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Bringing Green Revluation in eastern india

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Food Sovereignty and Small Scale Agriculture in India

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Food Sovereignty and Small Scale Agriculture in India

India is a global agricultural powerhouse. It is one of the world's largest producer of milk, pulses, and spices, and has the world's largest cattle herd (buffaloes), as well as the largest area under wheat, rice and cotton. It is the second largest producer of rice, wheat, cotton, sugarcane, farmed fish, sheep & goat meat, fruit, vegetables and tea. The country has some 195 m ha under cultivation of which some 63 percent are rainfed (roughly 125m ha) while 37 percent are irrigated (70m ha). In addition, forests cover some 65m ha of India's land.

The 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 dependant on their livelihoods on farm activity – be it crop agriculture, horticulture, animal husbandry or fisheries. The expansion of income opportunities in the farm sector and a progressive absorption into non-agricultural activity is the most potent weapon for reducing poverty.

About half of our population is either wholly or significantly dependant for their livelihoods on some form of farm activity. With low levels of infrastructure and human development, and in a context replete with inequalities and uncertainty, rural India views its future transformation with both hope and trepidation. Expansion of farm incomes is still the most potent weapon for reducing poverty. Non-farm income opportunities such as post-harvest operations, maintenance of farm equipment, etc. – offer a virtuous cycle connecting expansion of farm activity to that of rural non-farm income opportunities.

While agriculture's share in India's economy has progressively declined to less than 15% due to the high growth rates of the industrial and services sectors, the sector's importance in India's economic and social fabric goes well beyond this indicator. First, nearly three-quarters of India's families depend on rural incomes. Second, the majority of India's poor (some 770 million people or about 70 percent) are found in rural areas. And third, India's food security depends on producing cereal crops, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes. To do so, a productive, competitive, diversified and sustainable agricultural sector will need to emerge at an accelerated pace.

Although, according to government reports, incomes have increased and rural poverty has reduced over the years, the gap between urban and rural incomes has widened quite sharply because agriculture has grown slower than other sectors and because employment growth in non-agriculture has not been enough to sufficiently reduce the population dependent on agriculture. Productivity gains from the Green Revolution reached a plateau by the Eighth Plan end, causing per capita food grain production to decline thereafter. Agriculture did diversify

towards horticulture, animal husbandry and non-food crops, but agricultural GDP growth averaged only 1.9 per cent during 1997-98 to 2004-05. Farm incomes increased even less since terms of trade turned against agriculture during this period, indicating inadequate demand and lack of rural purchasing power.

The challenge is how to feed India's growing population with rising incomes, but limited land and water resources. The economy is expected to grow strongly and, as the latest NSSO survey data for 2009- 10 on household expenditure reveals, an average household still spends nearly half of its expenditure on food and food products. Thus, pressure on food demand is likely to remain strong over the Twelfth Plan period while consumption is likely to be more diversified as cereals now account for only 15.0 per cent of the total consumption expenditure.

The food consumption basket is getting increasingly diversified and though cereals still dominate, this dominance is being increasingly eroded by rising expenditure on fruit, vegetables, milk, eggs, meat and fish which together is sometimes referred to as the 'high value' segment. This transformation of the Indian food consumption basket is in-line with expectations. 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.

Issues of food security have moved to the forefront of international discussions in recent years and in this context, the question is sometimes asked whether India will be able to feed herself or become dependent on food imports. The fact is that we have been a net exporter of cereals for most years since 1990. In 2010-11, despite bans on export of wheat and non-basmati rice, India 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. The key to ensuring long-run food security lies in targeting cereals productivity to increase significantly faster than the growth in population, so that adequate land becomes available for other agricultural use.

However, the government has focused as a matter of national priority from view of both food security and sustainability is to fully extend the green revolution to areas of low productivity in the Eastern Region where there is ample ground water. Bringing Green Revolution in the Eastern India (BGREI) has been introduced as a sub scheme of RKVY from 2010-11.According to government, this should be supplemented by investment in infrastructure, particularly in power, logistics and marketing.

What is a Green Revolution?

The Green Revolution is a term employed to describe the worldwide shift of farming that led to significant increases in agricultural production between the 1940s and 1960s. The term "Green Revolution" was first used in 1968 by former United states Agency for International Development (USAID) Director William Gaud, who noted the spread of the new technologies.

The initiatives, led by Norman Borlaug, the "Father of the Green revolution", involved the development of high-yielding varieties of cereal grains, expansion of irrigation infrastructure, modernization of management techniques, distribution of hybridized seeds, synthetic fertilizers, and pesticides to farmers.

Green Revolution in India

India was the second country which introduced the Green Revolution. The Punjab, Uttar Pradesh and West Bengal were the first three States in which the idea of Green Revolution was firstly introduced. The focus of the Green revolution in India was mainly on the package of three products; High yielding variety seeds (basically wheat and rice), pesticides and fertilizers. Double cropping was also introduced as a main feature of green revolution in India, since India was traditionally a single crop farming country. The fact that the Indian agricultural system was mainly dependent on monsoon for irrigation, one crop per year was quite natural.

Thus, to introduce the two crop system in a year had to have two monsoons in a year, one is natural and the other is artificial monsoon (basically depend on the ground water), which resulted in ground water depletion. Use of excessive pesticides to get the higher production of agricultural product also contaminated and polluted the ground water. The focus on high yield crop (wheat and rice) destroyed the diversity of crop like millets and other crops which have sufficient amount of protein and fibers.

Impact of Green Revolution in India

The Green Revolution, howsoever impressive, has increased the food stock (wheat and rice) of India several times since its introduction till date, however, not succeeded in making India totally and permanently self-sufficient in required food content for human being. Even today India sometimes suffers from shortfall of the essential food product other than wheat and rice. Several times India has to export onions and sugar. In 1998, 2006 and 2014 India had to import onions for domestic consumption. In 2006, India imported sugar, since there was shortage of sugar in domestic market. Although there was an increase in rice production from 292,000 metric tons to 3,228,000 metric tons and in wheat production from 1,916,000 to 7,694,000 metric tons between 1965 and 1980, India is still not self sufficient. During the

same time production of pulses and oil seed has been decreased, which is the main source of protein and fat in India. In 1979 and 1987, India faced severe drought conditions due to poor monsoon; this raised questions about whether the Green Revolution was really a long-term achievement.

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
C. 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 (m.bls)	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	21.20	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.

The above government data shows the rapid growth in production of cereals like wheat , rice and sugarcane, apart from this, we can see there is very less significant growth in production of Pulses and oil seeds, which is 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 provides 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 Agri	Public GCF i	Private (GCF)	% share (GCF)	
				Public	Private
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(Q)	6961	1268	5693	18.2	81.8
1996-97(Q)	6999	1132	5867	16.2	83.8

Q: Quick estimates; GCF: Gross Capital Formation; GFCF; Source: CSO, National Accounts Statistics, Various Issues.

However, the Table 1 shows the production report, that how the growth of food grain increased during the period of time, from 1950- 1960 and in the decade of 1960s after the implementation of Green revolution in Punjab, Haryana and western Uttar Pradesh. From 1970s to 1997, there is a steep increase production of food grains (cereals- wheat, rice. If we analyze the table 2, we can see the agricultural investment data from 1991 to 1997, that the public investment has gradually decreasing and private investment is increasing at the same rate. This data clearly shows that, even after the claim of heavy subsidy on agricultural product, such as fertilizers, pesticide and other agricultural instrument, government share in agriculture is decreasing and farmers has to invest more in order to achieve the target production of government.

