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Ailing Agricultural Productivity in Economically Fragile Region of India: An Analysis of Synergy between Public Investment and Farmers' Capacity

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ICAR Lal Bahadur Shastri Young Scientist Award 2005-06

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Principal Investigator

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Project Report

on

Ailing Agricultural Productivity in Economically Fragile Region of India: An Analysis of Synergy between Public Investment and Farmers' Capacity

(Funded by AP Cess fund, ICAR, New Delhi under Lal Bahadur Shastri Young Scientist Award in Social Science- 2005-06)

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Executive Summary

The agriculture productivity in the states of Bihar, M.P. and Orissa are since long remained ailing. Although, the region presents uncommon opportunities for becoming another "fertile crescent". The increasing integration of these states into the national economic growth offers the promise of more rapid progress towards poverty reduction-but not if current practices of neglect by design continue.

Investment in agriculture infrastructure like irrigation, transportation, rural electricity, storage services, research, etc. is crucial for farm growth in any region. The present study on '***Ailing Agricultural Productivity in Economically Fragile Region of India: An Analysis of Synergy between Public Investment and Farmers' Capacity***' therefore, is an attempt to examine the public investment in agriculture, its effect on agriculture performance and relationship between crop output with infrastructure variables and public expenditure. On the basis of field survey of 200 farmers in each state, income from the farming and thereby economic capacities of the farmers were also estimated in Bihar, M.P. and Orissa states. In these states, more than 80% of the total population are staying back in rural areas creating huge pressure on agriculture in terms of fragmentation of land holding, under-employment in agriculture, low agricultural wages, etc. About half of the total population in these states remains below poverty line. High population growth, more dependency on agriculture, high level of illiteracy, lacking access to adequate nutrition, medical care and sanitation put big barrier for increasing economic capacity of the small and marginal farmers.

On the other flipside, public expenditure in agriculture sector was given least priorities in Bihar and Orissa, while deserves the most, as large population depends on it as except in M.P. state, share of the public expenditure on agriculture in total value of agricultural output is declining. Among the factors responsible for ailing agricultural productivity, it was observed that still about 50 percent of the GCA is not under HYV. Similarly, seed replacement rate varies between 5 to 20% depending on the crops. The growth in fertilizer consumption has slowed down significantly in all 3 states even before peaking out. There is significant volatility in growth of irrigated area in Bihar and Orissa, though it is consistent in M.P. The growth in irrigated area in these states reflects that it will take another 20-30 years to match 80 percent irrigated NSA in Punjab and Haryana, unlike 20-50 percent in Bihar, M.P. and Orissa states. Most of the irrigation in Bihar and

M.P. are done by private tube-wells showing utter failure of government policy in augmenting irrigation through surface irrigation (canal). Lack of adequate supply of electricity to rural area, as its consumption in agriculture is hardly 100KWh per ha of GCA as compared to more than 1100 KWh/ha in Punjab and Haryana, irrigation and other agricultural operations with diesel operated energy source makes agriculture highly uncompetitive in these states.

The poor farmers of these 3 states have also very less access to cheaper institutional credit which led to collateral damage in the progress of agriculture, as with small saving left with them, it would be difficult to go for capital intensive agriculture with quality seeds, fertilizer and optimum irrigation. The institutional credit disbursed to agriculture varied from about Rs.3000/ha to Rs. 6000/ha as compared to about Rs. 12000/ha of GCA in Punjab and Haryana states.

Cropping pattern in Bihar and M.P. has remained almost static during last 10-15 years, however in Orissa there has been significant crop diversification in favor of fruits and vegetables. Interestingly, growth in foodgrain production has been see-saw during last 3 decades in Bihar and Orissa (which might be due to frequent occurrence of natural calamities), while in M.P., it is consistently growing. During 2000-05, growth of most of the crops in Bihar has been negative, except that of vegetables. It was not so in M.P. and Orissa, except few exceptions, as yield of major crops in later two states are growing by 2-5 percent per annum. The forecasts for next one decade (2005-15) using ARIMA model shows that the production growth of quite good number of crops are going to be snubbed in 3 states, if the production environment are kept constant. The foodgrain production (and yield also) is expected to grow between 1-2 per cent annually. This poses serious questions for the food and nutritional security of poor farmers, wherein population growth is more than 2 percent.

The relationship between agricultural output and different infrastructural and input variables during the period of 1990-2005 shows that electricity consumption in agriculture doesn't influence the agriculture in 3 states, as it is used very minimally. Similarly, public expenditure in agriculture and road density in M.P. and Orissa states and institutional credit to agriculture in Bihar has positive and significant influence. This explains that although, there was no growth in these variables, agriculture in Bihar state has grown, which was mainly due to efforts of individual farmers and the government has not played any proactive role.

From survey of farmers' field, it emerged that though the state departments are spending huge amount of money, the penetration of soil testing facilities in these states are rare thing to talk about among the farmers. Due to this, they are unaware about the situation of nutrient mining and deficiency of other micro-nutrients, which if not taken care of soon, will cause irreparable loss to soil fertility.

The results of cost and returns from crop cultivation were un-nerving for at least Bihar and Orissa farmers. First, it was found that farmers in these two states are selling their main produce to local traders even below the MSP/ procurement price announced by the government in lack of proper agency to purchase from them. Secondly, in the light of dwindling profitability from farms, even small farmers are hiring labour for all kinds of farming activities, which are making their economic situation even worse. Thirdly, the net profit from agriculture in Bihar and Orissa is as low as Rs. 15000 to Rs. 21000 per annum, which is much lower than the standard set for the poverty line. Fortunately, the draught in large part of the country during study period fuelled the price of pulses and oilseeds, thus farmers in M.P. were able to sell their produce at much higher price than the MSP, making their annual income up to Rs. 72000. Thus, farmers in M.P. have better economic capacity than those of in Bihar and Orissa.

During survey, majority of farmers expressed that they were using the inputs sub-optimally and though, they have willingness to use these inputs according to recommendations, but due to the certain socio-economic, technological as well institutional constraints, they were unable to do so. For example, the reliability and affordability of the quality seeds are the major factors/ constraints due to which small and marginal farmers (who are in majority) are not going for quick replacement of seeds. In absence of soil tests facilities in the vicinity or awareness about its benefits, farmers are applying the fertilizers according to their established knowledge. Similarly, in absence of cheaper energy source, the diesel-based groundwater irrigation being costly affair, even rabi crops like wheat are given hardly 2-3 irrigations in Bihar state. Infrastructural bottlenecks (unsurfaced rural roads, poor or no electricity supply, etc.) and institutional insensitivity (lengthy procedure or rules practically debarring marginal farmers from accessing institutional credit) to the farmers need serious overhauling for keeping the food growers in the region afloat. However, from the findings of the study, it appears that among the 3 states under study, Madhya Pradesh would come out from the

poverty cycle first, although with very high income inequality among farmer-households followed by Bihar and lastly, Orissa state.

The quality of economic infrastructure, energy infrastructure and technological divisions between rich and poor states therefore threaten to intensify the disadvantages of the poor states and the advantages of the developed states. In the current situation, the government policy to help agriculture in terms of all kind of subsidies - minimum support price/procurement price, fertilizer subsidy, electricity subsidy, interest rate subvention, etc. are helping mainly those farmers who are main user of these schemes. The farmers in poor states like Bihar, M.P. and Orissa in general don't participate in government procurement at MSP, use less fertilizer, very least user of electricity; have poor access to institutional credit; thus not getting required benefit of the government schemes. The farmers in the selected states by and large, are also disadvantaged in terms of access to extension services. These interlocking inequalities have an important bearing on the distribution of benefits from economic growth.

The results of this study have important policy implications to break the jinx of ailing agricultural productivity of the selected poor states. In order to make agriculture in this region remunerative, there is a need of multi-pronged approach:

- **Priority to increase public spending on agricultural research & extension.**
- **Increased technical assistance to the farmers for technology related capacity building.**
- **Expansion of surface irrigation to augment groundwater irrigation and reduce cost of irrigation.**
- **Assure supply of low cost energy source (electricity) for agricultural operations.**
- **Improved accountability to financial institutions to disburse credit to small and marginal farmers.**
- **Improved marketing infrastructure to reduce transaction and transportation costs.**
- **Emphasis on education and health to increase the overall labour productivity.**

Thus, the farmers' economic capacity in economically fragile region of the country like states of Bihar, Madhya Pradesh and Orissa largely depends on the public investment in road, research & extension, energy, irrigation, credit, education and health, many of which directly affect the crop productivity and therefore, there is an urgent need to improve the synergy among these socio-economic, technological and institutional variables.

1

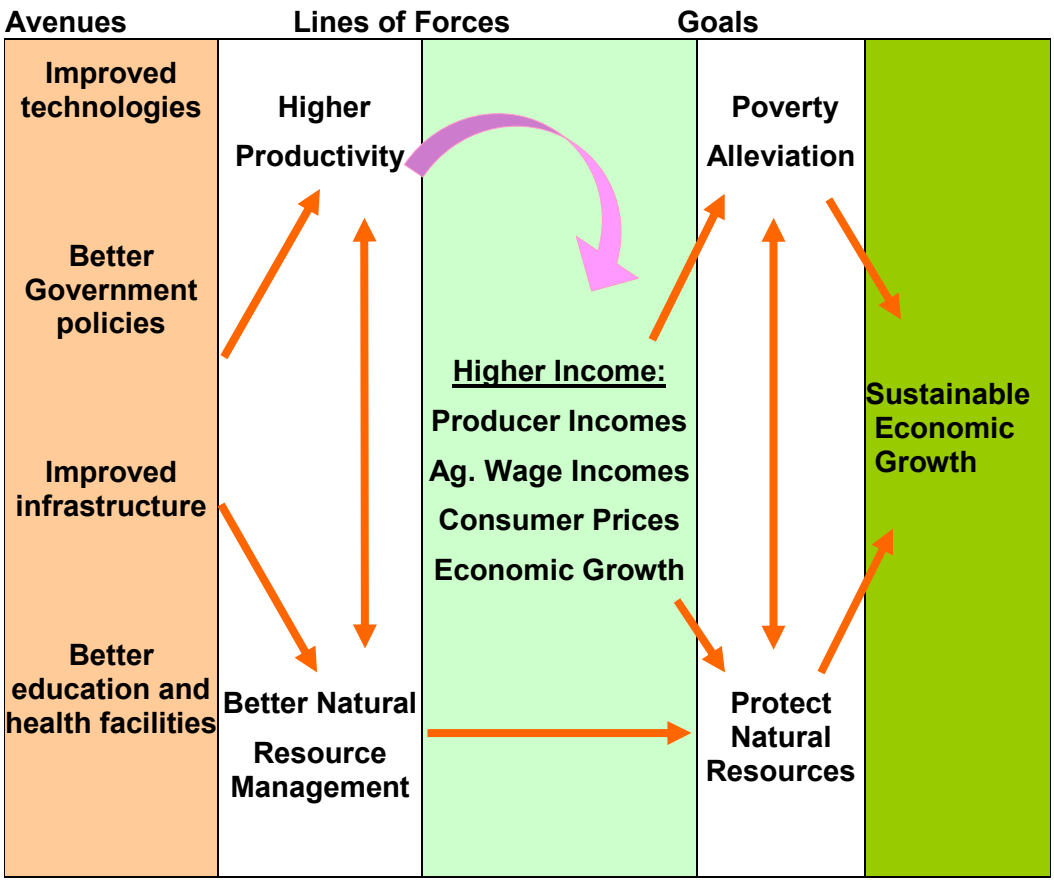
Introduction

India is surging ahead to impatiently claim its long-denied status of a giant economic superpower with the world's largest vibrant acquisitive consuming middle class and confident business leaders. Though, most often, the nation get embarrassed by reminders of a much larger population of people with stagnant or falling living standards, millions of whom struggle daily to feed their families. In a country where agriculture directly employs about 60 percent of the population- and where there are already over 1.14 billion mouths to feed- it's time to give agriculture some special treatment. Across the country, lakhs of farmers are giving up on agriculture and selling out to the highest bidder. According to a report, a total of 8 million farmers quit farming during 1991-2001. With rising input costs and poor access to irrigation and markets, farmers are turning away from agriculture, choosing to sell fertile lands to builders and industrialists in peri-urban region. The father of green revolution Dr. M.S. Swaminathan professes for Special Agricultural Zones (SAZ) to conserve prime farm land for farming and to bring about convergence among all ongoing government programmes, like the Rashtriya Krishi Vikas Yojana, the National Food Security Mission, the National Horticulture Mission and so on. This is supposed to enhance the productivity in perpetuity without harming ecology, thereby attracting youth in farming by making agriculture both intellectually stimulating and economically rewarding. However, the idea of SAZ is contested by Prof. Abhijeet Sen, Member, Planning Commission, according to whom, for a country like India, no one size-fits-all. The view gives an idea how complicated the agriculture enterprise has become in India *per se*.

Good monsoon between 2005-06 and 2008-09 and the efforts of our farmers led to consistent increase in food production during the period and a record production of 233.88 million tonnes of foodgrains in 2008-09. Notwithstanding the fact that the south-west monsoon was the most deficient since 1972, by 23 per cent compared to the long period average (LPA), the overall agricultural gross domestic product (GDP) is estimated to have fallen by only 0.2 per cent in 2009-10 (advance estimates) as against the previous years growth rate of 1.6 per cent. Foodgrain area sown in kharif season declined by 6.5 per cent compared to last year and food production is expected to be short by 16 per cent compared to the fourth advance estimates of 2008-09. Rising food prices, spurred by expectations of shortfall in food production, have brought the issues of

food security, food stocks management and need for improving food production and productivity to the forefront of national strategy. According to Economic Survey 2009-10, the fiscal year 2009-10 has been a year of a somewhat unusual inflation. In 2009-10 (April- November), food inflation was 12.6 per cent and non-food inflation *minus* 0.4 per cent. If we look at India's inflation history from 1971, this kind of inflation, where food inflation is above 10 per cent and non-food inflation is negative, has happened only twice before–in 1992-93 and 1996-97. The weekly food price inflation on a year-on-year calculation reached a maximum of 19.95 per cent for the week ending December 5, 2009. The skewedness of inflation that has been observed—some sectors are facing huge inflation, some no inflation and some deflation—is rather rare in the country's history. The primary cause of the recent food-price inflation was the severe drought of 2009, which caused a downturn in food production in the third quarter of 2009-10 and the expectation of the resultant price rise itself fed further into the inflation.

Sustainable economic growth model given below, suggests that for viable income and employment generation in any economy, improved technology, congenial government policies, better physical infrastructure (transport, energy, finance and irrigation & flood control, etc.) as well as healthy social capital (education, health & family welfare and water supply & sanitation) are must. India's recent success in growth and its sources have been widely discussed and debated both in academic and policy circles extensively (see Balakrishnan & Parameswaran (2007a, b), Rodrik & Subramanian (2005), Bosworth et al. (2007)). There are other set of studies that have shown that these high growth phase has also resulted in widening regional disparities at the state level (Ahluwalia (2000), Rao, et al. (1999), Bhanumurthy & Singh (2009)). The World Bank estimates that a one percent increases in the stock of rural infrastructure can lead to a one percent increase in GDP across all countries. But in India between 1993-94 and 2003-04, the share of budgetary expenditure on rural infrastructure and social services has declined from 32 to 25 percent. Consequently, over 40 percent of India's rural habitants are not connected to all-weather roads, 56 percent rural households don't have access to electricity and 80 percent do not have access to sanitation facilities.



