GOI and SDAs

And if we compare it with the yield Kg/Hectare again (as given in Table 14), only Bihar has shown the significant change, Eastern Uttar Pradesh and Assam has increased the yield by 6% kg/ha. However, the overall yield of all these seven states has only nominally changed by 2 percent in 2010-11 and 3 percent in 2011-12. This nominal growth depends on the climatic condition of the year, like a flood or drought, and affects the traditional farming at the same level.

Table 14: Yield matrix of Rice during QE: 2009-10, QE: 2010-11 & QE: 2011-12 (4th Advance estimates) in BGREI States vis-a-vis All India					
State	Yield (kg/ ha)			% Change	
	QE: 2009-10	QE: 2010-11	QE: 2011-12	In QE: 2010-11 over QE: 2009-10	In QE: 2011-12 over QE: 20010-11
Assam	1522	1601	1695	5	6
Bihar	1308	1317	1453	1	10
Chhattisgarh	1287	1352	1402	5	4
Jharkhand	1754	1853	1901	6	3
Odisha	1574	1591	1576	1	-1
Eastern UP	1968	2019	2143	3	6
West Bengal	2551	2575	2600	1	1
Total BGREI States	1781	1818	1875	2	3
All India	2148	2175	2224	1	2
Source: Source: DES, GOI and SDAs					

This is not only the case of rice, but if we take a look at the production and yield of the wheat, we find almost similar results. The yield of wheat has significantly increased in the first year of implementation of BGREI in all seven States, but in the very next year the yield of wheat derided by almost 18 percent (Table 15).

Table 15: Yield matrix of Wheat during QE: 2009-10, QE: 2010-11 & QE: 2011-12 (4th Advance estimates) in BGREI States vis-a-vis All India					
State	Yield (kg/ ha)			% Change	
	QE: 2009-10	QE: 2010-11	QE: 2011-12	In QE: 2010-11 over QE: 2009-10	In QE: 2011-12 over QE: 20010-11
Assam*	1129	1376	1152	22	-16
Bihar	1948	2504	2069	29	-17
Chhattisgarh*	1015	1378	1107	36	-20
Jharkhand*	1573	2038	1712	30	-16
Odisha*	1457	1698	1475	17	-13
Eastern UP	2529	3320	2732	31	-18

West Bengal	2423	3169	2666	31	-16
Total BGREI States	2264	2957	2437	31	-18
All India	2776	3587	2938	29	-18
Source: Source: DES, GOI and SDAs					

The production of pulses (Table 16) also not shown the remarkable growth in the first two years of the implementation of BGREI. And the overall production has increased only by 3.6 percent in both the years. So the BGREI has not much impact on the overall production of food grains in Eastern India

Table 16: Production matrix of Pulses during QE: 2009-10, QE: 2010-11 & QE: 2011-12 (4th Advance estimates) in BGREI States vis-a-vis All India

State	Production ('000 tons)			% Change	
	QE: 2009-10	QE: 2010-11	QE: 2011-12	In QE: 2010-11 over QE: 2009-10	In QE: 2011-12 over QE: 20010-11
Assam	61.0	64.2	74.0	5.3	15.3
Bihar	464.7	482.9	497.1	3.9	2.9
Chhattisgarh	494.2	511.0	511.6	3.4	0.1
Jharkhand	247.3	278.8	325.6	12.7	16.8
Odisha	371.7	389.8	390.9	4.9	0.3
Eastern UP	526.4	522.4	529.9	-0.8	1.4
West Bengal	150.9	151.3	158.1	0.2	4.5
Total BGREI States	2316.3	24005.	2487.2	3.6	3.6
All India	14314.4	15285.7	15887.77	6.8	3.9
% BGREI to All India	16	16	16	-	-
Source: Source: DES, GOI and SDAs					