After the liberalization of economy in 1991, government always claims the burden of subsidies on agriculture, however, in small date from 1991 to 1997, clearly reflects the government's role in promotion of green revolution, that they decreased the expenditure in agriculture from 21.2 percent in 1991 to 16.2 in 1997.

Table 3

Eighth Plan Targets and Production Performance of Crop (In Million Tonnes/Million Bales of 170 Kg.each of Cotton)						
Crop	8th Plan Targets	1992-93 Achiev.	1993-94 Achiev.	1994-95 Achiev.	1995-96 Achiev	1996-97 Achiev.
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
C. 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/Ministry of Agriculture.

As we discussed the investment of government and private investment in agriculture as well as the production of food grains. As we compare the production from 1950 to 1990, we can see the significant and positive changes but if we compare the recent available data from 1991 to 1997 , we find that it never achieved the targeted production , in some years it has been decreased, even the full support of government in Green Revolution technology. In case of rice production, according to 8th Plan target it must be 88 million tones production, but it never reached near to that. In year 1994-95 it reached at 81.81 million tones but very next year it went down to 76.98 million tones, however, it became successful to reach at 1994-95 production in next year, but it was merely a cover up, not an increase in production.

In the same pattern, wheat, pulses, oil seeds, sugarcane and cotton never achieved their target, but sometimes production got down from previous years. Even if we consider the climate condition and market condition, there is stagnation in crop production after 1991.

Now the stagnation of production of food grains bother he government to reconsider the policy of Green Revolution, however, central government has not accessed the situation clearly and now they are bringing the Green Revolution in Eastern India to promote the production of food

grains. Green revolution has never the option for other than food grains, which is essential for basic nutrition. Modern technology and Green Revolution has brought some major concern in environment and agriculture in Eastern India.

Impact on diversity of Crops

Since the beginning of the history of farming in India, generation to generation, Indian farmers persistently modify and adapted the various genetic varieties of crops available to them from nature. The diversity of crops is neither purely natural nor accidental. 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 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). 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.

Due to the green revolution in North India, several species are replaced by specific species. In other words, Inter cropping is replaced by monocroping. The profit became the primary focus in crop selection instead of extensive diversity of local species of crops. In this process, the great genetic diversity of crops has been replaced by a narrow genetic range of crops. Local varieties of rice plant are replaced by new rice plant known as IR8, which has 3-4 time more production per hectare. The majority of indigenous crop variety is no longer growing, which have a special tendency to survive in adverse conditions due to low production.

The constancy of a bio-diverse agriculture is possibly its most important characteristic, as

recorded from many regions of the globe. This is marvelously exemplified by a formerly-common pattern of the Garhwal Himalaya, the baronage. Literally meaning "12 grains", this exercise involves the sowing of a mixing of crops into a single plot of earth. Kidney beans, black gram, green gram, horse gram, Amaranthus, finger millet, barnyard millet, and other crops are raised in a way which aids to obtain optimal and sustained production. Since maturity periods of these crops vary, different crops are harvested at different times, helping to retain soil moisture, and furnishing a ceaseless provision of nutrient. The birth rate is continuously recharged by the use of leguminous plants like pulses. Agreeing to some assessments, baronage gives a higher overall productivity (apart from meeting various needs) than if the area was to be changed into a soybean monoculture, which is being propagated by agricultural authorities in the area.

Impact of mechanization

In general terms, mechanization is equated with the modernization, most of the developing countries. In the field of farming, the perception is same in India. Without analyzing the impact of mechanization of agriculture, we have followed the western countries, 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 the high risk involved modern agricultural structure.

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. Many very poor farmers, were tenants, for them use of heavy machine and the seeds and fertilizers which is required was not possible.

Rapid increase in mechanization lead to the increase in unemployment in several areas, since a very less number of people are required to operate the machine, for example use of tractors

significantly decreased involvement of people in agricultural activities. The result of the mechanization come with heavy unemployment in rural areas and migration from rural to urban establishment, where there is no alternative plan to induct these migrant laborers (which were basically the traditional farmers), causing new problems in big cities and other urban settlement.

Many small farmers tried to adapt the new technologies and heavy machines are heavily in debt, with no proper mechanism to return the debt in easy way, leading them into high stress and in some cases suicides (very frequent in Maharashtra, Punjab).

New technology therefore disturbs the equilibrium of the receiving environment 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.

Impact on Water

The green revolution initially focused on the high yielding variety of crops which required more water than torsional indigenous crop varieties (especially High Yielding variety of rice). To meet this requirement, new irrigation schemes were implemented. New irrigation policy was comparatively expensive as well as inappropriate irrigation schemes turned into the problem of salinisation of water. To fulfill 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 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 serious problem, which not only destroy the cultivation land but also generates the serious ecological problems. The Indira Gandhi canal can be one of the best examples in which water logging became a multidimensional problem. In the district of Jaislmer, Ganga

After the flood condition near Patna

Nagar and Bikaner in Rajasthan, 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, on the other hand intensive irrigation of these crops generated soil depletion and water logging problems.

Presently, water resources are scarce and expensive in India. Large farms benefit because they can afford canal irrigation, whereas small farmers need to resort to taking out loans with high interest rates to irrigate their fields.

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 egregious 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 50cm 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.

Thus the valuable resource of ecology, underground water becames vulnerable, water level is rapidly going down where irrigation is based on ground water. In some areas of Punjab and Uttar Pradesh, water level has gone 4 to 6 feet down. 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 ground water irrigation to HYV of crops. Though, the challenge is that, if it continues like that, like if tube well water supply continues for the irrigation of crops like rice and vegetable, it is invertible to maintain the underground water level. And the major apprehension is that, if excessive use of ground water continues like that, it would be impossible to recharge the ground water level.

On the other hand, areas where canal system is well connected and extensively used to irrigate the crops, underground level is rising. Which is also not good for the soil, since the rise of underground water results into capillary action, heavy evaporation of water through capillaries makes the soil saline and alkaline, which affects the quality of soil and vegetation.

Impact on Health

The implementation of the Green revolution, led to the High Yielding variety of wheat and rice and as we discussed before these HYV crops need large amounts of water for irrigation,

adequate amount of chemical fertilizers and other crop protection chemicals. Adequate Water and fertilizer, which is necessary for fast growth of HYV is highly suitable for the growth of Insects and pests also. Now, these insects and pests are controlled by crop protection chemicals like insecticides and pesticides. Use of insecticides, fungicides and pesticides on vegetables and cereals, on the one hand increases the production and on the other hand are undoubtedly injurious to health.

Plant protection chemicals are artificially produced compounds to increase the production of beneficial crop by eliminating the harmful weeds. These chemicals are poisonous and harmful to human being and animals. However, to increase the production and profit these chemicals are very largely 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.

The major health hazard is caused by the contaminated food and polluted water in India. Uses of toxic chemicals, such as gano-chlorine, gamyxicne and DDT had major effects on human being 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.

In order to overcome the problem of food security, new poisonous chemicals are introduced which bring more changes and pollute the environment. On the one hand, insecticides and pesticides are polluting water and on the other hand other harmful chemicals are polluting air, which causes serious health hazards and increases the number of cancer, asthma and breathing problems.

The recurrence of malaria in the states of Punjab, Haryana and Uttar Pradesh is also being attributed to the moist condition of the field throughout the year. The moist fields and high temperatures are the ideal breeding grounds for mosquitoes. Every year, an increasing number of malaria cases are reported in the areas of the Green Revolution.

The Green Revolution came about as a means to present a solution to resource and food scarcity. However, physicist and ecological activist Vandana Shiva believe that this solution led to the "ecological breakdown in nature and the political breakdown of society [as] consequences of a policy based on tearing apart both nature and society" (quoted in Shiva 1993: 24).