Essentials for sustainable economic growth

Investment in agriculture infrastructure like irrigation, transportation, storage services, and research is crucial for farm growth. But declining government investment in agriculture from 14.9 percent in the first Five Year Plan (FYP) to 5.2 percent in the current plan, has had an adverse impact on the livelihood of rural India. An IFPRI study by Fan *et al* (1999) says that investment in agriculture R&D and irrigation have the highest impact on farm growth. But India invests only 0.5 percent of agriculture GDP into agriculture research and over 50 percent ongoing irrigation projects are far behind schedule due to paucity of funds. About 50% is rural India's contribution to GDP but rural per capita income is 56% less than urban average. The next FYP is likely to double infrastructure spending to $1 trillion. A 10 percent growth rate for the economy over the next FYP is only possible, if the nation cranks up infrastructure capacity. Unlike at the all India level, there are not many rigorous studies at the state level that examines the underlying determinants of poor economic, particularly agricultural growth in the recent period and particularly for the poor states.

Against this background, the state of Bihar, M.P. and Orissa are being talked about as a sleeping giant of Indian agriculture. The National Commission on Farmers has concluded that Bihar and Eastern India present uncommon opportunities for becoming another "fertile crescent" even as the present Fertile Crescent (Punjab, Haryana and Western Uttar Pradesh) have reached a state of economic and ecological distress. Water, the lifeline of agriculture, is abundant in Bihar and the real issue is not availability but management. **It is becoming increasingly important that more attention needs to be given to less-favoured states with strikingly very high level of poverty like Bihar, Madhya Pradesh and Orissa, in setting priorities for inclusive growth.** This leads to few important questions: 1. Is the public investment made in the past sufficient to create an environment for agricultural growth in these states; 2. Whether the farmers' have their own capacity to use inputs at optimal level; 3. If yes, then whether the farmers' are using it optimally; 4. Whether the farmers are applying nutrients to the field according to the requirement/ soil fertility status and, 4. Are the farmers optimistic about the profitability from agriculture in future? The present study is an attempt to answer these questions based on secondary as well as field survey data with specific objectives as:

1. to examine the trend of public investment in agriculture and agricultural productivity in selected states
2. to study the intensity of rural infrastructure and its interaction/impact on use of critical inputs (quantity and quality of seeds, fertilizer, irrigation) in crops' production in the region
3. to assess the farmers' economic capacity and willingness to use the critical inputs optimally
4. to estimate future projection of production and productivity of major crops in the selected states
5. to identify and prioritize the constraints in and suggest suitable policy options for increasing the agricultural productivity in the region

2

Study Area, Data and Methodology

The present study was based on secondary as well as primary farmers' field survey data conducted in three states *viz.* Bihar, Madhya Pradesh and Orissa. However, to examine the factors languishing in these states affecting the agricultural development, the trend and growth of these parameters have also been compared with two other agriculturally developed states *viz.* Punjab and Haryana- which are considered to be food bowl of the country. All these five states receive most of the rainfall from South-West monsoon and at one stage of the development, they were almost standing together, but as the time passed, the economic divergence kept on increasing.

2.1. Study Area

The salient features of different agro-climatic zones falling in the selected three states are given below in Tables 2.1 to 2.3, which exhibit wide range of variations particularly in M.P. and Orissa. Similarly, the two selected districts in each state represent entirely different agro-climatic conditions.

Table 2.1. Salient features of Agro-Climatic Zones of Bihar state

Agro-Climatic Zone	Districts	Area ('000 ha)	Average rainfall (mm)	Soil and Topography
Zone- I North West Alluvial Plains	Bettiah, Motihari, Gopalganj, Siwan, Vaishali, Seohar, Muzaffarpur, Samastipur, Sitamarhi, Madhubani, Darbhanga, West & East Champaran	NSA-2281 GCA-3260	1234.7	Medium acidic, heavy textured, sandy loam to clayed, flood prone (Large area remains under water called Chaur, Maun & Tal lands)
Zone- II North East Alluvial Plains	**Purnea**, Katihar, Saharsa, Madheura, Araria, Kishanganj, Supaul, Khagaria, Begusarai	NSA-1147 GCA-1677	1382.2	Light to médium textured, slightly acidic, sandy to silty loam (Large area comprise of Tal and Diara lands)
Zone- III South Bihar Alluvial Plains	Patna, Gaya, Buxar, Jahanabad, Nawada, Nalanda, Rohtas, **Bhojpur**, Aurangabad, Kaimur, Banka, Munger, Jammui, Lakhisarai, Shekhpura, Bhagalpur	NCA-241 GCA-3408	1102.1	Old alluvium to sandy loam

NSA is Net Sown Area and GCA is Gross Cropped Area. Districts surveyed during the study are given in bold.

Table 2.2. Salient features of Agro-Climatic Zones of Madhya Pradesh state

S.N.	Agro-Climatic Zone	Districts	Average rainfall (mm)	Soil group
1	Chattisgarh Plain Zone	Balaghat	1000-1200	Red and yellow soil
2	Northern Hill Zone of Chattisgarh	Shahdol, Sidhi, Mandla and Dindori	1000-1200	Gravelly, mixed red & light black soil
3	Kymore Plateau & Satpura Hills	Panna, Satna, **Rewa**, Katni, Seoni and Umaria	1000-1200	Mixed red & black soil
4	Central Narmada Valley Zone	Jabalpur, Hoshangabad and Narsimhapur	1000-1200	Medium to deep black soil
5	Vindhya Plateau Zone	Bhopal, Rajgarh, Guna, Vidisha, Sagar, Damoh, Raisen and Sehore	1000-1200	Medium black soil
6	Gir (Gwalior) Region	Morena, Bhind, Gwalior, Sheopur & Shivpuri	700-1000	Alluvial and Mixed red & black soil
7	Bundelkhand Zone	Datia, Tikamgarh & Chhatarpur	1000-1200	Mixed red & black soil
8	Satpura Plateau Zone	Betul and Chhindwara	1000-1500	Mixed red & black soil
9	Malwa Plateau Zone	Neemuch, Mandsaur, Ratlam, **Ujjain**, Shajapur, Dewas, Dhar, Indore & Badwani	800-1000	Medium black soil
10	Nimar Valley Zone	Khandwa (East Nimar) & Khargone (West Nimar)	800-1000	Medium black soil
11	Jhabua Hills Zone	Jhabua	800-1000	Medium black soil

Districts surveyed during the study are given in bold.

Table 2.3. Salient features of Agro-Climatic Zones of Orissa state

Sl. No.	Agro-climatic Zone	Agricultural Districts	Climate	Mean annual rainfall (mm)	Broad Soil groups
1	North Western Plateau	Sundargarh, parts of Deogarh, Sambalpur & Jharsuguda	Hot & moist sub-humid	1600	Red, Brown forest, Red & Yellow, Mixed Red & Black.
2	North Central Plateau	Mayurbhanj, major parts of Keonjhar (except Anandapur & Ghasipura block)	Hot & moist sub-humid	1534	Lateritic, Red & Yellow, Mixed Red & Black.
3	North Eastern Coastal Plain	Balasore and Bhadrak	Moist sub-humid	1568	Red, Lateritic, Deltaic alluvial, Coastal alluvial & Saline.
4	East and South Eastern Coastal Plain	Kendrapara, Khurda, Jagatsinghpur, part of Cuttack, Puri, **Nayagarh** & part of Ganjam.	Hot & humid	1577	Saline, Lateritic, Alluvial, Red and Mixed Red & Black.
5	North Eastern Ghat	Phulbani, Rayagada, Gajapati, part of Ganjam & small patches of Koraput.	Hot & moist, sub-humid	1597	Brown forest, Lateritic Alluvial, Red, Mixed Red & Black.
6	Eastern Ghat High Land	Major parts of Koraput, Nawarangpur.	Warm & Humid	1522	Red, Mixed Red & Black, Mixed Red & Yellow.
7	South Eastern Ghat	Malkangiri & part of Koraput.	Warm & Humid	1710	Red, Lateritic, Black.
8	Western Undulating Zone	Kalahandi & Nuapada.	Hot & moist sub-humid	1352	Red, Mixed Red & Black, Black.
9	Western Central Table Land	**Bargarh**, Bolangir, Boudh, Sonepur, parts of Sambalpur & Jharsuguda.	Hot & moist sub-humid	1614	Red & Yellow, Red & Black, Black, Brown forest, Lateritic.
10	Mid Central Table Land	Angul, Dhenkanal, parts of Cuttack & Jajpur.	Hot & moist sub-humid	1421	Alluvial, Red, Lateritic, Mixed Red & Black.

Districts surveyed during the study are given in bold.

2.2. Data

The project envisaged various types of primary as well as secondary data pertaining to different factors and indicators of agricultural development in the selected 3 states. The primary data was collected by surveying 600 farmers in three states for the **cropping year 2007-08** using pre-tested questionnaire. The secondary data were collected from the Directorate of Economics and Statistics (DES), Government of India, various issues of Economic Survey, Agricultural Situations in India, various issues of Statistical Abstracts published by the State Governments and other published sources.

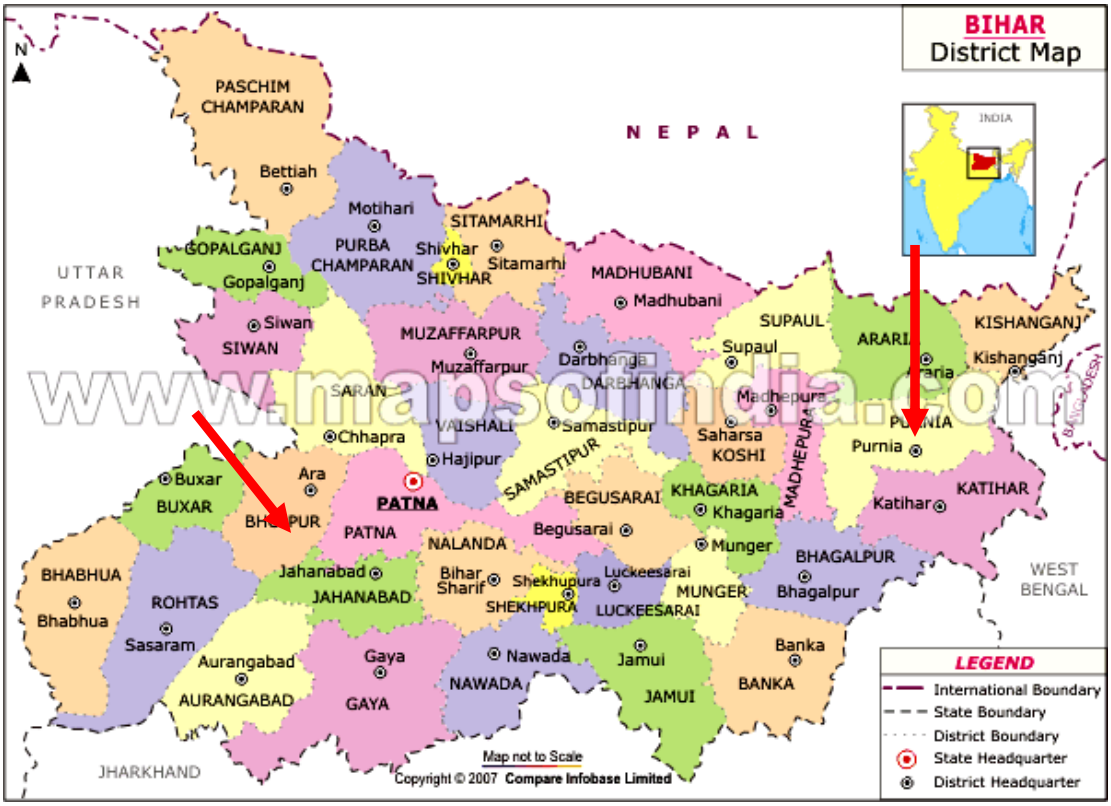
2.2.1 Sampling design for selection of the study area

Stratified multistage sampling design was used for selecting the sample units. Three states (Bihar, Madhya Pradesh and Orissa) were taken as first Strata, then within the state, districts, blocks and village were considered as second, third and fourth unit of study. While selecting districts, care has been taken that one district from each state should have higher foodgrain productivity than the state average during triennium ending 2005-06 (latest data available for the districts) and another district should have lower foodgrain productivity than the state average. Thus, two districts were selected randomly from each state from two groups and it is expected that the average results of the two districts would give better representation for the state as a whole. To have more representation of the farmers, four blocks from each selected district and two villages from each block were randomly selected. Finally, 12-13 farmer-households were randomly selected from each village. Thus, as a final stratum, a total of 600 farmer-households were identified (Table 2.4). From district-wise maps of three states under study (Map 1-3), it is also quite evident that the two randomly sampled districts in all three states represent different socio-economic as well as agro-climatic conditions, and therefore pooling of the information from these two districts are expected to give overall picture of the respective entire state.