7.2 High Yielding Varieties of Seeds | High cost and no results lead to low adoption

TThe BGREI program promotes the High Yielding Varieties of seeds in eastern India, however, these HYVs seeds are produced and sold by few agribusiness corporations and these

companies seeds are very limited in diversity. Since the HYV package is costly and represents a financial risk to traditional farmers, proponents of the Green Revolution targeted a specific client base they called " progressive farmers".[74]

Table 17: Adoption of High Yielding Vareities in Eastern India

State	Number of Varieties available for cultivation				
	Irrigated (IR)	Rainfed Shallow Lands (RSL)	Rainfed Uplands (RUP)	Boro	Total
Assam	09	19	02	03	33
Bihar	19	21	13	03	56
Chhattisgarh	15	06	06	-	27
Jharkhand	12	16	04	-	32
Orissa	45	30	28	-	103
West Bengal	23	10	06	01	40
Total	123	102	59	07	291

Source: Viraktamath, Dr. B. C., Presentation on Bringing Green Revolution in Eastern Region, nfsm.gov.in/Presentations/EasternIndia/DRR.ppt

The eastern part of the India is not a homogeneous geographical landscape, but it comprises different agroecological areas, various topography, diverse soil type, and many climatic zones. Because of these the use of HYVs and modern varieties of seeds to increase the production of crops is not ecologically and practically viable for the entire region. Even the HYVs seeds simply cannot match the diversity of land and climatic zones. As we have discussed earlier that there are thousand of traditional varieties of every crop in eastern India, according to their climatic and ecological need. But the few numbers of HYVs and modern varieties (as given in Table 17) cannot meet the diverse cultural and ecological needs of small farmers. Moreover, the HYVs are destroying the seed keeping and conservation techniques and practices.

Even though modern varieties, including high yielding varieties and hybrids dominate the scene in Eastern India after BGREI, yet traditional/ local/ farmers varieties are still being grown in every eastern states which shows that HYVs and hybrids (as shown in Table 18) are not very successful in this region.

[74] *Rorabacher. J.A. (2010). "Hunger and Poverty in South Asia", Gayan Publishing House, New Delhi; page 61*

Table 18: Area of Rice crop (%) under Traditional Varieties (TVs) in Eastern India's States (2002 to 2011)											
State	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	Average
Rice											
West Bengal	10.9	10.8	10.6	10.6	9.3	9.2	8.5	8.5	8.5	-	9.8
Orissa	36.5	37.6	35.8	32.8	30.7	28.9	26.5	22.9	21	19.4	30.3
Bihar	52.1	48.5	54.1	52.3	50.8	48.7	49	49.2	52.6	29.0	49.0
Chhattisgarh	83.3	74	80.8	80.5	78.3	76.3	75.8	74.5	77.6	-	78.6
Wheat											
Bihar	23	25.8	29.2	27.4	26.2	23.7	25.7	25	26.8	-	26.0
Maize											
Bihar	65.5	51.7	66.2	64.8	63	62.8	61.4	-	64.6	-	62.9
Source: http://xiss.ac.in/JJDMS/Vol14/Issue2/pdf/2-Singh,%20Kumar%20&%20Pal.pdf											

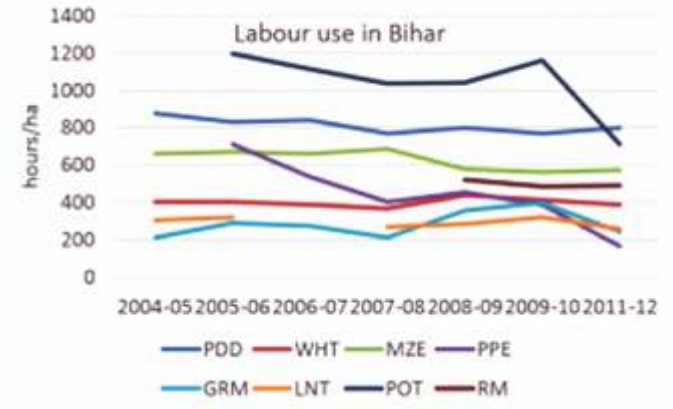
In rice the average percent area (2000-01 to 2010-11) under traditional varieties varied from 9.8 percent in West Bengal to 30.3 percent in Odisha, 49 percent in Bihar, and 78.6 percent in Chhattisgarh. About 26 percent of the area covered by wheat is under traditional varieties and in maize approximately 63 percent areas was covered by traditional varieties. One of the key reasons for continued dependence on traditional varieties was that modern varieties perform better under high input (irrigation and fertilizer) conditions with better management while farmers' varieties are being grown in less favourable conditions, i.e. rainfed, with low inputs. Many farmers have to re-drill their pumping sets, since the water level in these areas is steeply gone down, and these farmers have no other option than to use ground water to irrigate HYVs crops.