The adoption of HYV has thus brought environmental changes which are detrimental to the soil fertility to environmental sustainability and injurious to health. The reduction in biodiversity in the areas of Green revolution may have long term serious ecological consequence. The ecological cost of agricultural development in India is thus quite high and the new seeds of staple foods are resulting into new socioeconomic and environmental problems.

Green Revolution in Eastern India

In spite of the success of the green revolution in terms of food grain production, it remains mainly limited to food grains only, not all kinds of agricultural products. In regional terms, only the states of Haryana and Punjab have shown the significant results in food grain 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 severalproblems; mainly it affects the labour and work dynamics, which led to the mass migration towards the metropolitan and other big cities, due to heavy mechanization of Agriculture, 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 rise in the salinity of the land. Although high yielding varieties had their plus points, it has 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

Orissa and Bihar is the lowest of any Indian state, since, still most of the farmers are stick to the traditional farming and use the traditional practices to cultivate the crop as well as to fulfill their bascic needs without depending on the market. The cumulative result of these factors is low productivity and near stagnation or marginal growth in agriculture sector during the recent years. Average farm size, irrigation coverage, average fertilizer consumption and power consumption in agriculture are all below the national average. Average fertilizer consumption in Orissa is lowest of any Indian state.. The data in the chart clearly shows the average size of operational holding in Bihar and U.P is very low in comparison to all India average, which is 1.6 and in Bihar, it is 0.9 and in U.P it is 0.39. in this small land holding, use of machines and technology becomes more costly than traditional method of farming.

Agricultural Indications in Eastern States (Mid-1990s)						
Indicators	Unit	All India	Orissa	Bihar	Chhatisgarh	U.P.
Average size of operational holding	Ha	1.6	1.3	0.9	2.6	0.39
Marginal holdings as a % of total	%	59.0	53.6	76.6	37.3	73.8
Net irrigated area as a % of net sown are	%	35.1	32.8	46.7	24.4	65.6
Fertilizer consumption	Kg/ha	74.8	25.2	77.0	34.7	101.4
Power consumption in agriculture	KWH/'000 ha	379	35	142	228	351
Yield of food grains	kg/ha	1547	1250	1480	1080	1920
Rice production as % of good grais	%	42.8	93.5	52.5	25.8	29.1

Source : CMIE, Profile of states for various years : Economic Survey and Agricultural Statistics at a glance, Govt. of India.

To increase the production, in the wave of the Green revolution, on the one hand farmers increased the use of fertilizers, on the other hand for high yielding variety it was necessary too. In the above chart, it is clearly showing that Bihar and U.P consuming 77.0 Kg/Ha and 101.4 Kg/ha respectively, which is again above of national average 74.8 kg/ha.

Climatic and soil conditions of the state are congenial for productionof different types of vegetables in the state. However, it lacks the basic infrastructure for storage,packaging,

transportation, organized marketing system and post harvest handling facilities. Seedthe most important input which influences the output of vegetables crops. Even then, acoording 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 depends 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.

If we compare these states with Punjab and Haryana, which is most affected by the first green revolution, we can find a clear data of low production of vegetables and nowhere stands even in top 10 producers at the same time west Bengal produces (25466.8MT) vegetables and leads in the list, Uttar Parades with (19571.6 MT) is the second producer, third is Bihar (16325.7MT), and this amount is produced without any help of government and State policy. These producer or farmers are basically dependent on the traditional method their input cost is very low, so to grow the seasonal vegetable they don't need any heavy investment, they procure their seeds from previous crop and use it in next season. Since these are seasonal vegetables, they don't need much water, rain water or climate moisture is enough for growing these vegetables.

This method of agriculture also provides a social stability as well as fulfills 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 make the farmers less vulnerable towards the crop failure. Unlike the farmers of Punjab and Maharashtra where the input cost is very high, farmers use to take 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 production of Spices these states are ahead of Punjab, Haryana and Maharashtra. Uttar Pradesh is the one of the largest producer of the mustered oil, Biharis the second largest producer of mustard oil, and Andhra Pradesh is on the third position. We know, mustard oil is one of the most favorite cooking oil and bascic 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. 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 9 and 1th place respectively. We all know the medicinal value of turmeric and their use as spices. 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 placed as 5th largest producer and Bihar 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. Chilly is one the most common spices in India.

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 percent of the area under spices and 39.5 per cent of the production followed by turmeric, which occupies 26.3 per cent of the area under spices and accounts for 36.4 per cent of the production in the state.

Basic difference between modern and traditional Agriculture

Farming has enabled human populations to dominate the world's landscapes for many thousands of years. The science of agriculture has been refined and perfected over time to accommodate for the ever-increasing human population. Until recent centuries, productive crops were mostly organic and existed with some permanence as part of a landscape. As communities grow though, less and less land is available for food production and existing crops become easily exhausted. Food insecurity caused by rapid population growth has pressured science to step in and produce many synthetic chemicals and gene manipulation techniques to maximize the potential of plants. In addition, agricultural production has increased tremendously worldwide over the last century. Coupled with this growth however is the pollution and degradation of the natural environment. Many agricultural techniques exist today, but in an effort to adjust to the exponential trends of our population without compromising the integrity of the environment and society it is necessary to have a global transition towards sustainable and traditional farming. With the current population at seven billion and rising, an important question must be addressed: What is the most sustainable and cost effective way to feed the world's population? Fortunately, humans have been perfecting agricultural methods for thousands of years, which can help to answer this question.

We can analyze and compare two types of farming, traditional or conventional and modern or mechanical farming. In a comparison of agricultural method, the goal is to assess the impact and performance of each practice and then identify the best method for growing crops. Although there are many types of agricultural practices, they can be generalized as sustainable or conventional based on the techniques used. Sustainable farming aims to produce a number of crops, without the use of synthetic chemicals or fertilizers, while enhancing soil composition and promoting biodiversity. This is a traditional, more permanent type of farming that relies on ecosystem services to maintain the integrity of the landscape while still producing

sufficient yields. Modern farming after introduction of green revolution in India, promotes the uses synthetic chemicals and fertilizers to maximize the yield of a particular crop or set of crops, which are typically genetically modified. This method requires a significant amount of chemical and energy input and weakens the ecology of a landscape. In a comparative analysis of these two techniques, it is important to highlight the fact that the crops studied differed in soil composition, geography, and rotation systems. "To carry on extensive long-term trials for a number of crops in several different geographical areas would be of fundamental importance to understand the potential of traditional farming as well as to improve farming techniques in general." Due to the many different factors determining crop health and productivity, there is a need for much more extensive research on the subject.

Techniques such as irrigation, intercropping, and crop rotation have progressively increased efficiency in agriculture. Over the last few centuries however, radical changes have been made in farming and many countries have made a shift toward conventional methods. Factors such as growing populations, economic instability, climate change, and pressures from companies to produce higher yields have contributed to this shift. However, adopting these conventional methods subjects farmers to the greed of industry, as their crops depend on a high input of energy, synthetic chemicals, and genetically modified organisms. And once committed to the conventional practices, farmers find themselves locked in a perpetual cycle of loans, subsidies, and debt.

I. Modern Agriculture

Modern agriculture under the green revolution is a broad term that has a number of definitions, but a crop can be classified as conventional if synthetic chemicals are used to maintain the plants. A significant amount of chemical and energy input is required in modern agriculture to produce the highest possible yield of crops. This method usually alters the natural environment, deteriorates soil quality, and eliminates biodiversity. Modern agriculture was developed to make farming more efficient, but achieves that efficiency at a major cost to the environment.