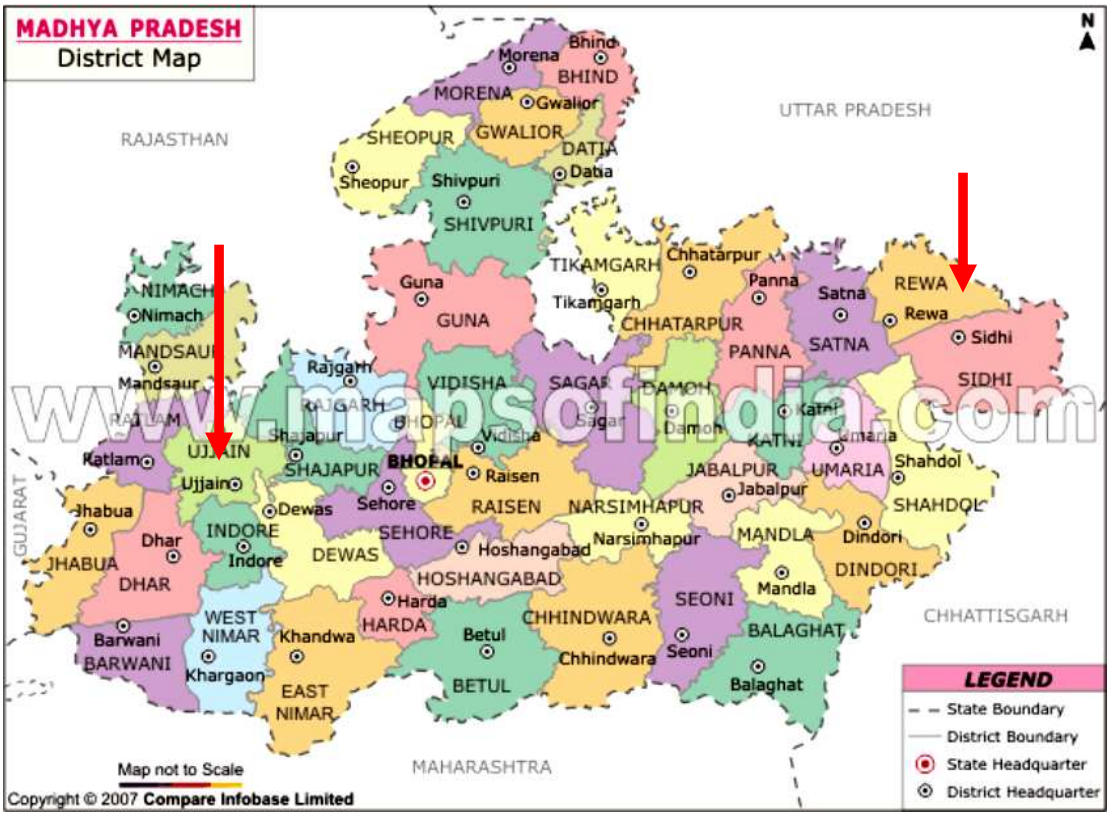
Table 2.4. Sampling pattern of households in study area

State	District	Block	Village	No. of households
Bihar (200)	Bhojpur (100)	Charpokhari (50)	Charpokhari	13
			Barhara	12
		Arah (50)	Sonadia	13
			Damra	12
		Jagdishpur (50)	Bajwawar	13
			Morcha	12
		Sandesh (50)	Nasratpur	13
			Salempur	12
	Purnea (100)	Banmankhi (50)	Dhima	13
			Jiwachhapur	12
		Dhamdaha (50)	Dhamdaha north	13
			Rangpura	12
		Purnea East (50)	Mahinderpur	13
			Majheli	12
		Jalalgard (50)	Ramdeli	13
			Bhatheli	12
Madhya Pradesh (200)	Ujjain (100)	Ghattia (50)	Piplai	13
			Kadwali	12
		Badhnager (50)	Arandia	13
			Uttwas	12
		Tarana (50)	Laxmipura	13
			Nanukheda	12
		Ujjain (50)	Talaod	13
			Karandiya	12
	Rewa (100)	Mauganj (50)	Baryakala	13
			Umrishripati	12
		Raipur-Kal (50)	Kapuri	13
			Geruar	12
		Tyother (50)	Sohagi	13
			Hanumanganj	12
		Sirmor (50)	Dhari	13
			Amra	12
Orissa (200)	Baragarh (100)	Barapali (50)	Lenda	13
			Sarandapali	12
		Bijepur (50)	Manapur	13
			M.Gandapali	12
		Baragarh (50)	Barahguda	13
			Saharapali	12
		Attabira (50)	Bhoipura	13
			Debahal	12
	Nayagarh (100)	Bhapur (50)	Fategarh	13
			Bijipur	12
		Nuagaon (50)	similisahi	13
			Bakalbandha	12
		Daspalla (50)	janisahi	13
			Digiri	12
		Nayagarh (50)	Kantabania	13
			Jadupur	12
			Total	**600**

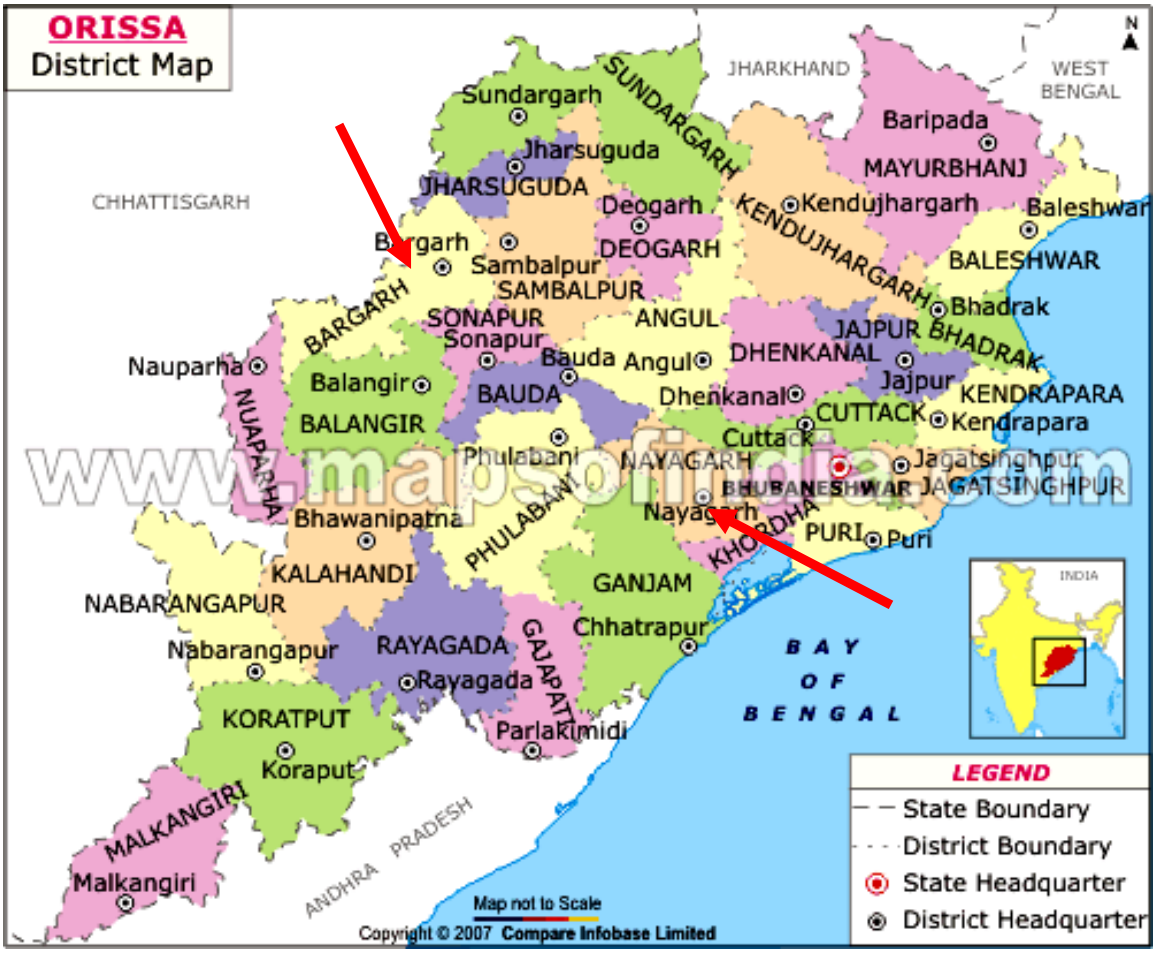
Figures within parentheses indicate number of sample farmer-households.



Map 1. Map of Bihar state and sample districts



Map 2. Map of Madhya Pradesh state and sample districts



Map 3. Map of Orissa state and sample districts

2.3. Analytical framework

As per the requirement in the specific objectives, data were analyzed. The statistical/ analytical methods used were:

- Growth analysis
- Fitting of regression equation
- Farmers' economic capacity
- Farmers' willingness to use the inputs
- Auto Regressive Moving Average (ARIMA) analysis
- Constraint analysis

2.3.1. Growth analysis

Growth and trend analysis has been used invariably in the study to examine the trend and pattern of various parameters related to crop production as well as factors influencing crop production in the selected states.

The annual growth rates for area, production and yield of different parameters were estimated using the growth model (1):

Exponential growth function, $Y_t = A\, e^{bt}$

where, Y_t = Area/production/yield/ other parameter for the year 't'.

A = Constant

t = Time variable (1,2…, n) for each period.

Log transformation of the above function is $\ln Y_t = \ln A + b\, t$

Growth rate (%) = $b \times 100$

2.3.2. Regression analysis

To examine the relationship and impact of rural infrastructure variables on agriculture in the selected states, both linear and double-log forms of the equations were estimated. However, only results of the linear specification are being reported as it gave superior fits and had more statistically significant coefficients. The correlation and regression analysis were carried out for the 15 years period (1990-2005). In absence of data for Bihar and M.P. alone for the period before the year 2000, when two states were carved out from these two, these analysis are based on combined data of Bihar+Jharkhand and M.P.+Chhattisgarh states. The linear production function was applied as:

$VOA_{ij} = f(GCA_{ij}, GIA_{ij}, CI_{ij}, FERT_{ij}, ECA_{ij}, CREDIT_{ij}, PEXP_{ij}, RDDEN_{ij,}$ Error term)

where, the dependent variable is value of output from agriculture (VOA_{ij}) in Rs. Crore at current prices, while explanatory variables include gross cropped area (GCA_{ij}) in '000 ha, gross irrigated area (GIA_{ij}) in '000 ha, cropping intensity (CI_{ij}) in percent, chemical fertilizer consumption ($FERT_{ij}$) in '000 tonnes, electricity consumption in agriculture (ECA_{ij}) in million Kwh, institutional credit disbursed to agriculture ($CREDIT_{ij}$) in Rs. crores, public expenditure in agriculture ($PEXP_{ij}$) in Rs. crores and road density ($RDDEN_{ij}$) in km per '000 sq km.

2.3.3. Farmers' economic capacity

The ability to generate an adequate income from farming enables farmers to devote resources to quality food production and to land stewardship that is essential to maintaining the value of natural capital in agriculture. An *inadequate* return on investment can produce a wide range of negative social and environmental effects, each of which carries significant costs. In extreme cases, when farmers cannot make ends meet, prime agricultural land may be sold and converted to other uses, resulting in the loss of a valuable natural capital asset and a decline in food security for future generations. Therefore, in the present study, the net return from crop cultivation has been considered as a proxy of farmers' economic capacity. Thus, the economic capacity of the farmer = Total return from selling of crop output – Paid out cost in crop cultivation.

2.3.4. Estimating Willingness to use the critical inputs

To examine the farmers' preference for use of critical inputs, the ranking method was used using survey of sample of farmers. The respondents were asked to give ranks for the factors influencing their decision about the use of critical inputs in the crop production, say improved seed, fertilizer, irrigation, crop protection, etc. Those ranks were arranged according to their preferences and the most preferred factors were considered as major factors.

2.3.5. Auto Regressive Moving Average (ARIMA) analysis

Forecasts of production and productivity of major crops

Trend and prediction of time series can be computed by using **ARIMA model** also known as **Box-Jenkins** methodology. In general, an ARIMA model is characterized by the notation ARIMA (p,d,q), where p, d and q denotes **AR** (Autoregressive), **I** (Integrative/ Differencing) and **MA** (Moving average), respectively. In ARIMA parlance, Time Series is a linear function of past values and random shocks. For instance, given a time series process (y_t), a first order auto-regressive process is denoted by ARIMA (1,0,0) or simply AR(1) and is given by

$$y_t = \mu + \Phi_1 y_{t-1} + \varepsilon_t$$

and a first order moving average process is denoted by ARIMA (0,0,1) or simply MA(1) and is given by

$$y_t = \mu - \theta_1 \varepsilon_{t-1} + \varepsilon_t$$

Alternatively, the model ultimately derived, may be a mixture of these processes and of high orders as well.

Autoregressive (p)- This measures the independent effect of values with a specified lag. Thus, an autoregressive order of 2 means that a series value is affected by the preceding two values (independently of one another).

Difference (d)- It is the number of times the series must be differenced to make it stationary. If series is already stationary, d=0.

Moving Average (q)- It is the order of moving average of the process. 'q' equals 0 for an autoregressive process, 1 for a first-order moving average, 2 for a second-order moving average, etc.

The method consists of four steps (Gujarati, 1995):

Step 1. Identification of appropriate values of p, d, and q using correlogram (ACF) and partial correlogram (PACF).

Step 2. Estimation of parameters of the AR and MA.

Step 3. Diagnostic checking of most suitable ARIMA model, in which the residual estimates are white noise.

Step 4. Forecasting

In the study, SPSS package has been used to forecast the production and productivity of different crops up to the year 2015 on the basis of previous data on crop production for the period 1975 to 2005 in 3 selected states. From several probable ARIMA models, only that model was chosen for final forecast, where AIC (Akai information criteria) and SBC (Schwartz-Bayes criteria) were minimal and Log likelihood was maximal. At the end, the residual component was verified for white noise.

2.3.6. Constraint analysis

To identify and prioritise the constraints faced by the farmers in 3 states, the ranking method was used during survey. The farmers were asked to give ranks to the different constraints. The constraints with maximum number of farmers were assigned top priority.

3

Socio-Economic Status

The trend and pattern of economic or agricultural development of any region heavily depend on the people and social capital of that region. Therefore, it is necessary to look into the details of the demographic features of the 3 states. In this section, these social parameters of 3 states have been compared with other two agriculturally developed states *viz.* Punjab and Haryana along with the national average.

3.1. Demographic features

3.1.1. Population and their classification

It is quite evident that the 3 selected states right from beginning borne the burden of larger population of the country, even though each had poor agricultural growth. The percentage share of population ranged from 3.5 percent to 8 percent as compared to 1.8 to 2.5 percent in Punjab and Haryana (Table 3.1). Not only this, the current population growth in Bihar and Madhya Pradesh (from here onwards M.P.) are significantly higher than that of in Punjab state. Furthermore, much larger section of the total population in these states are staying back in rural areas creating huge pressure on agriculture in terms of fragmentation of land holding, under-employment in agriculture, low agricultural wages, etc.

Table 3.1. Population growth in recent periods

States	% of total population		Per cent annual growth		Population share, 2001	
	1971	2001	1981-1991	1991-2001	Rural	Urban
Bihar	7.68	8.07	2.34	2.86	89.54	10.46
Madhya Pradesh	5.48	5.87	2.73	2.43	73.54	26.46
Orissa	4.00	3.58	2.01	1.63	85.01	14.99
Punjab	2.47	2.37	2.08	2.01	66.08	33.92
Haryana	1.83	2.06	2.74	2.84	71.08	28.92
India	100	100	2.39	2.15	72.18	27.82

Large dependency on agriculture led to further casualization of agricultural labourers (Chadha, 2001; Bandyopadhyay and Giri, 2001). In Bihar, M.P. and Orissa, more than one third of rural workers are agricultural labourers and the ratio is increasing over the years as marginal farmers are slowly and slowly selling their lands and joining the labour workforce. Unlike in Punjab and Haryana, where non-agricultural enterprises has shared the burden of workforce, in the 3 states under study, only 11 to 23 percent of workers are engaged in non-agricultural enterprises (Table 3.2).

Table 3.2. Classification of workers- 2001

(Per cent of rural workers)

States	Agricultural Labour	Cultivators	Household industry workers	Other workers
Bihar	51.26	31.18	3.65	13.91
Madhya Pradesh	34.11	51.40	3.33	11.17
Orissa	39.12	33.22	5.02	22.64
Punjab	22.00	31.51	3.13	43.36
Haryana	18.93	46.09	2.09	32.89
India	33.20	40.14	3.77	22.90

3.1.2. Health and education

During last 25 years or so, there has been significant improvement in health and education sector in these poor states also. Though, the achievements are not matching even with the national average in terms of infant mortality or literacy level and these are way behind than that of in Punjab and Haryana (Table 3.3). The development in health and education has long-lasting influence on labour productivity- be it in agriculture or non-agriculture enterprises.