Unsurprisingly the productivity of HYVs and hybrids was found to be better than local varieties, though their adoption was influenced by many other factors. The low adoption rate of HYVs and hybrids in rainfed rice environments in Eastern India is mainly due to undulated topography and lack of assured irrigation. However, there were various factors responsible for the preference of farmers' varieties in Eastern India including bio-geophysical, geographical, topographical, irrigation facilities, timely availability of quality seed, inputs and credits, land holdings and farm size, acceptable nutritional qualities, scale neutrality including economics of production, desirable varietal traits for food, feed and fodder, tolerance to various abiotic and biotic stresses, and socio-economical condition of the farmers. For example, farmers did not adopt modern varieties of rice despite the availability of irrigation water, mainly because of the high cost of irrigation, which was fundamentally caused by investment in a specific type of shallow tube wells. The adoption of modern varieties has generally been low among subsistence farmers in marginal areas in Eastern India because of low provision of credit

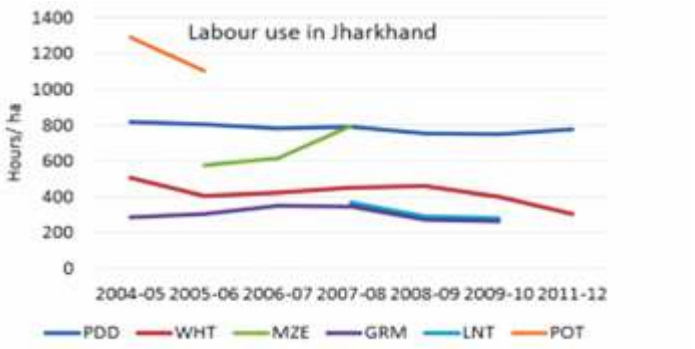
facility. Similarly in upland rice, traditional varieties are preferred over modern varieties due to their tolerance to abiotic and biotic stresses. Moreover, the traditional varieties are preferred for better nutritional quality among other reasons.[75]

7.3 Failed to Generate Employment:

The graph given below shows the decrease in the use of labour in agriculture after 2010-11. There are lots of reasons for this decrease in labour, which include increasing use of heavy machinery like tractor, harvesters and tillers. As we know, harvesting and tilling are labour intensive activities in agriculture. The data of two major States, Bihar and Jharkhand which provides maximum numbers of the labour in metropolitan cities, shows the decline of agricultural labour in almost every crop, so we can say that its not seasonal.



Sources: Directorate of Economic and Statistics, Ministry of Agriculture, Govt of India.



Sources: Directorate of Economic and Statistics, Ministry of Agriculture, Govt of India

(PDD-Paddy; WHT-Wheat; MZE-Maize; PPE-Pigeon pea; GRM-Gram; LNT-Lentil; POT-Potato; RM-Rapseed/Mustered; MNG-Moong;NSD-Niger seed; SSM-Sesame; BLG-Blackgram; JUT-Jute; CTN-Cotton; GNT-grund nut)

[75] *http://xiss.ac.in/JJDMS/Vol14/Issue2/pdf/2-Singh,%20Kumar%20&%20Pal.pdf*

Earlier there was a seasonal migration of labour during those seasons when agriculture didn't require labour but now because of heavy use of machines and technologies the labour migration has became a permanent phenomenon. Hence BGREI was not very successful in generating employment in eastern states and thus, it failed to stop the migration of labour from eastern states, especially Bihar, Jharkhand, Orissa and West Bengal to big cities.