The goal of modern agriculture is to maximize the potential yield of crops. This is achieved through the application of synthetic chemicals, genetically modified organisms, and a number of other industrial products. In maintaining a conventional system, biodiversity, soil fertility, and ecosystems health are compromised. Production of these crops is beneficial to nothing but food security and economy. Once established, a green revolution technology of farming requires constant maintenance but produces maximal yields.

Maintenance is made easy for farmers as modern farming typically involves monocropping, but is also very expensive. In a modern system farmers will designate entire fields to just one

crop, which creates uniformity. Uniformity can determine both the success and failure of conventional systems. A uniform crop is ideal because it reduces labor costs and makes harvesting easy, but it can also impact biodiversity and make crops susceptible to pathogens. Chemicals and genetically modified organisms make maintenance of modern systems relatively simple for farmers, but require a constant input of energy and money. In a modern system, farmers can apply pesticides and herbicides to crops at a much more efficient rate if they are made up of just one type of plant, but this has a number of unintended consequences. Since the goal of conventional agriculture is to maximize yields, environmental health and biodiversity are usually not preserved.

II. Sustainable or traditional Agriculture

Where modern farming represents one extreme of agriculture, sustainable or traditional farming represents the other. "traditional agriculture in India is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. Sustainable agriculture is a more holistic approach to farming than modern (technology based) in that it relies on ecosystem services and is typically much less detrimental to the surrounding landscape. Sustainable agriculture is a natural way to produce food and has a number of social, economic, and environmental benefits.

There are many types of sustainable farming that all rely on natural cycles to ensure plant health and crop performance. In India and especially in eastern India, farming forgoes the use of synthetic pesticides, herbicides, and fertilizers to produce food from centuries. Instead, farmers plant a variety of plants together to promote biodiversity and ward off pests and pathogens. Where conventional systems promote uniformity and depend on synthetic chemicals for protection against disease and pests, sustainable systems rely on biodiversity as a measure to protect against these things.

Sustainable agriculture profits farmers, economies, and food banks while existing symbiotically with the landscape. One example of many in sustainable farming practices, which emphasizes economic benefits and environmental health, is conservation agriculture. By increasing soil organic matter contents and moisture-holding capacity. Conservation agriculture can double subsistence crop yields in areas where use of fertilizers is uneconomic and it can sustain production in years with low rainfall. Conservation agriculture underlines the focus of sustainable agriculture in that it focuses on producing high yields without compromising the integrity of the environment.

III. A Comparison of Agriculture

In a comparison of modern and sustainable agriculture there should be several points of focus: production, biodiversity, soil composition / erosion, water use, energy use, and greenhouse gas emissions. The environmental impact and production levels of each method will determine its overall viability as a solution to growing trends. It is necessary to make these comparisons in order to identify the best agricultural method that can sustainably meet the needs of the current population. Although these comparisons are based off of scientific data, there is much more research that needs to be done in order to make a definitive judgment.

To meet the needs of the current population requires a tremendous amount of resources. Not taking into account the environmental damage associated with intense production, modern agriculture is a feasible way to provide for more people. In addressing this rapid growth, production levels become a serious point of comparison. According to studies, Organic yields are globally on average 25% lower than modern yields according to a recent meta-analysis, although this varies with crop types and species and depends on the comparability of farming systems. Most research indicates that sustainable crops produce much less than modern agriculture systems.

However, there are many environmental benefits associated with sustainable or traditional agriculture, but its production capacity is limited. In general, traditional or sustainable agriculture fails to match up to conventional agriculture in terms of production. This result varies though, and in some instances traditional crops actually beat conventional crops(the model is Kedia village of Bihar, where with help of Green Peace Organization, villagers invented traditional method to increase the growth of production). For example, under drought conditions traditional crops tend to produce higher yields because they typically retain more water; "As part of the Rodale Institute Farming System Trial (from 1981 to 2002), found that during 1999, a year of extreme drought, (with total rainfall between April and August of 224 mm, compared with an average of 500 mm) the organic animal system had significantly higher corn yield (1,511 kg per ha) than either organic legume (412 kg per ha) or the conventional (1,100 kg per ha)

Although, modern agriculture is designed to produce the highest yields possible, however, certain the environment and social conditions favor the traditional crops.

Many factors contribute to this difference in production. Modern crops are designed specifically to produce maximal yields; therefore, the difference should be expected. Typically modern crops are genetically modified to perform better under certain conditions than sustainable crops However, these crops are also sprayed with toxic pesticides and herbicides to make up for their uniformity. Some research has been done to determine whether increased

biodiversity is related to increased yields; farmland biodiversity is typically negatively related to crop yield; generally, organic farming per se does not have an effect other than via reducing yields and therefore increasing biodiversity. Although levels of production are reduced in sustainable agriculture, studies show that higher levels of biodiversity are linked to healthier crops.

Biodiversity plays a large part in this comparison because it is a determinant of agricultural health and performance. The greater the biodiversity, the more immune plants are to pests and disease This is important to highlight because modern agriculture discourages biodiversity and instead relies on synthetic chemicals to maintain crop health. Over 940 million pounds of pesticides are being applied annually with only 10% of that reaching the desired target, a number that could be greatly reduced if conventional agriculture were to implement sustainable alternatives .Techniques such as integrated pest management and intercropping could be applied to conventional systems and in turn promote biodiversity.

High biodiversity is important to sustainable farming because it enhances the performance of the ecological cycles that the crops depend upon. Traditional agricultural systems are typically much more rich in nutrients and diverse in organisms in eastern India than newly introduced modern systems. Traditional farming in eastern India is usually associated with a significantly higher level of biological activity, represented by bacteria, fungi, springtails, mites and earthworms, due to its versatile crop rotations, reduced applications of nutrients, and the ban on pesticides. It is important to encourage high nutrient levels and biodiversity as these two factors contribute significantly to the health of the crops and the landscape. Although biodiversity does not directly determine crop yield, it does play a major role in the health and permanence of sustainable farms.

The global impact agriculture has can be significantly reduced if modern farmers adopt sustainable techniques.

In addition to higher levels of biodiversity, sustainable farming is typically associated with better soil quality. Traditional farms have stronger soil ecology because they promote biodiversity rather than uniformity;The results confirm that higher levels of total and organic Carbon, total Nitrogen and soluble organic Carbon are observed in all of the organic soil. The increased concentrations of these nutrients can be contributed to the depth of the food web and amount of biomass in sustainable systems. Sustainable crops are more permanent than modern crops because they work in harmony with the landscape rather than drain it of nutrients and biomass.

Soil management is vital for existing farms because agricultural production is increasing globally and land is becoming less available to accommodate this growth. Modern systems can improve soil quality by practicing sustainable methods like no-tillage farming,

agroforestry, and integrated pest management, but sustainable agriculture is the most effective form of food production in terms of maintaining soil conditions. Establishing trees on agricultural land can help to mitigate many of the negative impacts of agriculture, for example by regulating soil, water and air quality, supporting biodiversity, reducing inputs by natural regulation of pests and more efficient nutrient cycling, and by modifying local and global climates. Again, research shows that an increase in biodiversity and a reduction of chemical input can result in conventional farms with more healthy soils and improved crop performance.

Soil degradation due to heavy use of synthetic fertilizers and pesticide

A major problem concerning agriculture is soil erosion caused by nutrient loss, run-off, salinity, and drought. Soil erosion presents a threat to the growth of agriculture because, Intensive farming exacerbates these phenomena, which are threatening the future sustainability of crop production on a global scale, especially under extreme climatic events such as droughts. Traditional method of farming enhance soil composition as well as prevent soil erosion due to the greater amount of plant material and biomass in the soil. Modern agriculture systems manipulate the landscape rather than adapt to it, while in conventional soil a rate of soil loss three times the maximum tolerance value was recorded

Compared to traditional or sustainable farming, modern crops are terribly inefficient at maintaining the integrity of agricultural landscapes. Modern agriculture is therefore unable meet the demands of the growing populations without consuming a substantial amount of land and non-renewable resources.