About half of India's children are malnourished, a record poorer than the world's poorest area, sub-Saharan Africa. India is home to a quarter of the world's hungry- about 230 million people- according to the World Food Programme. The rise in global food prices and domestic food inflation is pushing India's poor further to the brink. The Global Hunger Index 2008 prepared by IFPRI reveals India's continued lacklustre performance at eradicating hunger as India ranks 66th out of the 88 developing countries.

Table 3.3. Infant mortality, literacy and access to safe drinking water

States	Infant mortality rate, 2008		Literacy rate, 2001		*Household's access to safe drinking water, %	
	1961	2008	1971	2001	1981	2001
Bihar	94	56	23.17	47.00	37.6	86.6
Madhya Pradesh	150	70	27.27	63.74	20.2	68.4
Orissa	115	69	26.18	63.08	14.6	64.2
Punjab	77	41	34.12	69.65	84.6	97.6
Haryana	94	54	25.71	67.91	55.1	86.1
India	122	53	34.45	64.84	38.2	77.9

Source: Economic Survey 2009-10
*Household's access to tap/ handpump/ tubewell

Table 3.4. Under-nourishment and extent of hunger in selected states

States	Prevalence of calorie under-nourishment	Proportion of under-weight among children <5 years	Under-5 mortality rate, reported as deaths per 100	India State Hunger Index score (ISHIS)	Severity of the state by ISHIS
Bihar	17.3	56.1	8.5	27.30	Alarming
Madhya Pradesh	23.4	59.8	9.4	30.90	Extremely alarming
Orissa	21.4	40.9	9.1	23.79	Alarming
Punjab	11.1	24.6	5.2	13.64	Serious
Haryana	15.1	39.7	5.2	20.01	Serious
India	20.0	42.5	7.4	23.31	

Source: Menon *et al (2008)*

With over 200 million people who are food insecure, India is home to the largest number of hungry people in the world. The India State Hunger Index (ISHI) computed by Menon *et al* (2008) by averaging the three underlying components of the hunger index –

viz., the proportion of underweight children, the under-five mortality rate (expressed as a percentage of live births), and the prevalence of calorie under-nutrition in the population revealed that the 3 selected states under study has very poor ranking and in fact Madhya Pradesh falls under 'Extremely alarming' category (Table 3.4).

3.2. Income and Poverty

3.2.1. Per capita net state domestic product (NSDP)

Regional differences in per capita income levels have long been a matter of concern in India. Punjab, the richest State has a per capita SDP which is 4 times that of Bihar at the other end of the spectrum (Table 3.5) and although India's Plans have never adopted quantitative targets for income convergence or reduction in regional disparity over time, the objective of balanced regional development has usually been interpreted to mean that regional differences should narrow with development, and in any case not widen. A reduction in regional inequality is only possible if the poorer States actually grow faster than the richest States, but the pattern of growth witnessed over the years has been quite different (Fig 1). Three of the poorest States, Bihar, Madhya Pradesh and Orissa, which together account for over a fourth of the population of the country, did fare very poorly initially. In fact, the year 2002-03 was inflection point, from where the growth in NSDP accelerated in all states, though, with that growth the divergence between two group of states became very much evident.

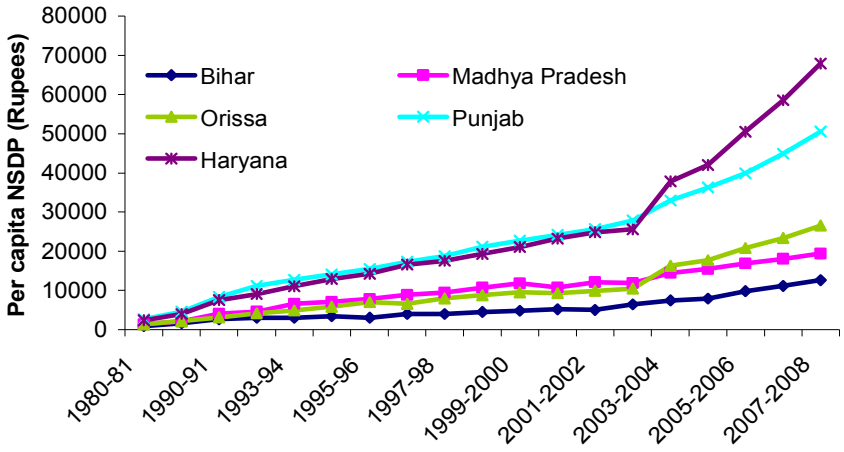


Fig 1. Growth of per capita NSDP in selected states

Table 3.5. Ratio of per capita NSDP with respect to Punjab states

States	Ratio of NSDP w.r.t. Punjab							Growth rates	
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2007-08	1990-2002	2002-07
Bihar	0.34	0.35	0.32	0.22	0.23	0.25	0.25	7.11	14.77
Madhya Pradesh	0.51	0.46	0.49	0.42	0.43	0.42	0.38	11.21	9.59
Orissa	0.49	0.48	0.37	0.39	0.38	0.52	0.52	11.57	18.36
Punjab	1.00	1.00	1.00	1.00	1.00	1.00	1.00	11.01	12.10
Haryana	0.89	0.87	0.90	0.85	0.87	1.27	1.34	12.25	19.98

3.2.2. Income of farmer households from different sources (agricultural year July 2002 to June 2003)

From National Sample Survey (NSS) 2002-03, it was found that the share of wages in the total of income from the four sources was as high as 53-54% in Orissa. Table 3.7 shows very interesting results that though, in all the states, monthly income per household increases with increase in land holding barring few exceptions at lowest strata, where wage income might be surpassing the income from other sources as compared to neighbour category. But, interestingly, in Bihar, the farmers with more than 4 hectares of land holding have higher monthly income than their counterpart even in Haryana state. Therefore, the income inequality in Bihar state is very high. But, overall income for all categories in 3 states- Bihar, M.P. and Orissa were less than the national average. The average monthly income from wages and entrepreneurial activity of farmer households was Rs. 2115 per month at all India level. At all-India level, the average income increased steadily from Rs.1380 per month in the size class '<0.01 hectare' to Rs. 9667 per month in the size class '> 10 hectares'. In Punjab, the average income is seen to be double as one moves from the size class '2.01-4.00 hectares' to'4.01-10.00 hectares' and increase still more steeply as one moves to the next (highest) size class. Table 3.6 reveals that the share of casual labour in total expenses of crop cultivation is higher in 3 states as compared to Punjab and Haryana. This suggests that farmers in these states are hiring more labor than their counterparts in agriculturally developed states thus, badly affecting the profitability from agriculture. In fact, even many small farmers of young generation aren't interested to do the farm operations themselves.

Table 3.6. Percentage composition of average expenses for cultivation per farmer household during the agricultural year July 2002 to June 2003

States	Percentage of cultivation expenses spent on											Average annual expenses on cultivation (Rs.)
	Seeds	Pesticides & insecticides	Fertiliser /manure	Irrigation	Maintenance of machines & equipment	Interest	Lease rent for land	Labour		Other Expen-ses	Total	
								Regular	Casual			
Bihar	15	4	22	17	1	0	5	1	21	13	100	6809
Madhya Pradesh	29	6	21	9	2	1	1	2	17	12	100	8886
Orissa	14	5	21	3	1	1	13	2	32	9	100	3143
Punjab	8	14	19	12	4	2	13	2	16	9	100	25945
Haryana	9	7	16	16	4	3	15	2	11	17	100	18270
India	16	7	23	12	2	1	5	2	20	12	100	8791

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Table 3.7. Average total monthly income per farmer household by size class of land possessed during the agricultural year 2002-03

States	Size class of land possessed (hectares)							
	< 0.01	0.01 - 0.40	0.41 – 1.00	1.01 – 2.00	2.01 – 4.00	4.01 – 10.00	>10.00	all sizes
Bihar	1720	1281	1678	2667	4460	9526	27766	1810
Madhya Pradesh	1157	1033	1106	1193	1439	3066	8000	1430
Orissa	666	875	1035	1425	2456	3724	11451	1062
Punjab	2838	2763	3011	4462	6605	13770	34340	4960
Haryana	1688	2596	2143	2919	4289	5353	16110	2882
India	1380	1633	1809	2493	3589	5681	9667	2115

* Monthly income excludes rent, dividend, interest and remittances.

3.2.3. Poverty

The Tendulakar Committee Report submitted to Planning Commission in the year 2009 suggests that the percentage of the population below the poverty line during last 10 years has declined from 45.3% in 1993-94 to 37.2% by 2004-05. The reduction in poverty of about 8 percentage points in ten years is obviously somewhat slow - at this rate it would take nearly 30 years to bring poverty below 15%. The State level data in Table 3.8 show that all States experienced a decline in poverty over the ten year period with only one exception – Madhya Pradesh. But the pace of decline in poverty in other two states i.e. Bihar and Orissa are precarious- merely 2 to 6 percentage. At such pace, it may take another 50 years or so, to tame the poverty and malnutrition in these poor states. In M.P. states, percent of population BPL has increased by 4 percentage point in both rural and urban areas. This is difficult to explain as per capita NSDP in the state has grown by 11 percent annually during 1990-2002, which means there is an under-current problem of distribution in the state. From Fig 2, it can be observed that more than half of the rural population in the 3 states- Bihar, M.P. and Orissa are below poverty line, which is the highest among all the Indian states.

Table 3.8. Percent of population below poverty line (BPL)

States	1993-94			2004-05		
	Rural	Urban	Total	Rural	Urban	Total
Bihar	62.3	44.7	60.5	55.7	43.7	54.4
Madhya Pradesh	49.0	31.8	44.6	53.6	35.1	48.6
Orissa	63.0	34.5	59.1	60.8	37.6	57.2
Punjab	20.3	27.2	22.4	22.1	18.7	20.9
Haryana	40.0	24.2	35.9	24.8	22.4	24.1
India	50.1	31.8	45.3	41.8	25.7	37.2

* According to Tendulakar Committee's Report, 2009
Source: Economic Survey 2009-10

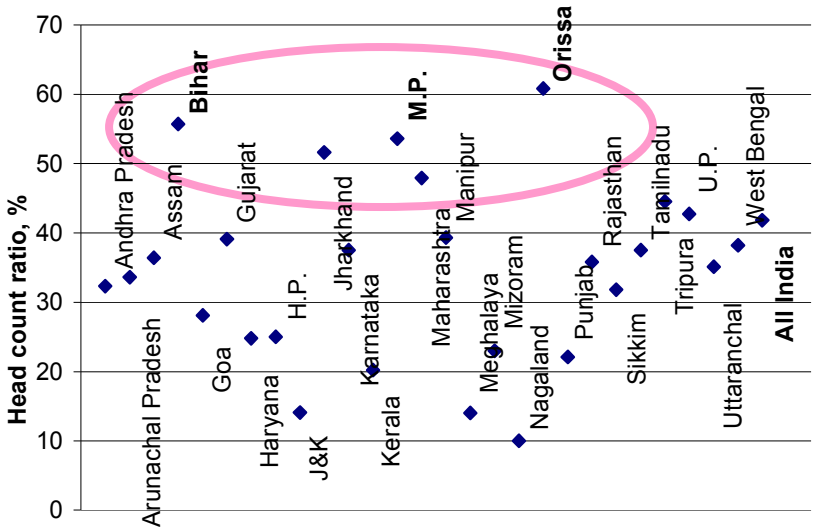

Fig 2. Rural BPL population, 2004-05

3.3. Distribution of land and productive assets

Indian agriculture can be aptly described as small holder agriculture with over two-thirds of holdings in every major state being marginal and small holdings (Table 3.9). In Bihar and Orissa, 70-90 per cent of the farmers have less than 2 hectares of land. Productivity rise on the small holdings, thus, determine the future agricultural prospects of the country and also welfare levels of the rural societies. Land needed to meet the

basic needs of a five-member family in each state under the prevailing productivity conditions is referred to as economic holding. During 1970-73, the economic holdings varied from 1.13 hectares in Kerala to 5.84 hectares in Rajasthan. By 1998-99, the economic holding size dipped to 0.31 hectares in Tamil Nadu and to a maximum of 2.41 hectares in Rajasthan with expansion of irrigation and technology. In fact, in seven states, the size of economic holding was less than one hectare in 1998-99. Percentage of sub-optimal holdings (holdings with operated area less than the economic size) currently at all-India level is about 75 indicating that (Basic Needs Income) unless the rural economy is diversified, the poverty in these states would not be addressed effectively through agriculture alone. Landlessness has been growing at the rate of 0.3 million per annum in rural areas during 1971-72 to 1991-92. Similarly, vulnerability of livelihoods due to sub-optimal landholdings is also high in these states.

Table 3.9. Spread of small and marginal farmers (<2 ha) in India, 2000-01

Share of small & marginal holding	**Share of area operated by small & marginal farmers**						
	<20%	**20-30%**	**30-40%**	**40-50%**	**50-60%**	**60-70%**	**70-80%**
30-50%	Punjab						
50-70%	Raja-sthan	Haryana Gujarat, **M.P.**					
70-90%			C.G., Karna-taka, Maha-rashtra, All India	Assam, A.P.	H.P., **Orissa**, Uttara-khand, T.N.		
>90%						U.P., **Bihar**	Kerala, W.B.

Among the poor farmer-households, livestock remain the mainstay for sustainability of livelihood. From table 3.10, it can be seen that in the selected 3 states, number of most of the livestocks are significantly higher, except poultry which are highly technological driven livestock. The large organized poultry industry in other states like Andhra Pradesh, Maharashtra or Punjab, doesn't make competitive enterprise in these poor states. On the other hand, the basics of farm mechanization i.e. tractor density in

these states are very poor as compared to Punjab, Haryana or even nation as a whole. In Bihar and M.P., tractors are mainly owned by the large farmers, while in Orissa, it is almost nil across the farm sizes (Table 3.11). The poor penetration of tractor makes difficult to entry of new farm implements and machines in the farmers' fields. The reason behind the poor tractor density is the wide-spread of small parcel of lands.

Table 3.10. Average number of selected productive assets possessed per 100 farmer households

States	Cattles	Buffaloes	Sheep, goats & pigs	Poultry/ duckery	Minor implements*	Tractors
Bihar	73	40	24	20	499	1.6
Madhya Pradesh	211	70	70	30	720	4.0
Orissa	172	10	75	173	578	0.2
Punjab	93	230	7	413	647	18
Haryana	64	229	52	10	810	10.9
India	129	68	83	107	633	2.9

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* Sickles, chaff-cutters, axes, spades, etc.