7.4 Other Useful and Nutritional Crops

Even though the Central and State governments are blindly promoting the BGREI with the sole focus on promoting rice and wheat production in this region but they are oblivious of the fact that promotion of rice and wheat will impact the production of other useful and nutritive crops which eastern India is producing. This will not only impact the reduction of land under these crops but it will also impact the nutrition security of the small and marginal farmers in eastern India. Secondly, eastern India is not using much of chemical fertilizer and pesticides in production of oilseeds, vegetables, spices etc., but with the intensive promotion of BGREI and its technologies, especially chemical fertilizer and pesticides as well as heavy machinery, the production of oilseeds, vegetables, spices will also be impacted and the use of chemicals will increase in these crops as well besides it will contaminate the soil and the environment, besides increasing the cost of production.

According to Bihar Agricultural Planning Commission, Bihar ranks 3rd in vegetable production in the country and produces a variety of traditional and non-traditional vegetables without using synthetic fertilizers, pesticides, herbicides, and heavy machinery. Even the top two producers of vegetables in India, West Bengal and Uttar Pradesh, are basically depended on traditional farming and horticulture. Except for western Uttar Pradesh, most of the region of eastern Uttar Pradesh horticulture depends on traditional methods of cultivation with very limited use of synthetic fertilizers and almost no use of heavy machinery and technology.

If we compare these States with Punjab and Haryana, which is most affected by the first green revolution, we find these heartland of Green Revolution does stand in the top 10 producers of vegetables in the country compared to the eastern states where West Bengal produces (25466.8 MT) vegetables and tops the list while Uttar Parades with (19571.6 MT) is the second producer, and Bihar is third (16325.7MT), and this huge amount of vegetables are produced without much help from the government. These producer or farmers are basically dependent on the traditional methods, their input cost is very low, so to grow the seasonal vegetable they don't need any heavy investment, mostly save seeds and use it for next crop. Since these are seasonal vegetables, they don't need much water, rainwater or climate moisture is enough for grow these vegetables.

This method of agriculture also provides a social stability as well as fulfils the nutrient value of

the food. Exchange of food items such as cereals to the vegetable and fruits build a social fabric which is most required in any traditional society. At the same time low input cost makes the farmers less vulnerable towards the crop failure. Unlike the farmers of Punjab and Maharashtra, where the input cost is very high, farmers are used to taking loan with high interest rate from local moneylenders, but in eastern India most of the framers invest their savings in farming and are not dependent on loans. And this is visible in the significant difference in the number of suicides in eastern India in comparison to Punjab and Maharashtra.

Even in the production of oilseeds and spices, eastern States are ahead of Punjab, Haryana and Maharashtra. Uttar Pradesh is the one of the largest producers of the mustard oil, Bihar is the second largest producer of mustard oil, and Andhra Pradesh is in the third position. We know, mustard oil is one of the most favourite cooking oil and basic source of fat in North India and western India, since most of the population of the region cannot afford the butter and ghee in that quantity.

In turmeric production West Bengal, Uttar Pradesh and Bihar are in the top 15 list. West Bengal is the fifth largest producer of turmeric and Bihar and Uttar Pradesh is placed at 9th and 10th place respectively.

In garlic production Uttar Pradesh is placed as 5th largest producer and Bihar is stick to the 10th position. It also has great medicinal values and a great part of our daily food ingredients. In chilly production, if we leave the south India and Gujarat; Uttar Pradesh, West Bengal and Bihar are the highest chilly producer.