On a global scale, water is a renewable resource that can meet the needs of our current population. Locally, however, water is a scarce resource and must be appropriated efficiently. The amount of fresh water available for consumption globally is small, but regional constraints make accessing that water even more difficult for many millions of people. To conserve this resource a drastic overhaul of water saving techniques, especially in agriculture, must occur. In most of the region of eastern UP, Bihar and several parts of Jharkhand water level is decreasing

rapidly, in case of West Bengal the situation is not that alarming but still some indicators show the situation considerable.

Due to the abundance of flora and fauna in sustainable systems, traditional agriculture soil typically retains much more water than modern agriculture soil. This increased retention rate enables sustainable agricultural systems to produce much higher yields than modern systems during drought conditions. This is a desirable characteristic in agricultural land as it allows crops to be more tolerable to changing climate. In heavy loess soils in a temperate climate in Jharkhand , water holding capacity was reported being 20 to 40% higher in organically managed soils than in modern ones. The primary reason for higher yield in organic crops is thought to be due to the higher water-holding capacity of the soils under organic management. To manage available water resources, sustainable agriculture is the more efficient approach to feeding the world.

A gap exists between current production rates and potential production rates of crops. Through better management of water and soil, much greater yields can be produced. Increasing efficiency to 100% is not entirely feasible, but implementing sustainable traditional farming techniques would conserve resources and improve crop performance. Meeting future food demands is a dynamic problem that requires consideration of all things, but most importantly water and soil conservation.

Sustainable traditional agriculture relies solely on natural processes for input and recycles nutrients on-site to eliminate the use of non-renewable resources. Alternatively, modern agriculture requires an incredible amount of energy to produce, prepare, and transport food. Energy efficiency is important to agriculture as it can reduce greenhouse gas emissions and lower costs of production; "Agricultural activities (not including forest conversion) account for approximately 5% of anthropogenic emissions of CO2 and the 10–12% of total global anthropogenic emissions of GHGs (5.1 to 6.1 Gt CO2 eq. yr−1 in 2005), accounting for nearly all the anthropogenic methane and one to two thirds of all anthropogenic nitrous oxide emissions are due to agricultural activities. Agriculture is responsible for a significant percentage of greenhouse gas emissions, but can also mitigate this impact using sustainable methods. Traditional method of management of agricultural land is used to reduce the effects of crop production.

Sustainable traditional agriculture has the ability to offset global greenhouse emissions at a greater rate than conventional agriculture because it is more permanent and does not require much input to produce food. Modern systems are inefficient at capturing carbon because of soil composition, constant production, and how much energy is being used to maintain the crops. "We use so much machinery, pesticides, irrigation, processing, and transportation that

for every calorie that comes to the table, 10 calories or energy have been expended. However, there are measures that can be taken to increase energy efficiency. "This carbon can be stored in soil by SOM and by aboveground biomass through processes such as adopting rotations with cover crops and green manures to increase SOM, agroforestry, and conservation-tillage systems. Modern agriculture operates at a net energy loss, but implementing sustainable practices can reduce costs and benefit the surrounding landscape.

Sustainable traditional agriculture aims to enhance the composition of a landscape while producing sufficient yields. This method is so efficient compared to modern agriculture because it requires no input of synthetic chemicals or fertilizers, which accounts for a large amount of the greenhouse gas emissions. However, energy efficiency also takes into account the ratio of input to output. In that sense, there is no substantial difference between the two types of agriculture; the energy efficiency, calculated as the yield divided by the energy use, was generally higher in the organic system than in the modern system, but the yields were also lower. This meant that modern crop production had the highest net energy production, whereas organic crop production had the highest energy efficiency. Even though modern agriculture systems produce greater yields than sustainable systems, organic crop production is the most energy efficient method.

Most of the government oversee only the data of production out put and Punjab ,Haryana and Western Uttar Parades has became the role model of their planning to bring green revolution in eastern India. However, some of the precaution has been taken by few government but they are also promoting the market oriented farming, which is not only disastrous fro environment but also affect the live of farmers and common people.

States like Bihar ahs say no to GM crops but allowed the HYV of seeds and competing with Punjab and Haryana in wheat production, which is not feasible, since Bihar ahs different type of land, suitable for rice production and vegetable crop. Since Bihar is flood and drought prone area, new and uncertain climate make it more vulnerable for crops, HYV crops merely sustain in such climate. At the same time various traditional seed have the capacity to survive in extreme weather, though the production is low but at least produce a sufficient amount of crop to survive. Bihar government is also promoting the new players in the field of agriculture, such as providing subsides on machine and other technologies. Several companies on the name of agriculture development are getting money from governments plan and providing a heavy cost support to the farmers. And most of the small farmers never get any support from the government's policy.

The West Bengal government is also against the GM crop but as similar to Biahr government focusing on the HYV crops. Although the water management and distribution is better than

Bihar and Uttar Pradesh, new variety of seeds required more and more fertilizers, pesticide, herbicides and fungicides. However, these varieties of seeds and crops have low resistant to new type of pest or insects. In two three years, most of the insects develop the immune system and resistance towards the pesticides and insecticides, which cause a huge loss of crop.

Jharkhand government is promoting the all the new technologies in the name of green revolution. Although, Jharkhand is predominantly tribal area, and tribal have their own knowledge based agriculture activities, have not impacted much. However, the migrant from Bihar and west Bengal, those are newly settled in Jharkhand are involved in new type f agriculture. Many beurocrates and government employee has started the modern agriculture with the collaboration of multinational companies. West Bengal ahs the highest number of verities of rice, and quality has also variation. Introduction of HYV has reduced it from almost 3000 to 400-500 varities.

Tribal used to do jhoom farming; they are eco friendly and never grow the crops for surplus and market purpose. They only grow the crops for their food requirements and rotate the land for cultivation, which provides land a ample time to rejunvate their fertility and productivity. Sustainability is the basic criterion of Jharkhand local people, whether it is environment or the society. Variety is another positive point in Jharkhand agriculture, from cereals to fruits, spices, vegetable and medicines all are available in local production, without destroying the environment as well as social fabric.

However, government is implementing their own agenda, to focus on the few things which have their own market value and replacing the other variety of crop which has low market value. Several local fruits and vegetables, which had rich nutrient value is about to instinct since, farmers are attracted towards the popular fruits and vegetables. If it happens, it will demolish the entire ecosystem as well as it will gravely impact the society.

Major Problem with BGREI (Bringing Green Revolution In India)

The Green Revolution was initiated in India in the 1960s' to increase food production and feed the millions of malnourished people throughout the nation. It has been credited with increasing yields in many of the places where the technology has been adopted, but the benefits experienced have been unequal across regions and groups.

Emphasis has been placed on Bihar and Jharkhand, the adverse recipients of the Green Revolution technologies. Being, one of the most populous region in the India, it is important to understand how farmers are affected since they are responsible for feeding the exceedingly large and growing population of the eastern part of India. There are many people in India who live in extreme poverty and suffer from malnutrition and understanding how to increase

agricultural productivity and yield in a way that benefits all farmers is very important. The decades since the dawn of the Green Revolution in India have revealed large disparities in the overall benefits to farmers in India and specially gangetic plain of eastern India.