Table 3.11. No. of tractors per 100 farmer households across farm sizes, 2002-03

States	Farmer households in land class (hectares)							
	< 0.01	0.01 - 0.40	0.41 – 1.00	1.01 – 2.00	2.01 – 4.00	4.01 – 10.00	>10.00	all sizes
Bihar	0.1	0.2	0.7	3.0	7.7	37.3	11.2	1.6
Madhya Pradesh	0	0	0.5	1.1	3.0	15.0	55.9	4.0
Orissa	0	0	0.3	0.4	0	7.4	0	0.2
Punjab	0	0.2	10.3	10.9	49.9	71.8	114.8	18.0
Haryana	0	0.1	6.5	8.8	24.8	43.7	89.3	10.9
India	0.2	0.2	1.0	2.6	7.7	18.7	37.8	2.9

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4

Investment, Infrastructure & Input Use

The availability and quality of infrastructure is a critical determinant of rapid economic growth. Agricultural growth depends upon rural infrastructure such as the spread and quality of irrigation, land development, extent of rural electrification, spread of rural roads, etc. Good infrastructure not only increases the productivity of existing resources going into production, it also helps to attract more investment which can be expected to increase growth further. States with the poor economic performance are generally perceived to be lagging behind in this area. The Centre for Monitoring Indian Economy (CMIE) has produced a composite index of the relative infrastructure capacity of different States based on 13 separate components, according to which, the 3 selected states scored almost half of the score or index values obtained by Punjab and Haryana (Table 4.1). Since agriculture is the mainstay of the economy of these States, acceleration of SDP growth necessarily requires acceleration in agricultural growth. This calls for improvement in agriculture related infrastructure such as improved irrigation, regular supply of electric power to rural areas, better road connectivity, provision of easy and cheaper finance, etc. This is a formidable task since the better performing States are not only more able to invest more in infrastructure themselves, they are also more able to attract private investment to these tasks. In these circumstances, the development of infrastructure in the poorer States must have top priority.

Table 4.1. Relative Infrastructure Development Index

States	1980-81	1991-92	1996-97
Bihar	83.5	81.7	77.8
Madhya Pradesh	62.1	71.5	74.1
Orissa	81.5	95.0	98.9
Punjab	207.3	193.4	185.6
Haryana	145.0	143.0	137.2
All India	**100**	**100**	**100**

Source: Centre for Monitoring Indian Economy (CMIE), 1997.

Note : The CMIE infrastructure index is based on 13 variables: per capita electric power, percent of villages electrified, railway route length per 000 sq.km,, surfaced road length per 000 sq.km., unsurfaced road length, handling capacity of major ports, gross irrigated area as % of cropped area, teledensity plus the following per lakh of population: bank branches, post offices, primary schools, hospital beds, and primary health centers. Each indicator is computed for each State relative to the all India average=100. The composite index is the weighted sum of individual indices.

Similarly, according to another district-wise study showed that the composite index based on 6 basic infrastructure facilities in these states are also very disappointing. Table 4.2 exhibits that of the total districts studied in Bihar, M.P. and Orissa, most of them scored between 25-75, while in Punjab and Haryana states, all the studied districts scored more than 50. This shows the dismal performance on basic physical as well as social infrastructure in the states under study.

Table 4.2. Number of districts according to composite index scores for basic facilities

States	No. of districts studied	Composite Index Scores, 1991			
		0- 25	25- 50	50- 75	75- 100
Bihar	28	nil	15	13	nil
M.P.	36	nil	32	4	nil
Orissa	13	5	8	nil	nil
Punjab	13	nil	nil	7	6
Haryana	17	nil	nil	8	9

Source: www.indiastat.org.in

Note: Composite Index Score is a simple arithmetic average of the six Index Scores. (Index Scores have been calculated for six facilities namely, primary school, any medical facilities, hand pump, post office, approach through pucca road and electricity for any purpose in the villages). Composite Scores vary between 0 and 100. A low Composite Score indicates poor extent of availability of the six selected facilities and a high Composite Scores reveals just the opposite.

Successive Human Development Reports have recommended that the rural poor need to be equipped with resources and skill for livelihood options outside the cycle of subsistence agriculture, which needs investment in rural infrastructure. Studies conducted by NABARD demonstrated that rural purchasing power and agricultural productivity are directly linked to transport, irrigation and research infrastructure. According to a study by Fan et al (1999), government expenditure on roads has by far the largest impact on rural poverty followed by agricultural R&D (Table 4.3). Every one million rupees (at 1993 constant price) spent on building rural roads pull at least 165 people out of poverty. Investment in roads reduces rural poverty through productivity growth, but it also increases non-agricultural employment opportunities and leads to higher wage.

Table 4.3. Effects of additional government expenditures on poverty and productivity

Sectors	Marginal impact of spending Rs. 100 billion, % (at 1993 prices)		No. of poor reduced (Per million rupee spending)
	Poverty	TFP	
Roads	-0.87	3.03	165
Agricultural R&D	-0.48	6.98	91.4
Irrigation	-0.04	0.56	7.4
Education	-0.17	0.43	31.7
Power	-0.015	0.02	2.9
Soil & Water Conservation	-0.035	0	6.7
Health	-0.02	N.A.	4.0
Rural development (Anti-poverty) programme	-0.15	N.A.	27.8

Source: Fan, Hazell and Thorat (1999) N.A. is not available.

However, against the above findings, one can find that the poor states (Bihar, M.P. and Orissa) are not poor only due to low productivity but also due to less effort on most poverty abetting factors, *viz.* roads. From Table 4.4, it appears that though road density in the 3 states are comfortably high and in fact in Orissa, it is the highest, but at the same time, the proportion of unsurfaced road in these states are exceptionally high.

Table 4.4. Progress of roads and proportion of unsurfaced roads in selected states

States	Road Density (km per '000 sq km of geographical area)			Proportion of unsurfaced road (Percent)		
	1990-92	2000-02	2004-05	1990-92	2000-02	2004-05
Bihar	496	815	784	63	56	61
M.P.	482	526	537	44	51	51
Orissa	1295	1522	1373	87	78	85
Punjab	1095	1222	908	22	14	31
Haryana	603	637	649	9	7	7
India	616	750	812	47	42	43

Source: CMIE-INFRASTRUCTURE-1998, 1999, 2001 and Road Transport Year Book, 2006-07, Ministry of Road Transport, Government of India

One can understand that the unsurfaced road never attracts public transport system, which can boost the local economy by transporting the local produce from point of production to point of consumption (urban area). In fact, most of these roads are practically for small vehicles or for walking on foot. This is why, due to high proportion of unsurfaced roads in 3 states, the road density figures are too high, which sometimes give misleading trends.

4.1 Public investment in agriculture

The lack of reliable data on investment at the State level makes it very difficult to assess the impact of investment across States which is an important mechanism for economic growth. In the current environment, private investment flows are likely to be reallocated towards States which are perceived as having better infrastructure facilities, better labour skills and work culture, and a more investor friendly environment. The net result could be a substantial increase in investment in the better performing States and a reduction in the others. Since the selected states in the study are considered as poor in not only socio-economic parameters but also infrastructure and governance, the implications of public investment in agriculture has been considered as driving force for the agricultural prosperity.

4.1.1 Public expenditure in agriculture

Trend of public expenditure (includes expenditure on crop husbandry, soil & water conservation, food storage & warehousing and agricultural research & education) by the state governments in agriculture during 1990-2004 given in Fig 3 shows that MP has highest expenditure on agriculture and allied activities, while Bihar has the lowest. In fact, over the years, growth in expenditure by the Government has declined in Bihar. Similarly, in the state of Orissa, investment in agriculture increased significantly after mid-1990s. However, most surprising, most of these expenditures were incurred on revenue account, which means only 10-15 per cent of total expenditures (capital expenditure) were meant for creation of assets. Secondly, the expenditure on agricultural research and education by Punjab and Haryana in recent years are far ahead of other three states under study (Fig 4).

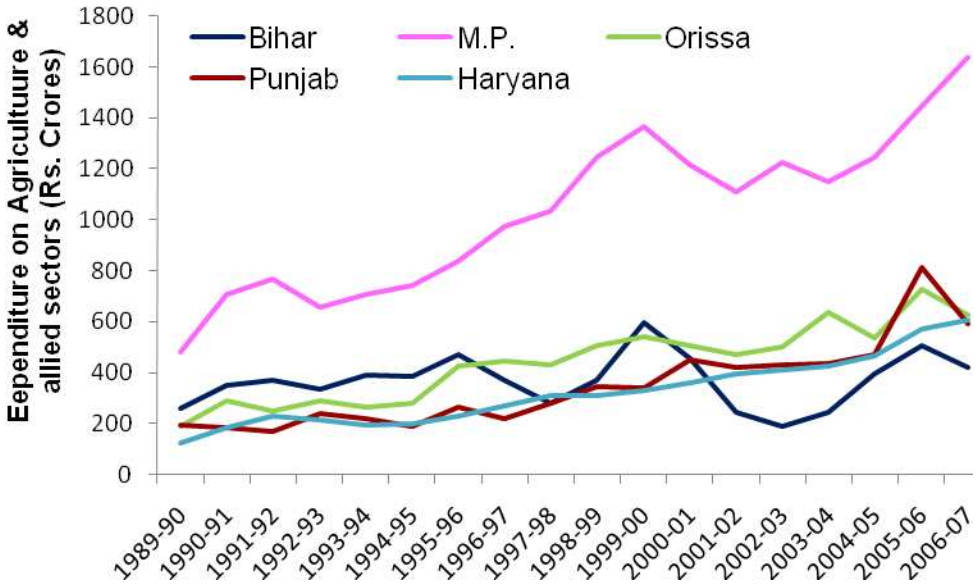

Fig 3. Public expenditure on agriculture & allied activities

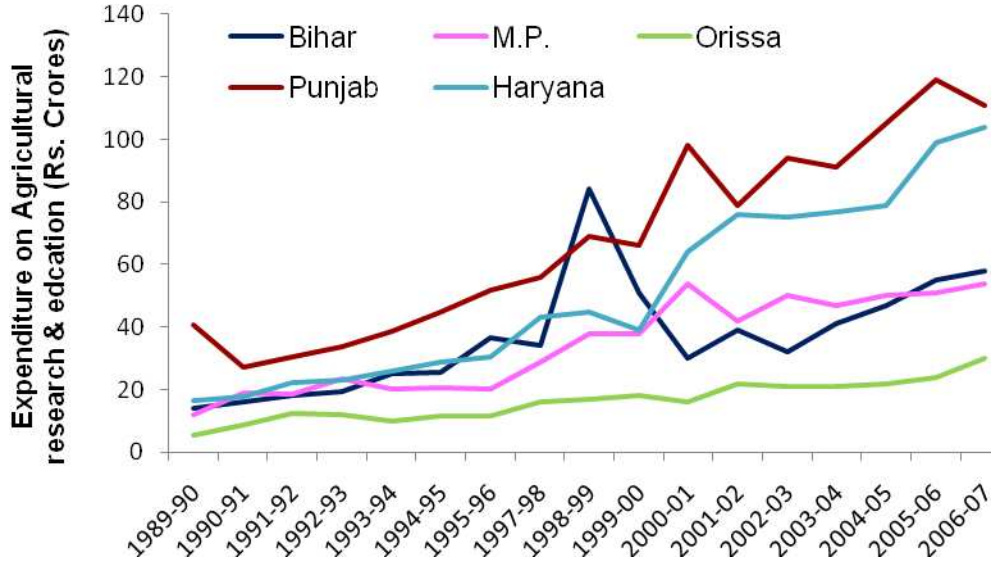

Fig 4. Public expenditure on agricultural research & education

It is very interesting to note that although total expenditure on agricultural development as well as share of these expenditure in total value of agricultural output is the lowest and declining in Bihar state as compared to other two states, but expenditure on agricultural research & education was significantly high till the end of Nineties (Fig 5 & 6). However, of late, its share has declined due to relatively better realization of value of agricultural output in Bihar state. Still, the spending on research & education in Bihar

is the highest (Rs. 58 crores) in 2006-07 followed by M.P. (Rs. 54 crores) and Orissa (Rs. 30 crores).

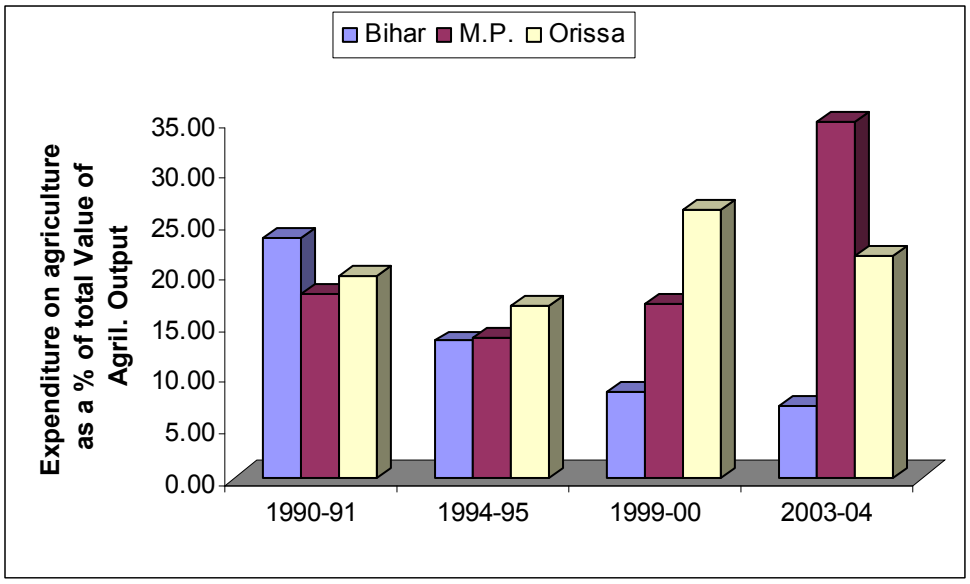

Fig 5. Share of expenditure on agriculture in total value of agricultural output

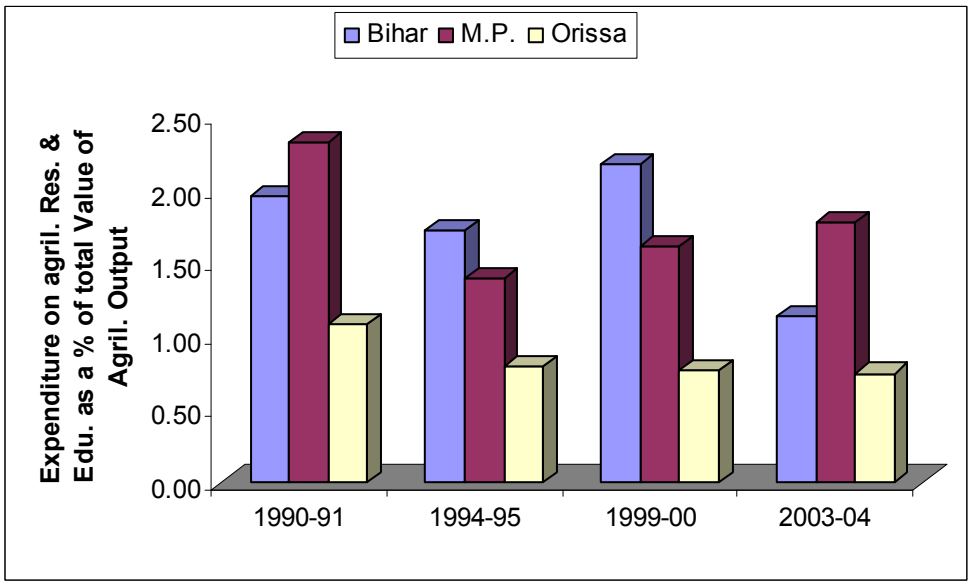

Fig 6. Expenditure on agricultural research & education as %age of total Value of agricultural output

4.2 Growth of factors affecting agriculture

In order to find out the reasons for the stagnation or deceleration in yield growth of food crops in 3 states, trend of critical factors used in agriculture has been analysed and tried to link these changes to output growth. It was hypothesised that the level of agricultural output over time is affected by area, inputs like irrigation, fertiliser, prices, technology and infrastructure. Year to year changes in agricultural output were also influenced by weather, particularly monsoon rainfall. Ramesh Chand *et al* (2007) observed that in Bihar, M.P. and Orissa, growth in parameters like net sown area (NSA), irrigated area, NPK use and electricity consumption in agriculture (ECA) has came down drastically during recent past (1995- 2003).