A variety of spices are produced in Bihar. According to government reports, at present Bihar produces about 20 thousand tonnes of spices annually from an area of nearly 15,081 ha. The important spices are Ginger, Turmeric, Chilly, Coriander, and Garlic. Chilly accounts for 47.6% of the area under spices and 39.5% of the production followed by turmeric, which occupies 26.3% of the area under spices and accounts for 36.4% of the production in the state.

7.5 The Impact of Mechanization:

In general terms, mechanization is equated with the modernization, in most of the developing countries, including India. Without analysing the usefulness or impact of mechanization of agriculture, we have followed the western countries pattern and adopted heavy mechanization to revolutionize or modernize the farming technique. With the implementation of heavy machines and technological advancement, the production structure of Indian agriculture has been altered, from stable, traditional agriculture structure to high-risk modern agricultural structure.

The disparity in the income and holding of land has shown the different impact on various

categories of farmers. India has a great number of small and medium farmers. Unfortunately for these farmers, the cost of machinery is not affordable and even the maintenance cost of this machinery is too much. For many poor farmers and tenants farmers who are in majority in Eastern states, for them use of the heavy machine was not possible. But government under the BGREI is promoting heavy mechanization under which farmers are provided with subsides to buy implements, machines and/tools such as tractor, power tiller, zero till seed-cum-fertilizer-drill, raised-bed planter, sugarcane- cutter planter, potato planter, potato digger, tractor driven reaper, seed cleaner-cum- grader, mobile foot harvester, power weeder, power thresher, winnower, conoweeder irrigation pipe, sprinkler, pump set (diesel/electric driven), rotavator, combine harvester, wheel-ho, multi-row seed drill, sprayer duster, and other power driven/human driven agricultural implements, machines, etc.

Conclusion

The argument for the second green revolution in the eastern states, like the green revolution in the North, is that India needs food to feed its large population. T BGREI was launched inthe backdrop of Right to Food scheme, since it was the fundamental need.

Sustainable agriculture and growth of food production was the objective of this programme. Though one cannot criticize the objective without knowing the intention, but the approach and implementation of BGREI is not up to the mark and it needs a critical approach to analyse it.

BGREI is being driven by an aggressive use of micro-nutrients and hybrid seed of wheat and rice to raise productivity. Surprisingly, father of green revolution in India, MS Swaminathan, calls the government approach to the second Green Revolution "technocratic", with the sole emphasis on hybrid rice. "The other aspects, particularly water management, assured irrigation and soil health management are not receiving the same attention," he stressed.[76] R.S. Gopalan, director, agriculture department, Odisha, said farmers are also not very keen on hybrid paddy since hybrid seeds cannot be used for a second year.[77]

Increasing the dependence of poor adivasi, women and smallholder farmers in the Eastern States of India on external inputs including highly expensive hybrid seeds and chemicals in addition to a focus on rice and wheat alone as in the earlier Green Revolution only spells disaster in future.[78]

Alliance for Sustainable and Holistic Agriculture (ASHA) held a Farmers' Jury on the future of agricultural development and improvement of farm livelihoods in the eastern India, where instead of second green revolution, farmers had expressly asked for a Debt-Free, Poison-Free, Self-reliant, integrated and empowering agriculture to be strengthened in eastern India. Farmers also said that they don't want any Punjab in their states, where there might be an initial phase of growth but will soon end in health, environmental and economic disaster. They do not seek any such wealth from the government and reject any Green Revolution that rests on hybrid and other seeds, along with chemicals in farming. This will only increase the costs, affect their health adversely, contaminate all their resources and push them into indebtedness.

The eastern region of Uttar Pradesh in West Bengal grows several diverse crops like potatoes, pulses, spices, maize and other horticulture crops, fruits like lychee in Bihar, Mangoes are a good source of income with sustainable development, but since the BGREI promotes the mono-cropping, it creates a roadblock to diversity.