Distribution and practical application of Green Revolution strategies have been uneven geographically as well as across socio-economic classes. Ancient property relations across the state have affected present land holdings as has the role of the government in the different states to support agrarian activity. Geographical distribution issues can be broken down further into ecological barriers, or the viability of the land to accept Green Revolution technology.

In Bihar and Jharkhand, uneven distribution among small and large farmers is apparent in three ways: small farmers' lack of funds to take advantage of Green Revolution technology; insufficient information and resources available to small farmers to effectively apply the technology; and the absence of government support for small farmers.

The uneven distribution of Green Revolution technology has led to increased social disparity among classes. A disproportionate amount of people achieved success with the modern technology that was developed to positively affect everyone.

There are four important effects of the spatial and social disparities caused by the Green Revolution in Bihar and Jharkhand. These are: the change from traditional sustainable methods to monocropping and unsustainable practices; violence and a dissolution of the sense of community among farmers; the loss of many small farmers' landholdings to large commercial farmers; and increased suicide rates of small farmers.

Problemswith theMechanization in eastern India

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. At the same time lot of other problems are related to the mechanization of agriculture, like availability of parts of the machine and its maintenance. At the same time there are other problems associated with the use of machinery in farming like maintenance of the machines, availability of parts, etc.

According to the study of C.S.C Sekhaar and Yogesh Bhatt,survey of Bihar and West Bengal, the farmers were asked questions regarding various problems associated with the use of machineries in different 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 animal operated plough. In case of ploughing activities, about 26 percent of the farmers consider tractor operated plough as 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 case of animal operated plough, there are much less 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 similar task much quicker and more efficiently. In case of sowing and transplanting operations, none of the farmers ranked any problem faced while using machines as no machines are actually used in these activities in the study region. Transplanting and sowing operations are carried out entirely with human labour with their bare hand, and no machines like seed drill etc. are used. This phenomenon also holds for de-weeding activities too, where no machines are used for de-weeding and interculture.

On the part of the irrigation activities, a large section of the farmers (41 percent) found diesel

and electric pumps as not readily available for hire when they are needed the most. Only a few (6 percent) of farmers alleged that yield rate after using diesel pump machines is not as expected, while another few (3 percent) farmers alleged that there are no government support on purchasing diesel pumps. Again, in case of harvesting activities, a small segment of the sample farmers (9 percent) consider that yield rate is not as expected after harvest using manual sickle. They in fact perceive that harvester machines can provide a higher yield rate as compared to manual sickle. However, the rationality behind such consideration remains highly doubtful in reality. Further, in case of threshing activities, while a few farmers (32 percent) consider threshing machines as expensive to purchase, other few (13 percent) consider high maintenance costs of threshing machines as the major problem. At the same time, about 8 percent of the farmers alleged that hire facility of threshing machines is not available, while 9 percent consider that yield rate after using threshing machines if not as expected. Lastly in case of marketing and transportation activities, a small part of the sample farmers (9 percent) perceive that tractor trolleys are expensive to purchase as compared to animal powered carts. As such they find it difficult to buy or rent one at the time of marketing or transportation from field to threshing floor or from the threshing floor to the market.

The Green Revolution was initiated in the 1960s' to address the issue of malnutrition in the developing world. The technology of the Green Revolution involved bio-engineered seeds that worked in conjunction with chemical fertilizers and heavy irrigation to increase crop yields. The technology was readily adopted in many states in India and for some it was a great success. However, there were many farmers who could not afford the inputs necessary to participate in the Green Revolution and gaps between social classes widened as wealthy farmers got wealthier and poor farmers lagged behind. Here, we will discuss the negative impact of Green Revolution and why the success was not evenly distributed, specifically in the region of Bihar and Jharkhand.

Farming Methods Introduced by the Green Revolution

The Green Revolution technology employed the use of new high-yielding varieties of seeds as well as chemical fertilizers. The problem with indigenous seeds was not the fact that they were not high-yielding, rather it was their inability to stand up to heavy applications of chemicals. The new varieties were created in combination with the fertilizers to work together with heavy irrigation to produce higher yields. Independently, the seeds as well as the fertilizers were fairly ineffective, but used together they promised to double or even triple crop yields.

Change From Traditional to Unsustainable Farming Practices

Traditionally, the farms in Bihar and Jharkhand were small plots of land protected by windbreaks and tree cover. The farmers employed sound methods of organic husbandry that

had been used for centuries. The practices of crop rotation and leaving fields fallow for long periods of time allowed the soil to retain nutrients. Because of this, the demands on the land were low, allowing farmers to establish a stable relationship with the environment. Maintaining a state of equilibrium with the soil enables farms to recover after disastrous events, such as droughts or monsoons.


Small farms with natural Forest

The natural forest in Jharkhand is naturally balanced and well-adapted to represent an ecologically optimal model for agriculture. The tree cover protected the soil from excessive heat and served as a safeguard against heavy monsoon winds. The multiple layers of vegetation protected the soil from erosion and allowed rain to circulate through the soil and restore aquifers, which the vegetation could tap into during long dry spells. The diverse mix of vegetation also enriched the soil with a variety of nutrients. All of these components created a highly productive ecosystem that had been functioning and evolving for centuries to withstand the volatile conditions of drought, flood and climate change.

Until the introduction of Green Revolution in eastern India, the farms in Bihar and Jharkhand were subsistence-based and sown with a number of indigenous species of plants. Between each row of crops were other crops, making efficient use of land and water. The research of the Center for Indian Knowledge Systems explains in their research that, for each small geographical region in Bihar and Jharkhand, each caste had its own niche in natural resource exploitation and use. Because of this, there were no overlapping and resources were not overexploited.

This allowed small communities to be independent and self-sustaining, giving every person a chance to participate in the region's economy. Farmers were then influenced by the Green Revolution and larger farmers who had changed to modern methods such as monocropping, in which they cultivated only one type of crop rather than multiple crops, as is done in traditional agriculture. While monocropping allows farmers to grow more of a certain crop that is usually of higher market value, it has negative effects on the soil as well. Monocropping

usually involves clearing large patches of land of trees. Also, farmers who use a monocropping system tend to leave their fields fallow for shorter periods of time, so the soil cannot replenish its nutrients.

Different crops have different needs, and planting more than one type gives the soil a chance to recharge what nutrients a certain crop does not need in preparation for the next crop. The soil does not get that kind of a break with a system of monocropping. Additionally, farmers that employ monocropping methods need higher inputs of chemical fertilizers.

The Green Revolution package offered high yielding seeds and the promise of double or triple yields. This involved the application of chemicals to enhance the quality of the soil as well as deter pests and insects. The local crops were unable to stand up to chemical application, so farmers had to purchase the seeds that were developed to withstand heavy chemical applications. The high yielding varieties of seeds had a narrow genetic base, and the farmers were sowing all of their fields with just one type of seed. This resulted in the displacement of thousands of locally indigenous species as well as agricultural systems that have been build up over generations on the basis of knowledge accumulated over centuries.

In Jharkhand, the trees that once protected the fields were also cleared, leaving the soil vulnerable to erosion and the plants open to intense sunlight and violent wind. Switching from traditional subsistence farming to industrial monocropping had negative effects on small farmers. They found themselves trapped in the cycle of high interest rates on seeds, fertilizers, and pesticides which they had to buy on credit. Because they were often only working with one dealer, there was no competition and prices remained very high.

Uneven Geographical Distribution of Green Revolution Technology

The region of Eastern India is comprised of a multitude of different topographies, climates and soil types, or agroecological zones. Because of this, the modern varieties of seeds developed to

increase production were not ecologically viable for all regions. The seed types developed simply did not vary enough to be used consistently across the region. This provided the Intensive Agricultural Development Program with the criteria needed to select the different villages that would receive the technological packages developed by Green Revolution scientists.