4.2.1 Area under HYV and Quality Seeds

Available evidence shows that there is a big gap between the level of yield with improved farm practices in farmers' fields and the yield with practices followed by the farmers. Seeds, which are considered the carriers of new technology for crop production and higher crop yields, are a critical input for sustained growth of agriculture. In India more than four-fifths of the farmers rely on farm-saved seeds leading to a low seed replacement rate. Most of the farmers do not distinguish between "seed and grain" and use common grain as seed. Research institutes have very limited capacity for seed multiplication and they can supply only quality seeds in small quantity. So far production and supply of quality seed were mainly entrusted to public sector agencies, namely, the National Seeds Corporation and the state level seed corporations. Compared to the need for quality seed in the country, these corporations as such are serving a limited purpose. India needs to develop a competitive market for seeds by expanding the role of public sector and by encouraging private sector in seed business in a big way alongwith transferring some of the subsidies from other inputs to seed (Chand, 2007).

In India, there are 15 State Seed Corporations besides two national-level corporations, namely National Seeds Corporation and State Farms Corporation of India with the responsibility to provide quality seeds to the farmers. At national level, a total of 9196 tonnes of breeder seeds, 8.22 lakh tonnes of foundation seeds have been produced during 2007-08 and 179 lakh quintals of certified/ quality seeds have been distributed. The level of quality seed production appears to be very small, as against it;

there are 1225.8 lakh hectares of area under foodgrains alone and another 264.5 lakh hectares of area under nine oilseeds during TE 2007-08. At disaggregated level, only 40-50 per cent of gross cropped areas in 3 states are under high yielding variety against 70-90 per cent in Punjab and Haryana (Fig 7).

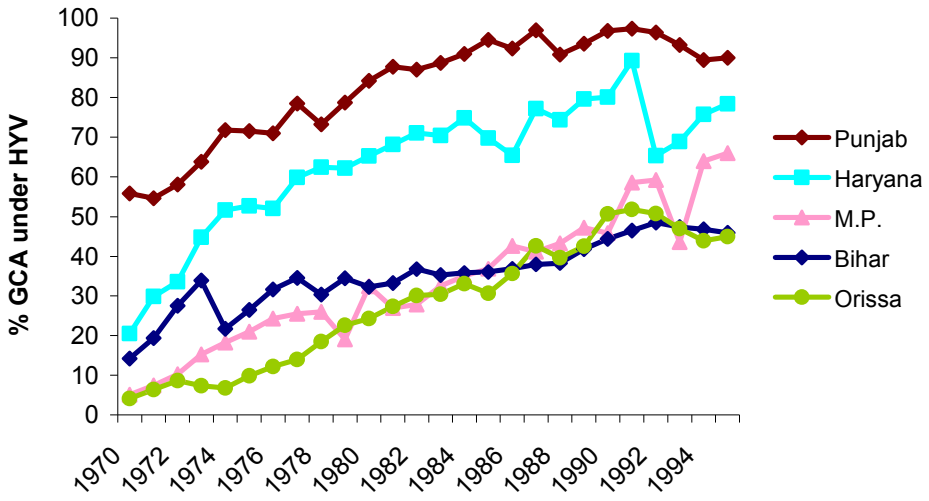

Fig 7. Percent of cropped area sown with high-yielding varieties (HYV)

4.2.2 Seed production and seed replacement rate (SRR)

In Bihar, during last 20 years (TE 1982 to TE 1999), nearly 68 per cent of the rice area, 91 per cent the wheat area and 75 per cent of the maize area were covered by HYV seeds. However, the HYV coverage alone is not sufficient to help raise the productivity unless the seeds are of the required quality accompanied by proper doses of fertilizers and assured water. Unfortunately, seed replacement rate for most of the crops in the state is one of the lowest in the country. Seed replacement ratio in the state is very poor as compared to other states in the country (Table 4.5). The Seed Replacement Ratio for paddy was 12% in 2005-06. For wheat, this ratio has increased from 8.1% in 2003-04 to 11 % in 2005-06. The ratio for cereals is about 10-12%, and for vegetables the ratio has increased from 20% in 2003-04 to 50% in 2004-05. Seed replacement target for vegetables in 2006-07 is 60%. Government of Madhya Pradesh aims to double SRR of all major crops in 3 years by increasing seed production throughout breeder-foundation-certified chain (Table 4.6). In Orissa, area under HYV paddy has increased by 14.26% during the period from 2000-01 to 2004-05, which is currently about 3.0 million ha. The State agriculture policy, 1996 accords priority to multiplication of high

yielding varieties of seeds to replace the traditional varieties being used in the State. With a view to encourage farmers to take up seed production of extra early, early and saline tolerant varieties of paddy suitable for escaping drought condition, production incentives were given to farmers through the Orissa State Seeds Corporation (OSSC). Seed multiplication is organised through departmental agricultural farms, Orissa State Seeds Corporation, seed village programme and private registered seed growers. During 2004-05, 231.60 quintals of extra early, 10,215.70 quintals of early paddy and a total of 89,700.01 quintal of paddy seeds were supplied by the Orissa State Seeds Corporation (OSSC).

Table 4.5. Seed replacement rates in Bihar

(Percent)

Crop	2003-04	2004-05	2005-06
Kharif			
Paddy	6.8	10	12
Maize	30	40	50
Pulses	6	7.5	8
Oilseeds	2	3	5
Rabi			
Wheat	8.1	9	11
Pulses	1.2	7.5	n.a.
Oilseeds	20	25	n.a.
Vegetables	20	50	n.a.

n.a. is Not Available

Table 4.6. Seed production and replacement rate in M.P.

(Seed Production in '000 Qtls, SRR in %)

Crops	2006-07		2007-08		2008-09	
	Seed prodn	SRR	Seed prodn	SRR	Seed prodn	SRR
Soybean	127.3 (4341)	15.84	160.4	14.77	232.4	19.37
Paddy	3.4 (1640)	3.96	2.1	8.85	2.4	11.05
Wheat	85.9 (3978)	8.03	109.3	19.19	120.0	13.62
Gram	5.1 (2743)	2.15	10.2	2.90	13.0	4.41

Figures within parentheses are area (in '000 ha) under the respective crops during TE 2006-07

4.2.3 Growth in irrigation, fertilizer and electricity consumption

Annual growth rates of gross irrigated area, fertilizer (NPK) consumption and electricity consumption in agriculture for two and half decades for 3 states *vis-à-vis* Punjab and Haryana are given in Table 4.7. There is significant volatility in growth of irrigated area in Bihar and Orissa, while in M.P., it is consistent. On the other hand, the growth in fertilizer consumption has slowed down significantly in all 3 states even before peaking out. Similar is the case with electricity consumption in agriculture.

Table 4.7. Growth in irrigated area, fertilizer (NPK) consumption and electricity consumption in agriculture

State	Period	Gross irrigated area	Electricity Consumption in agriculture	NPK consumption in kg/ha
Bihar	**1980-81 to 1989-90**	2.14	11.66	14.98
	1990-91 to 1999-2k	1.92	2.15	6.31
	2000-01 to 2005-06	-0.92	12.17	3.70
M.P.	**1980-81 to 1989-90**	5.19	19.83	15.51
	1990-91 to 1999-2k	2.42	19.01	6.78
	2000-01 to 2005-06	3.32	6.28	3.83
Orissa	**1980-81 to 1989-90**	4.53	10.84	10.2
	1990-91 to 1999-2k	-1.49	3.89	8.93
	2000-01 to 2005-06	3.92	2.81	2.84
Punjab	**1980-81 to 1989-90**	1.95	9.65	4.59
	1990-91 to 1999-2k	0.73	4.44	0.86
	2000-01 to 2005-06	0.48	4.37	3.93
Haryana	**1980-81 to 1989-90**	2.55	9.96	9.65
	1990-91 to 1999-2k	2.04	4.53	3.92
	2000-01 to 2005-06	-0.52	6.17	2.41

Trend and pattern of irrigation

Although irrigation infrastructure has expanded in the three poor states over the years with varying degree, the cropping intensity cold not catch up the trend in these 3 states as compared to other states like Punjab and Haryana (Table 4.8). Cropping intensity in Bihar, M.P. and Orissa are 134, 133 and 151 per cent, respectively in comparison to those of in Punjab and Haryana are 190 and 182, per cent respectively during TE 2005-06. Although, the growth trend in net irrigated area as well as area sown more than once have similar trend, as when irrigation growth decelerated in Bihar and Orissa, cropping intensity also declined, but it couldn't catch up the upward movement with same pace.

Table 4.8. Growth trend in net irrigated area (NIA) and area sown more than once (ASMO) in selected states

(Percent per annum)

States	Net irrigated area			Area sown more than once		
	1980-89	1990-99	2000-05	1980-89	1990-99	2000-05
Bihar	2.28	1.09	-2.86	1.64	0.90	-3.58
M.P.	5.34	5.23	7.54	2.33	5.48	7.95
Orissa	4.96	-5.05	6.22	3.20	-4.52	5.17
Punjab	1.50	-0.51	-0.12	3.04	1.47	0.27
Haryana	1.55	1.44	-0.06	2.53	1.72	1.89

Not only this, if one observe the progress of percentage of net sown area (NSA) irrigated during last one decade (1995-2005), there seems to be almost static (Fig 8). With this trend, it will take another 20-30 years to match the achievement made by Punjab and Haryana where more than 80 percent of NSA is irrigated, unlike 20-50 percent in Bihar, M.P. and Orissa states. There are further disappointments in this trend. In these poor states, efforts by state government in expanding the irrigation network has been lackluster as ratio of canal to well/tubewell irrigated area is continuously and fast declining in Bihar and M.P., except in Orissa where canal irrigated area is much higher (Fig 9). So, most of the irrigation in Bihar and M.P. are done by private investment by the farmers which are based on groundwater irrigation.

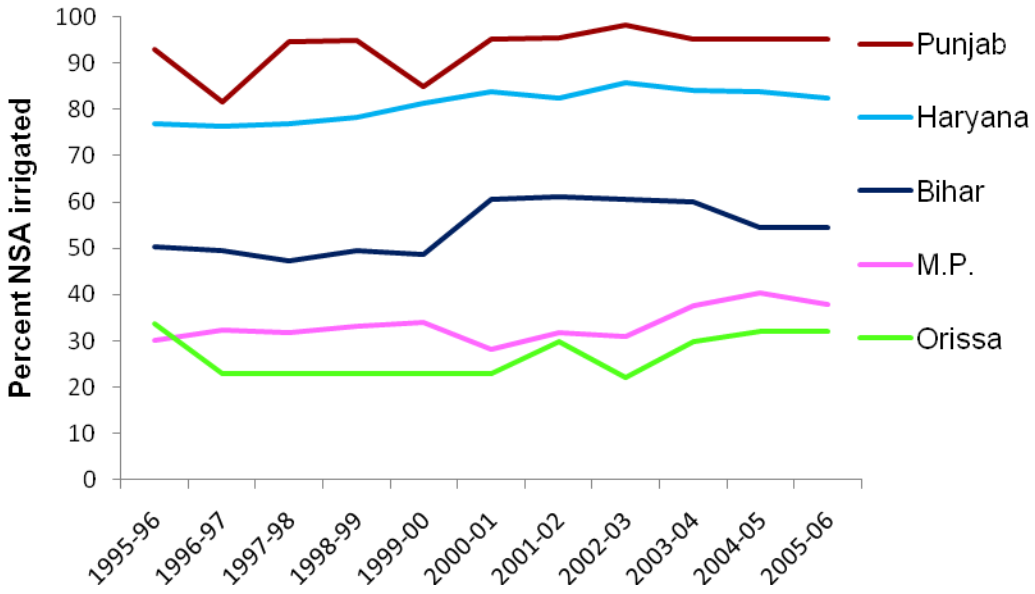

Fig 8. Percent of net sown area irrigated

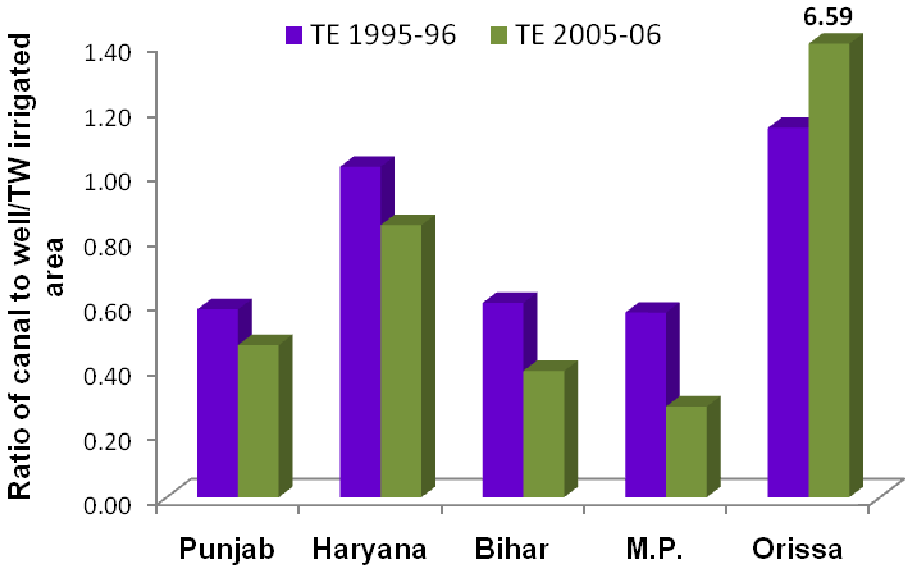

Fig 9. Ratio of canal to well/tubewell irriagted area

Trend of electricity consmption in agriculture

Keeping above trend of declining share of canal irrigation in view, it was expected that the poor farmers in poor region of the country would get some relief from the government in terms of assurred electricity supply, so that they can irrigated their crops easily by groundwater irrigation. But, it is more frustrating to note that the electricity consumption in agriculture in these states are dismal. In fact, even in absolute

term, total electricity consumption as well as per hectare of GCA is declining in 3 states, while in Punjab and Haryana, both are increasing (Table 4.9 & Fig 10). In later two states, more than one-third of electricity consumption are used for agricultural purposes. It is well known fact that across the region, proportion of area under surface irrigation is shrinking while that of by groundwater irrigation is expanding. Under such circumstances, in states like Bihar, M.P. and Orissa, where electricity for irrigation purposes is quite erratic and unreliable, farmers depend on diesel engine for drafting of groundwater. Under spiraling crude oil prices, groundwater irrigation has proved to be uneconomical proposition and therefore it became one of the most limiting factors for increasing crop productivity.