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[76] *https://www.telegraphindia.com/1120715/jsp/7days/story_15730495.jsp*

[77] *ibid*

[78] *http://www.kisanswaraj.in/tag/bgrei/*

Farmers at the Farmers Jury[79], sought Seed Independence, with access to and availability of diverse kinds of seeds and seriously believed that this focus on Rice and Wheat is inappropriate and adequate attention has to be paid to other crops like millets, pulses, oilseeds, vegetables etc. Only then can there be true food security. The intensive use of hybrid rice and wheat will require additional water resources, and this will jeopardize the water needs for living being.

ASHA also believe that any increase in allocation for BGREI would be counter-productive in the medium and long term especially, if such a Green Revolution is not expressly shaped to create debt-free, poison-free, ecological farming in Eastern India. Therefore, ASHA demanded for such funds to be utilized for integrated ecological farming to be set up on a large scale in addition to improving seed self-reliance even as productivity is increased.

Enhancement of technology is basically focused on the production growth, while post-harvesting technologies and storage facilities are somehow missing in the scheme. Due to inadequate storage facilities, farmers do not get the benefit of a higher production as they are often forced to sell their crop at less than the market price in despair. So production growth is not really benefiting the farmers, but middle men and multinational companies that buy the crops at cheap rate from farmers. Though the project seems to be taking off, concerns such as irrigation and a remunerative support price for paddy persist. Farmers, too, say they worry more about selling their paddy without any loss than about raising their production.[80]

Thus for the success of any agricultural program the focus should be on the sustainable growth, which can be achieved by the crop rotation, diversification of farming, promotion of water bodies and watersheds, decreasing the input cost by using natural manure instead of chemical fertilizers and nutrients, use of human resource instead of heavy machines, which on the one hand is harmful for environment as well as counter-productive in a country like India where the human labour is in abundance. It increases the food prices several times threatening the country's food security.

The government should not force Green Revolution in Eastern India unless there is a comprehensive evaluation, including through Kisan Panchayats organized for the purpose, to assess the benefits and harmful impacts of the earlier Green Revolution, including assessing who has benefited ultimately. This assessment would be quite valuable to evaluate what is the connection between Green Revolution (and its technologies) and the current indebtedness and suicides of farmers in India. Past mistakes from the earlier GR should not be repeated.

Therefore unless a comprehensive review of all agriculture-related policies is taken up, projects like this BGREI will not support farmers in any real manner. And secondly, unless policy level failures are addressed, farmers won't find any real progress in the country since right now most of these policies are in favour of the agro-industry and stacked-up against the farmers, especially smallholder, adivasi, women and ecological farmers.

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[79] *ibid.* [80] *https://www.telegraphindia.com/1120715/jsp/7days/story_15730495.jsp*

Appendix - 1

Major Rice Hybrid Seed Companies	
Company	Variety
J.K. Agri Genetics	JKRH-401 DRRH-3 RH-10
Dev Gen	PRH-122 (Ganga) RH-1531 (Gold)
Ganga Kaveri	GK-5003 (Rambha)
Rallis India	RIL-090
Sri Ram Fertilisers	Reshma DRRH-2
Nuziveedu	Sahadri-4 NDRH-2
Bisco-Bio Sciences	Bisco Gulab 907 Bisco Bela-911 Bisco Champa-803
Indo-American	India-200-017
Pioneer	PHB-71
Rassi Seed	RHR-111
VNR Seeds	VNR-2355+ VNR-2245
Bayer Crop Science	Arize-6129 Arize-6444
Nirmal	Sahyadri-4
Seed Works	US-312
Dhaanya	DRH-775 DRHCROH-3
Kaveri	Kaveri-9090 KPH-412
UPL Advanta	PAC-835 Pac-837
Sri Ram Bio Seeds	DRRH-2
MAHYCO	Suruchi-5401 Suruchi-5402 Suruchi-5629
Sansar Agro-Pol	Ajaya Rajalaxmi
Super Agri	SPH-115 SPH-125

Appendix - 2

CONVENTIONAL RICE SEEDS AND PLAN OF DR. RICHHARIA TO INCREASE RICE PRODUCTION IN EASTERN STATES AND OTHER REGION

A basic feature of rice cultivation is that it is grown in very different condition almost all-over India (conditions differ from field to field in a single village) and it is for this reason that over the years a great diversity of indigenous varieties have evolved, each variety being suitable for different conditions, with different qualities.