Modern varieties of crops such as sorghum, millet and barley, which grew in mainly semiarid and dry land conditions were not widely developed until the 1980's, and even then there was limited availability of these seeds. The most successful and highly distributed crops were rice, maize and wheat, which needed areas that had high rainfall or sufficient irrigation. Of all of these, wheat was the most successful, in the western Bihar, because of their irrigation systems.

Well irrigated farms in Muzaffarpur village

Not only did this limit opportunities for farmers in arid regions, it resulted in only a portion of land suitable for growth to be utilized. This was due to the lack of irrigation facilities needed to sustain the crops, in southern and eastern part of Bihar.

Farmers who are able to afford irrigation systems are having problems as well. They must use expensive pumps to tap into groundwater reserves, which are depleting rapidly. In some areas, groundwater levels are sinking up to three feet per year. Today, farms that had begun digging down ten feet now find themselves drilling down more than 200 feet, requiring even more expensive equipment.

Rather than cooperating with the environment by employing traditional methods of crop rotation and the planting of diverse varieties of crops to solve the problem of uneven geographical distribution, researchers developed strains of crops that would adapt to unsuitable conditions so long as they were heavily irrigated and received applications of expensive inputs of fertilizers and pesticides, which led to disparities between farmers who could afford these technologies and those that could not.

Loss of Small Farms to Large Commercial Farms

The Green Revolution came about as a means to present a solution to resource and food scarcity. However, physicist and ecological activist Vandana Shiva believe that this solution led to the "ecological breakdown in nature and the political breakdown of society as consequences of a policy based on tearing apart both nature and society".

The Green Revolution's method to increase food production and eliminate hunger is to introduce technologies such as bio-engineered seeds and chemicals that are developed to increase yields. However, smaller farmers have fallen behind and have had to take out loans and sell land to afford the technology of the Green Revolution. These farmers were left impoverished, and there were many reports which shows the mass migration from Bihar and Jharkhand to big cities like Mumbai, Delhi, Chandigarh and Kolkata.

Small farms

There are three important lessons we can take from the Green Revolution:

First, where farmland is bought and sold like any other commodity and society allows the unlimited accumulation of farmland by a few, superfarms replaces family farms and all of society suffers. Second, where the main producers of food (small farmers and farm Workers) lack bargaining power relative to suppliers of farm inputs and food marketers, producers get a shrinking share of the rewards from farming. Third, where dominant technology destroys the very basis for future production, by degrading the soil and generating pest and weed problems, it becomes increasingly difficult and costly to sustain yields.

Monkombu Sambasivan Swaminathan, who is considered the father of the Green Revolution in India, agrees that it may not have been the best plan for Indian agriculture. He attributes this to the fact that the industrialization and monoculture introduced to India by the Green Revolution have resulted in low water tables and soil that has been depleted of nutrients essential for growth.

Additionally, in Bihar and Jharkhand, where most of the farmers belong to medium and small category, these techniques sparked a vicious cycle in which farmers were forced to spend more and more money on chemicals to counteract what monoculture and heavy fertilizer applications have done to their land.

Presently, water resources are scarce and expensive in Bihar and Jharkhand . Large farms benefit because they can afford canal irrigation, whereas small farmers need to resort to taking out loans with high interest rates to irrigate their fields. Keith Griffin explains that, "The growth in inequality in rural areas stem in large part from the fact that small, poor peasants who have restricted access to credit, technical knowledge and the material means of production are unable to innovate as easily or as quickly as those who are landed, liquid and literate" (Griffin 1979: 216).

It shows that only big and medium farmers could afford to purchase the new inputs of the Green Revolution. In short, small farmers were just not equipped to keep up with the pace of the Green Revolution. In backward states like Bihar and Jharkhand, to obtain credit, farmers need to have a secure tenancy or own land, which makes them more viable for investment and provides an asset on which credit can be acquired. Liquid assets are essential for purchasing commercial inputs of seed and chemicals as well as enabling a farmer the stability to hold out and wait for the most opportune time for sales and purchases.

Bihar and Jharkhand are one of the most backward areas in India in terms of education, almost half of the population is illiterate. The farmers who are illiterate have less access to knowledge and information regarding commercial inputs, as well as the ability to learn about proper usage and techniques.

Small farmers also suffer the effects of heavy fertilization taking its toll on the land and destroying the soil. New seeds are dependent on large quantities of fertilizers, which decrease the presence of nutrients in the soil such as nitrogen, phosphorous, iron and manganese. To counteract this, farmers must apply even more fertilizers to make up for the lack of important nutrients and aid the growth of the plants.

Furthermore, pesticides and herbicides, lead to resistant species, creating further need for chemical applications. Farmers are finding it harder to stay ahead of these growing costs, but they have become dependent on the new technological inputs. The Green Revolution favored expensive technological investments for the "best endowed farmers in the best endowed areas, and directed away from resource prudent options of the small farmer in resource scarce regions" (Shiva 1993: 45).

Because of scarce resources, competition increased among farmers, which further widening

the gaps between social classes as well as geographical regions. In a system where purchasing expensive equipment is necessary for a farmer to stay competitive, small farmers often must rely on unofficial creditors and money lenders. These business men loan money and charge exorbitant interest rates, sometimes as much as double the interest rate that banks charge.

Traditionally, agricultural knowledge and customs in eastern India were shared among the people that had been passed down through social and cultural structures and practices. With the introduction of the Green Revolution and the commercialization of agriculture, farmers were faced with a difficult shift from traditional agricultural knowledge to a more modern methodology. Farmers now rely more on market-led fads as they are impacted by the growing competition among agri-businesses. Because of this, agriculturalists are constantly in competition, which causes the need to purchase new commercial varieties of seeds, pesticides, and fertilizers.

These new agricultural methods do not necessarily come equipped with the training and knowledge necessary to effectively implement them. Furthermore, several reports indicated that many farmers have encountered problems with their farms because of their lack of knowledge of pesticide use and commercial inputs. Soil tests must be conducted to determine the correct amount and composition of fertilizer and pesticide mixtures. A large amount of small farms have missed out completely in this process, leaving them ignorant of what they should be using on their fields. In fact, the leading cause for increasing debts of agriculturists was the inappropriately large amount of pesticides they sprayed on their fields.

In the political economy of the Green Revolution, it is evident that large, wealthy farmers in India have more influence in politics than do small farmers. The ends as well as the means of government policy usually are largely determined by the government's sources of support. In Bihar and Jharkhand where mostly this support comes from local elites and economic policy is designed to further their interests . The wealthy landholders are often the creditors and political bosses that make important decisions, or they have heavy influence on those that are by providing them financial support.

This makes it impossible for small farmers to share in any of the control because they lack the amount of land ownership and caste status to change their situation, when it comes down to it,

The government is most prone to protect the interests of those whom they rely on to provide support when it is needed.

In the 1970s' and 80s' a large number of small farms, unable to keep up with the competition, shut down. In 1984, 24% of small farmers and 31% of marginal farmers were living below the

poverty line in Bihar. From 1977-1979, there was an increase in per hectare income, there was a decline in the financial returns from farming in Bihar. The introduction of external inputs was only possible by the introduction of credit which led to the indebtedness of many farmers because of rising costs of chemicals and the necessity to apply more and more to fields as the soil continues to degrade .

In 1984, there were a lot of cases in which small landowners in several part of Bihar who still technically owned their land had leased it out to wealthier farmers and then subsequently worked with the very same land as labourers, enabling them to get at least some money out of the land, since they could not afford to purchase the inputs needed for Green Revolution agriculture.