Table 4.9. Electricity consumption in agriculture in selected states in recent years

States	Million KWh		KWh/ha of GCA	
	TE 2000-01	TE 2007-08	TE 2000-01	TE 2007-08
Bihar	1609	723.43	160.65	96.97
M.P.	10323	7281.92	396.17	364.55
Orissa	266	158.18	32.14	18.17
Punjab	6371	9125.85	805.38	1147.47
Haryana	4139	7103.65	672.52	1102.88

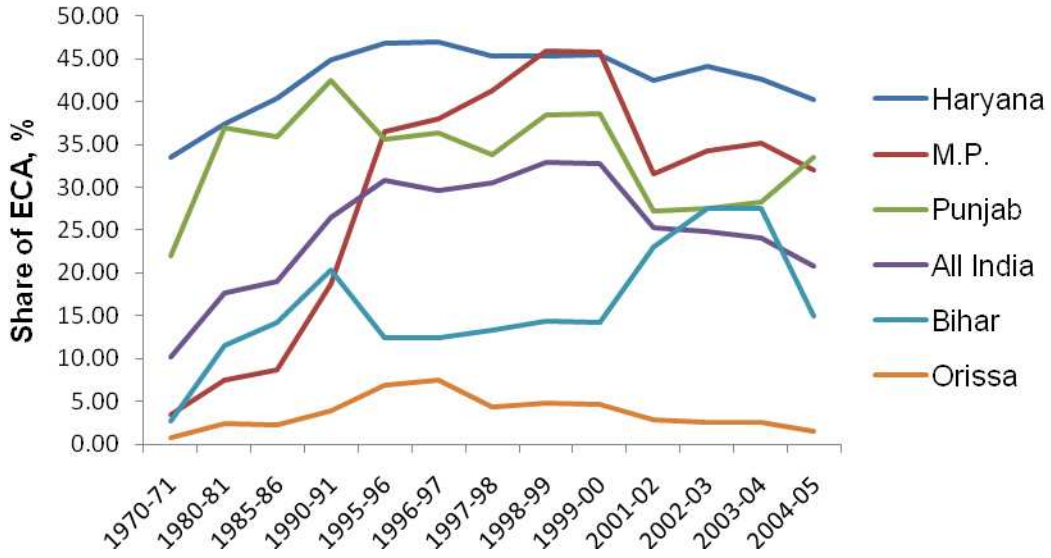

Fig 10. Percent of electricty consumption in agriculture

Trend and pattern of fertilizer consumption

Consumption of chemical fertilizers is also directly proportional to extent of irrigation. Since the selected states have very less area under irrigation, the consumption of chemical fertilizer mainly nitrogen (N), phosphatic (P_2O_5) and potassic (K_2O), from here onwards NPK, in these states is very low- 35-45kg/ha in M.P. and Orissa and slightly more than 100 kg/ha in Bihar (Fig 11) as compared to Haryana and Punjab or even other southern states of the country. Low doses of plant nutrients without supplementing with organic manures accordingly are also important factors for low productivity. From Table 4.10, it is also evident that in these 3 states, nitrogenous fertilizer is the main component of crop fertilization, ignoring the crop requirement of other macro- as well as micro-nutrients.

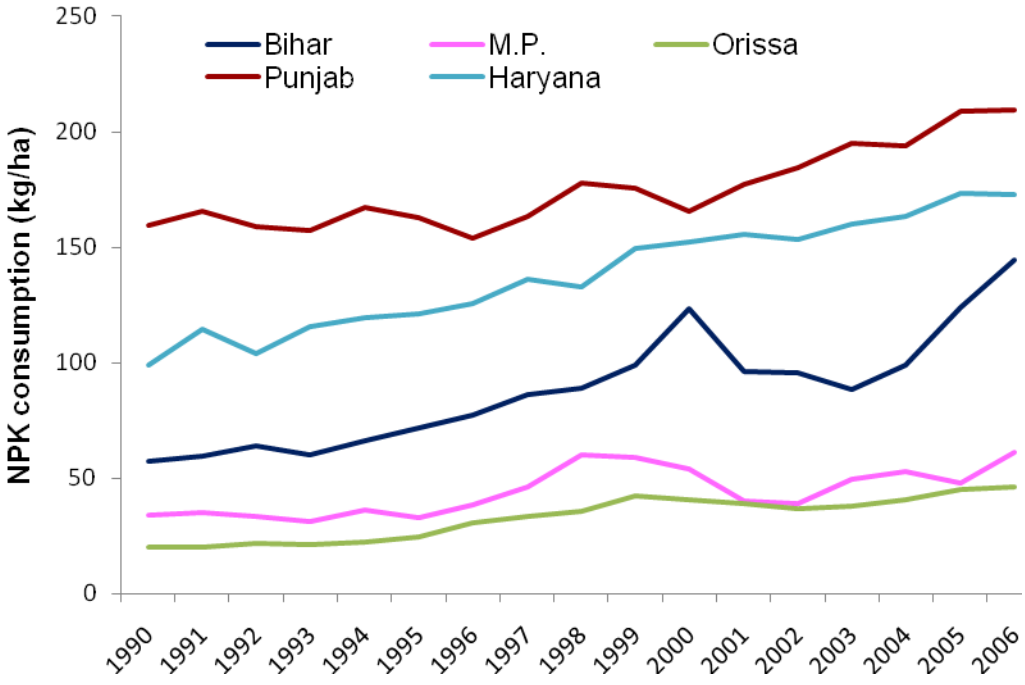

Fig 11. NPK consmption in kg per ha of GCA

Bhalla and Singh (2009) have also studied the trend and pattern of different inputs in major states of the country, which are presented in Table 4.11 for the selected states. It is very interesting to note that before the advent of Green Revolution, though the use of capital intensive inputs were low in 3 states, but cropping intensity was comparable to that of in Punjab and Haryana in the year 1962. Over the years, with all round efforts on irrigation, farm mechanization, fertilizer application, the entire gamut of

agriculture in later two states has changed and went onto different trajectory, while the 3 states under study remain languishing with old pattern of cultivation.

Table 4.10. Diversity in nutrients application across states, 2004-06

(Kg per ha of GCA)

N	**20-40**	**40-70**	**70-100**	**>100**
	Assam, **Orissa**, Rajasthan, Kerala, H.P., **M.P.**	Jharkhand, Chhattisgarh, Maharashtra, Karnataka, W.B.	Gujarat T.N. **Bihar**	Punjab, Haryana, A.P., U.P.
P_2O_5	**10-20**	**20-30**	**30-40**	**40-50**
	H.P., **Orissa**, Rajasthan, Assam, Kerala, **Bihar**, **M.P.,** Chhattisgarh	Jharkhand, Maharashtra, Gujarat	Karnataka, U.P., W.B., Haryana	T.N., Punjab, A.P.
K_2O	**1-5**	**5-10**	**10-15**	**15-50**
	Rajasthan Jharkhand **M.P.**, Haryana	Punjab, **Orissa**, Chhattisgarh, U.P., H.P., Gujarat	**Bihar** Assam Maharashtra	A.P., Kerala Karnataka, W.B., T.N.(45)

Disbursement of institutional credit to agriculture

Easy, timely and cheaper credit plays very important role in the growth of any sector. The concept of priority sector was introduced in 1969 to underscore the imperative of financing certain neglected sectors like agriculture. The channelling of credit to the priority sectors was sought to be achieved through the stipulation that a certain proportion of the total net bank credit be deployed in these sectors by specific target dates. Decentralised credit planning through the Lead Bank Scheme was also introduced to spearhead the credit allocation for, *inter alia*, agricultural lending. However, the divergence in priority sector lending across the regions still remained after 40 years. Disbursement of institutional credit in the 3 states has remained laggard (Rs. 1800-2500/ha) till mid-1990s, while developed states enjoyed more than double of this credit amount (Table 4.12 & Fig 12). Poor credit disbursement for agriculture in the poor states led to collateral damage in the progress of agriculture- on one hand, due to poor economic condition, farmers in these states are not able to use capital intensive inputs like fertilizer, irrigation or plant protection measures, on the other hand, it hampered in realization of higher crop production, thus left with very low investible surplus.

Table 4.11. Divergence in use of various inputs in agriculture

States	Tractors (Nos/'0000 ha)				Pumpsets (Nos/'000 ha)				Fertiliser consumption (kg/ ha)				% of Total cropped area irrigated				Cropping intensity			
	1962	1982	1992	2003	1962	1982	1992	2003	1962	1982	1992	2003	1962	1982	1992	2003	1962	1982	1992	2003
Bihar	2	18	19	130	1	47	89	117	3	24	77	108	18	34	43	48	141	133	133	133
M.P.	1	13	24	130	1	22	47	107	1	14	50	80	6	12	21	28	113	116	121	130
Orissa	1	2	4	28	0	3	6	19	1	14	33	61	16	22	26	30	121	141	152	150
Punjab	24	254	508	704	8	158	170	170	8	209	318	412	58	87	95	97	129	158	180	189
Haryana	7	170	444	549	2	71	143	155	2	71	175	307	31	62	76	84	131	153	164	181
All India	3	37	86	167	5	49	79	111	4	44	91	136	19	29	36	41	115	124	130	135

Source: Bhalla and Singh (2009)

Table 4.12. Growth trend in disbursement of institutional credit to agriculture in selected states

States	Growth of SCB's credit to agriculture (% per annum)			Amount of credit (Rs per ha of GCA)		
	1980-89	1990-99	2000-06	TE 1985-86	TE 1995-96	TE 2006-07
Bihar	18.09	5.99	31.40	276	1380	6157
M.P.	19.87	10.86	24.24	181	617	4570
Orissa	18.32	9.69	24.58	267	629	3389
Punjab	13.29	8.25	23.63	2242	2030	12278
Haryana	15.61	7.11	29.85	1008	1611	11334

SCB= scheduled commercial bank

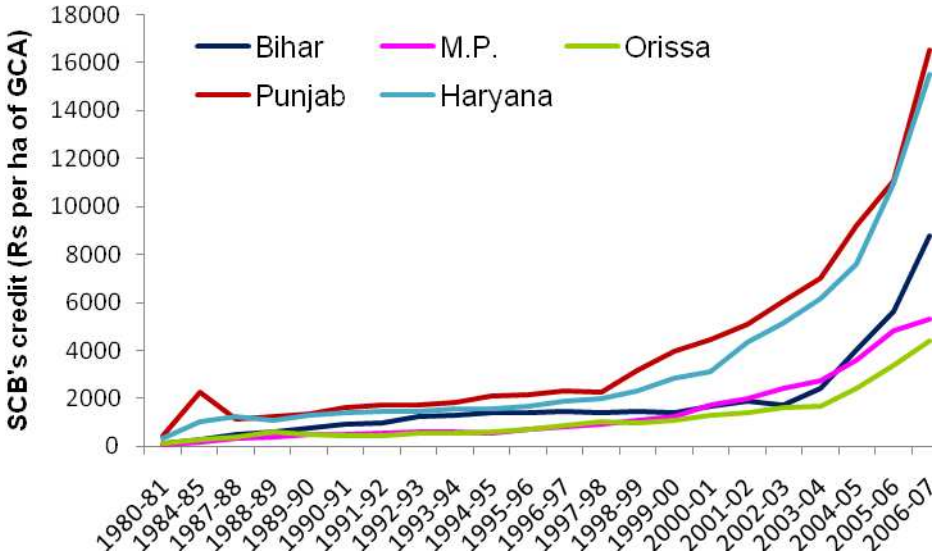

Fig 12. Scheduled commercial banks credit to agriculture

From the aforesaid discussion, it appears that in the selected states, resource poor farmers are struggling due to their own poor economic capacity but also due to the appropriate institutional support from the Governments in terms of physical and social infrastructure as well as assured supply of critical inputs like fertilizer, irrigation, farm credit and public investment.

5 Performance and Forecasts of Agriculture

Despite the declining share of the agricultural sector in gross (state) domestic product across the states, the importance of this sector can hardly be over emphasized in view of the observation that, apart from the fact that this sector still absorbs around 60 percent of the workforce, overall growth in the state economy is dependent on the growth of agriculture. Even though, the growth in agriculture sector as a whole (presented in the form of Net State Domestic Product (NSDP)), has been very dismal in Bihar, M.P. and Orissa as compared to Punjab, Haryana or nation as a whole (Table 5.1). In the earlier section, it was observed that non-agriculture sector in the 3 states has not absorbed sufficient labour-force, even then such negligible growth (0.77 to 2.02 %) is a cause of concern.

Table 5.1. Performance of agriculture with respect to state domestic product

(percent)

States	Share of agriculture & allied sector in GSDP at constant price			Growth rate of NSDP from agriculture		
	1970/71	1990/91	2006/07	1970/71-1979/80	1980/81-1990/91	1991/92-2006/07
Bihar	58.01	38.23	33.04	0.71	2.64	2.02
Madhya Pradesh	59.70	41.04	25.58	-1.79	3.59	1.06
Orissa	65.46	35.80	23.08	1.07	0.99	0.77
Punjab	58.33	47.06	31.93	3.95	5.03	2.25
Haryana	64.64	44.87	21.74	2.43	4.23	2.03
India*	46.30	32.20	18.49	1.39	4.71	2.76

Source: Madhusudan Ghosh (2010)
* For India, the figures are shares of gross domestic product (GDP) at factor cost and the growth rate is of gross domestic product from agriculture (GDPA)

5.1. Value of output from agriculture (VOA)

The increased variation in growth performance in the 1990s reflects the fact that whereas growth accelerated sharply for some States, it actually decelerated in Bihar and Orissa, which had relatively low rates of growth to begin with, and were also the poorest States. Madhya Pradesh have performed reasonably well. Madhya Pradesh's growth in the 1980s was below the national average, but it accelerated significantly in the 1990s

(Table 5.2-5.4). If these growth figures are deflated with the average growth in wholesale price index (inflation), the real growth in production of cereal, pulses and oilseeds turn out to be negative. In Bihar, agriculture has shown significant resilience with 4.79 per cent growth even after recurrent floods and draught. Among crop groups, cereals, pulses and oilseeds in these states have shown either very slow growth or negative growth during the period under study. Most of the positive growth has come from fruits and vegetables sector (Fig 13).