More than three decades ago, Smt. Indira Gandhi, the then Prime Minister of India asked Dr. R.C. Richharia, the distinguished rice scientist to prepare a plan for improving the rice production in the country.[81] Dr. Richharia prepared an invaluable document which still remains high relevant. However, following the sudden death of Mrs Gandhi, all interest in the plan appears to have been post in subsequent years.

Dr. Richharia had been the Director of the Central Rice Research Institute, Cuttack and the Vice Chancellor, of Agriculture University, Raipur. Dr. Richharia's repository, called the 'Raipur collection', now stored in the rice germplasm bank at the Indira Gandhi Krishi Vishwavidyalaya (IGKV) near Raipur, is the second largest such collection in the world, and first in India.[82]

The plan of Dr. Richharia needs to be revived as it offers a great potential for rice cultivation on a sustainable basis with the involvement of farmers. Dr. Richharia had identified some weaknesses of the existing official approach. According to Dr. Riccharia, "*The main constrain has been the hurried introduction of the undesirable new rice material, the HYVs (dwarfs) on which we based our strategy, replacing event he reputed high yielding varieties of the locality, forgetting at the same time unexpected drought situations, under which the HYVs lowered the yields*". In addition, under heavy fertilization and irrigation, the HYVs proved susceptible to diseases and pests which cannot be controlled easily, thus again result in reduction of yield.

Dr. Richaria's plan gives full credit to the wisdom of farmers and involves them in a bottom-up approach. This is very different from the centralised approach often seen in agricultural development and research in India. Dr. Richharia wanted his adaptive rice research model to be implemented in a decentralized manner for the conservation and development of rice varieties that would both act as a repository of public knowledge and help enhance local farming.

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[81] *Dogra, Bharat. (2013). "Rice Formula on the Back Burner", 13 October 2013, The Hindu, New Delhi.*

[82] *Krishna Kumar, Asha. (2003). The Raipur Collection, Vol. 20, Issue 02, 18-25 January 2003, Frontline, Chennai*

The adaptive rice centres will be the custodians of all local rice cultivars in respective localities. They will be known as local treasuries of rice germplasm. The function of the centres would be:

(a) To maintain the evolved rice genetic material for future studies and use as it is, practically impossible to retain it in its original form at a central place in India or abroad. It can be maintained in its original conditions at its natural habitat only seeking help of the rice growers themselves,

(b) To educate the young farmers to appreciate the value and importance of their own material,

(c) Rice growers in general stick to cultivate their own indigenous rice varieties. Indigenous seeds would be distributed from the centres in small quantities and the farmers would be explained how to multiply them rapidly by clonal propagating method which would be demonstrated to them at the centre.

The plan recommended by Dr. Richharia is highly eco-friendly as it emphasis on the existence of indigenous seed varieties which can give high production without any chemical fertilisers and pesticides.

Focus on the Global South

Focus on the Global South is a policy research organisation based in Asia (Thailand, Philippines and India). Focus provides support to social movements and communities in India and the Global South by providing research and analysis on the political economy of globalisation and on the key institutions underlying this process. Focus' goals are the dismantling of oppressive economic and political structures and institutions, the creation of liberating structures and institutions, demilitarization, and the promotion of peace.

Rosa Luxemburg Stiftung (RLS)

The Rosa Luxemburg Stiftung (RLS) is a Germany-based foundation working in South Asia as in other parts of the world on the subjects of critical social analysis and civic education. It promotes a sovereign, socialist, secular and democratic social order, and aims to present alternative approaches to society and decision-makers. Research organisations, groups for self-emancipation and social activists are supported in their initiatives to develop models which have the potential to deliver greater social and economic justice.