The increase in profitability of agriculture caused many landlords to take a new interest in farming, evicting tenants so that they may farm the land themselves. This made less land available to small farmers, as large farmers and landlords were increasingly repossessing the land for their own use. Even if they did not evict the tenant, many times landlords would charge higher rent or crop share or rotate the tenants, among the different plots of land so they were not able to acquire any rights to their land.

Impact on the Social Structure

The violence that was occurring in the 1980's and 1990s, when conflicts between caste groups, in Bihar was not solely to blame, and that focus should be placed on the unrest that was caused by the Green Revolution and its ecological and political demands. Farmers were left discontented and indebted as the result of degraded soil, and pestridden crops. This resulted in disillusionment and tension between the farming community and a newly centralized state taking charge of agricultural policy as well as agricultural commodities' prices, finance and credit.

The displacement of native plants and agricultural systems that had developed over centuries of local knowledge by modern techniques resulted in decentralized knowledge of traditional farming techniques, causing further fissures among the farming communities.

Inter Personal Relations

Farming was their livelihood and the way that they connected with each other. Changes toward external inputs not only had negative consequences for the ecology of the villages, they had social implications as well. Before the Green Revolution, agriculturalists relied on mutual relationships within their villages. After the introduction of Green Revolution technology, they found themselves solely dealing with banks and agribusiness, thus weakening relationships within villages.

Class Conflict and Violence

The farmers of Bihar and Jharkhand found themselves in the midst of increasing conflict that was converging and intensifying tensions. There was class conflict, pauperisation of the lower peasantry, conflicts over water resources and mechanization displacing labour. There was also conflict related to caste, religious and cultural relations among different peoples. The Green Revolution commercialized all relations and created an ethical vacuum where nothing is sacred and everything has a price. Tension also developed related to the center and state sharing political and economic power (Shiva 1993).

Before the Green Revolution, farmers relied on internal inputs and organized locally. This changed after the Green Revolution to centralized control of farming and external inputs. Because of this, social relations began to disintegrate, there was no longer a sense of community and violence had become rampant. In 1986, 598 people were reportedly killed due to violence among farmers in Bihar only. In 1987, the number grew to 1,544 and in 1988, 3,000 lives were lost to violence in Bihar only.

Gender Imbalance

Use of heavy and sophisticated machines as well as herbicides and pesticides has limited the role of women. In traditional agriculture, women used to do supportive work with men, like sowing, removing of unwanted herbs and other technical and time taking work in farms, at the same time many women used to transport the bundle of crop on their head from farm to home. These works used to provides a share in agriculture as well as give them a social status, as they equally contribute in agricultural production. In lower strata of farmers, women have always almost equal say in family, since they were the part of the production.

Acccording to Mr Ishteyaque Ahmed of Green peace, the female feticide and gender imbalance in Punjab and Haryana is directly related to the Green Revolution, since in these regions, due to implementation of herbicides and other machinery in farms, the women

became restricted to the home only. Most of the women were not well educated, and even if they were educated could not do other job than household work. The women or girls became the burden of the family as only dependent not contributor in family income.


Women join hands with men in Traditional farming

He also mentioned that in eastern India, increasing rate of dowry and dowry deaths are directly related to paradigm shift in agriculture pattern. Earlier it was a social problem that girls were not educated, since families never allowed to go out the girls to get education, but now a day's girls education is a financial burden. In states like UP, Bihar and Jharkhand majority of the families in the village are dependent on farming and new technologies has removed women from farms provides a reason to the family to discriminate with girls child.

Conclusion

The creators of the Green Revolution seemed to have had the best intentions at heart-- they were working to develop technologies that would increase productivity of farms in developing countries to combat hunger and poverty. They were not completely unsuccessful, either the modern varieties of seeds that they produced did, in many cases, increase yields and increase profits for farmers as well as reduce prices to feed the hungry. However, with these gains were major setbacks.

The lack of a stable agrarian system in India, especially in eastern India has made it difficult for Green Revolution technology to impact everybody positively. This is because of a rigid social structure of eastern India, which makes it difficult for those without money to improve their social conditions. Those with more money (and therefore more land) can afford the seeds and chemicals necessary to compete in the Green Revolution market. Farmers with less money cannot afford to buy the necessary technology and resort to money-lenders to purchase on credit. They then find themselves in debt and paying exorbitant interest rates. They buy the technology on credit to keep up with large farmers and stay competitive in the market, but the debt alone negates any possible financial success they can achieve by adopting Green Revolution technology.

Once a farmer does acquire the tools necessary to compete in the post-Green Revolution market, he or she is then trapped in a cycle that is nearly impossible to break. The modern varieties of seeds that were developed for the Green Revolution require heavy irrigation and applications of chemicals to be successful. Once a farmer applies these chemicals to the soil, the soil degrades and is left depleted of essential nutrients. To make up for that loss, the farmer needs to use even more fertilizers to make up for what is lacking. Additionally, the use of pesticides leads to the creation of pesticide-resistant pests. This vicious cycle leads to the need for more chemicals to keep up with the changing chemistry of pests and pesticides.

Ultimately, the ideas and concepts of the Green Revolution may have seemed beneficial for all, but when deployed it is evident that this is not the case. To be truly effective at eliminating poverty and hunger worldwide, researchers need to develop a system that works with the land, rather than against it. It is impossible for technology to ever completely control the land and as humans we are not able to completely control nature. That being said, the cycle that farmers find themselves in when they begin to utilize Green Revolution technology is not easily broken, and the dependence has led many into indebtedness and further impoverishment.

The argument for the Green Revolution was that India's people were starving, and if they could grow more food, the problem could be solved. Historians like Amartya Sen point out, however, that famine in India was not in the absence of food, but rather the inability of people to acquire food. During the later half of the nineteenth century, several severe famines struck India. The colonial government initiated the Famine Commission in 1880 to investigate the problem and find a solution to change conditions. Surprisingly, the commission found that every province was actually experiencing a surplus of food. The problem was not with underproduction at all; the people were just unable to afford the food that was being produced around them.

It is clear that the time has come for a plan for social development rather than a strategy for abundance. The Green Revolution may have been successful in increasing yields in many areas, but conditions have not improved for many of the farmers in Bihar and Jharkhand , that need help the most.

Studies point toward sustainable traditional agriculture as the best solution to managing the growing population. Although the benefits of sustainable traditional agriculture are abundant, there are several constraints to adopting this method worldwide. Climate conditions vary with geography so where sustainable agriculture is the most efficient system in one part of the world, it may not be entirely feasible in another. “Some authors suggest the adoption of integrated farming, rather than upholding solely organic practices, which they find more harmful than conventional farming, for instance in the case of pest control technologies.

Many factors determine the performance of agricultural methods and often the most effective type of agriculture requires a combination of techniques. In addition to local constraints, sustainable agriculture also requires much more labor to maintain crops.

The science of agriculture has allowed human populations to grow exponentially and dominate the world's landscapes. Advancements in this science have enabled humans to manipulate entire ecosystems to cater to their survival. But as populations continue to grow, resources are becoming limited. Water, fuel, and soil are three important factors determining the survival the world's population and it is crucial that they are used as efficiently as possible. In a comparison of sustainable and modern agriculture, organic farming methods are shown to perform much better for a number of indicators. Sustainable agriculture consumes less water and energy, enhances soil composition, and forgoes synthetic chemical input. Modern agriculture cannot meet the needs of the current population without compromising the integrity of the environment. Sustainable agriculture has the potential to sequester carbon, feed the world, and enrich the environment. The social, economic, and environmental benefits of this system are reasons why sustainable agriculture is the most viable way to accommodate growing trends.

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.