Table 5.2. Trend and growth of value of agricultural output at current prices

States	Average value of output (Rs. Crore)					Annual compound growth rate (%)				
	1962-65	1970-73	1980-83	1990-93	2003-06	1970-73/ 1962-65	1980-83/ 1970-73	1990-93/ 1980-83	2003-06/ 1990-93	2003-06/ 1962-65
Bihar	3933	4299	4128	5065	5241	1.12	-0.41	2.07	0.26	0.70
M.P.	4807	5621	6385	9939	13729	1.97	1.28	4.52	2.52	2.59
Orissa	2439	2639	3427	4544	4166	0.99	2.65	2.86	-0.67	1.31
Punjab	2208	3690	5865	8864	10951	6.63	4.74	4.22	1.64	3.98
Haryana	1630	2345	3156	5158	6928	4.65	3.01	5.04	2.30	3.59
All India	56564	66671	84347	117447	146972	2.08	2.38	3.37	1.74	2.36

Source: Derived from Bhalla and Singh (2009)

Table 5.3. Trend and growth of value of crop yield in selected states at current prices

States	Value of output (Rs. per ha of GCA)					Annual compound growth rate (%)				
	1962-65	1970-73	1980-83	1990-93	2003-06	1970-73/ 1962-65	1980-83/ 1970-73	1990-93/ 1980-83	2003-06/ 1990-93	2003-06/ 1962-65
Bihar	3680	4010	4049	5278	5670	1.08	0.10	2.69	0.55	1.06
M.P.	2603	2836	3070	4406	5640	1.08	0.80	3.68	1.92	1.90
Orissa	4114	4073	4375	5740	6690	-0.13	0.72	2.75	1.19	1.19
Punjab	5396	7476	9708	13215	15373	4.16	2.65	3.13	1.17	2.59
Haryana	3927	5090	6229	9682	11569	3.30	2.04	4.51	1.38	2.67
All India	3738	4257	5090	6957	8460	1.64	1.80	3.17	1.52	2.01

Source: Derived from Bhalla and Singh (2009)

Table 5.4. Growth rates in value of output from different crop groups and sectors in selected states during 1990-2005 at current prices

(per cent per annum)

State	Cereal	Pulses	Oilseeds	Fruits & Vege-tables	Total Agri-culture	Live-stock	Fish-aries
Bihar	2.73	2.15	2.70	8.12	4.98	5.87	8.52
Madhya Pradesh	2.27	6.21	7.52	7.93	5.25	5.94	8.94
Orissa	5.19	0.82	-0.94	10.92	7.01	13.20	8.20
All India	6.98	6.35	5.39	11.65	8.51	10.20	8.28

Average inflation during the period= 4.88

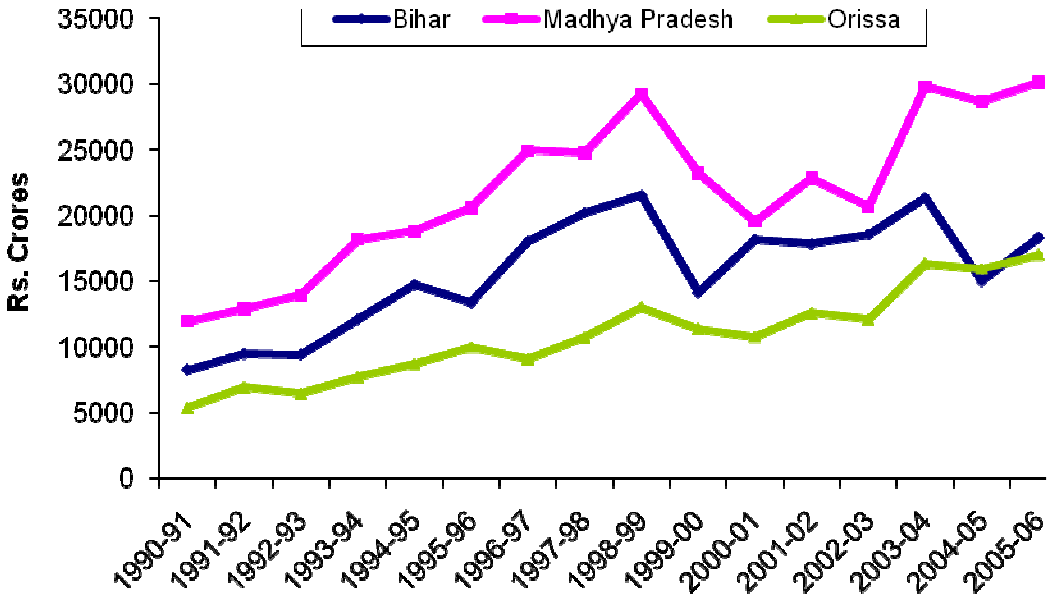

Fig 13. Trend in value of output from total agriculture

5.2. Land productivity

Several researchers have tried to estimate the land productivity of the states considering the value of output from all the crops and dividing with area under all the crops. Singh (2007) and Chand et al (2009) have estimated the land productivity for all the districts in major states of the country. For the 3 states under study, it was observed that there was huge variability in the land productivity (Fig 14a & b). Singh (2007) used

45 crops' output and a weighted average of three year prices for 2001-02, 2002-03 and 2003-04. The coefficient of variation in land productivity among districts in Bihar, M.P. and Orissa were 20.03, 39.18 and 22.02 percent, respectively. While in the study by Chand *et al* (2009) who used the 45 crops' output and a weighted average of two year prices for 2003-04 and 2004-05 observed the coefficient of variation in land productivity in Bihar, M.P. and Orissa to the extent of 31.68, 47.36 and 28.83 percent, respectively. The district-wise land productivity estimated in both the studies is given in Appendix IV-VI.

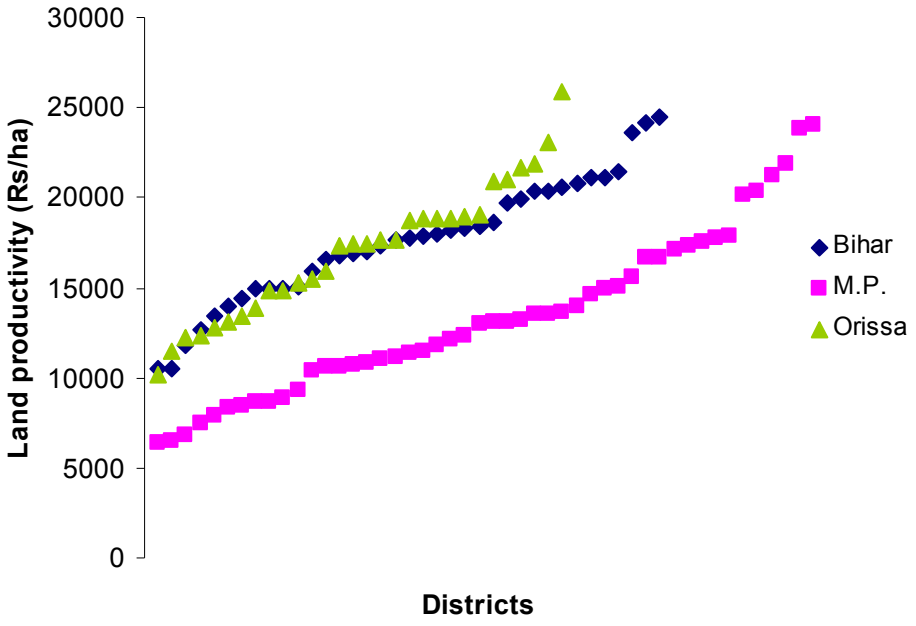

Fig 14a. Land productivity of all the districts by Singh (2007)

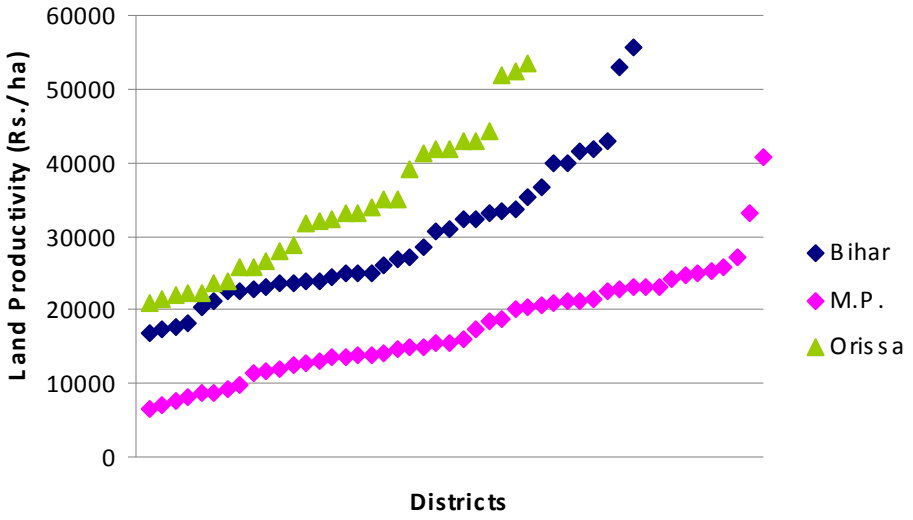

Fig 14b. Land productivity of all the districts by Chand *et al* (2009)

Thus, in the study of Singh (2007), the ratios of best performing and worst performing district in Bihar, M.P. and Orissa were 2.34, 3.74 and 2.55, respectively while in other study, those were 3.32, 6.29 and 2.55, respectively. One more very interesting thing observed was, the land productivity of majority of the districts in M.P. was far below than those in Bihar and Orissa and in fact, among these 3 states, overall Orissa had better land productivity, though it has highest number of people below poverty line. Rai *et al* (2008) have also observed that maximum number of low productive districts are in Madhya Pradesh (25), followed by Rajasthan (18), Orissa (15), and Chhatisgarh (14). Interestingly, in Bihar, only two districts viz. Darbhanga and Supaul were agriculturally low productive.

5.3. Change in cropping pattern in selected states

During past three decades, there has been significant change in the cropping pattern in these states. It can be observed from Table 5.5 that while foodgrain crops have consolidated their position in Bihar, the area under coarse cereals and pulses have declined considerably, which has benefited to rice and wheat crops. There has not been considerable commercialization of agriculture in Bihar. In Madhya Pradesh, area under rice, wheat and maize maintained their share, however, the area under minor cereals and pulses have significantly dropped and therefore the acreage under foodgrains came down from 80 percent in 1975-76 to about 68 percent in 2006-07. These area mainly got substituted by single crop i.e. Soybean. In recent years, there was little surge in area under cotton crop also. In Orissa state, there was upheaval in the choice of crops. The

agriculture of the state is mainly dominated by rice, which are taken in all 3 seasons at some places, though, the area under rice has declined from 63 percent in 1975-76 to around 50 percent. Similarly, share of coarse cereals and pulses in cropping pattern have also declined significantly. Interestingly, area under fruits and vegetables has increased very fast, keeping in view the rapid growth in urban population and thereby increase in demand of these food products. This may be the reason that as given in previous section, the land productivity in almost all the districts of Orissa is higher than those of in Bihar and Madhya Pradesh states, as horticultural crops fetches much better prices than the field crops.

Table 5.5. Changing share of different crops in the selected states

(% of GCA)

States	Triennium ending	Rice	Wheat	Maize	Coarse cereals	Pulses	Food-grains	Edible Oilseeds	Fibres	Sugarcane	Remaining crops
Bihar	1975-76	47.59	14.66	7.69	11.18	14.03	89.38	1.69	1.42	1.28	6.23
	1985-86	49.57	18.05	6.76	9.30	11.75	89.61	1.45	1.88	1.16	5.89
	1995-96	49.88	21.24	6.05	7.56	9.76	91.07	1.62	1.68	1.25	4.37
	2006-07	50.14	22.22	7.83	8.36	9.14	92.60	1.26	1.74	1.13	3.28
Madhya Pradesh	1975-76	21.44	15.03	3.06	21.06	22.22	80.71	6.27	3.03	0.27	9.72
	1985-86	21.71	15.97	3.76	19.54	21.96	80.29	8.86	1.38	0.31	9.16
	1995-96	21.13	16.50	3.46	13.23	11.27	70.99	20.11	1.97	0.19	6.74
	2006-07	21.11	15.97	4.04	10.44	13.16	67.76	21.65	2.27	0.23	8.10
Orissa	1975-76	62.52	0.77	1.36	7.11	13.99	84.25	5.49	1.13	0.59	8.54
	1985-86	47.33	0.68	1.89	7.32	15.88	73.60	9.68	0.97	0.53	15.22
	1995-96	46.47	0.21	0.52	2.24	8.49	58.48	4.57	0.41	0.21	36.33
	2006-07	51.64	0.06	0.66	1.96	7.83	61.18	3.32	0.35	0.16	34.99

5.4. Growth and instability in foodgrain production

As is evident from table 5.6, the area under the foodgrain crops in these three states have decelerated. At the same time, the yields of these crops are moving towards stagnation (compound growth rate ≤ 1%). The situation has further aggravated due to high volatility in crop yield (CV ≥ 10%), which adversely affect the profitability of widespread small and marginal farmers in the study area, who are, as a result, left with negligible investment surplus in agriculture.

Table 5.6. Growth and instability in food grain production in study area

State	Area			Production			Yield		
	Average ('000ha)	CGR, %	CV, %	Average ('000 t)	CGR, %	CV, %	Average (kg/ha)	CGR, %	CV, %
Bihar									
1980-89	3538	-4.45	33.64	3839	-0.36	32.41	1106	4.28	19.36
1990-99	4958	10.71	36.18	7429	12.47	43.00	1490	1.59	15.27
2000-07	6868	-0.84	3.99	10456	-2.32	14.80	1504	-1.49	11.76
M. P.									
1980-89	11531	2.02	12.13	9626	3.62	12.37	838	1.56	9.03
1990-99	11343	0.55	21.66	12513	3.43	21.91	1109	2.87	10.53
2000-07	11483	1.56	8.61	12659	3.58	18.30	1094	1.99	10.54
Orissa									
1980-89	6685	-0.10	5.52	6180	2.88	16.95	921	2.98	13.54
1990-99	5845	-2.67	11.50	6500	-3.02	15.07	1112	-0.36	10.46
2000-07	5271	-0.67	4.40	6576	5.91	23.16	1244	6.62	21.80

CGR= compound growth rate per annum, CV= co-efficient of variation

Frequent natural calamities in Bihar kept the foodgrain (FG) production of the state on tenterhook, due to which overall production grew by 9.35 per cent during Seventies, but it decelerated in next decade by about 2 per cent annually followed by resumption by over 5 per cent and again came back in negative zone (Fig 15). It is quite interesting to note that the foodgrain production growth in Orissa was just opposite to that of Bihar state, i.e. when the growth was phenomenal in Bihar, it decelerated in neighbour state (Orissa) and when the production declined in Bihar state, it was very satisfying in Orissa state. This diametrically opposite connection between two states needs to be carefully treaded, as both the states are prone to frequent natural calamities. In the third state i.e. Madhya Pradesh, foodgrain production increased steadily during last 35 years. The positive trends in FG production during entire period

are due to consistent growth in irrigated area, fertilizer consumption, and public expenditure in agriculture; thereby increase in yield of almost all the cereals and pulses.

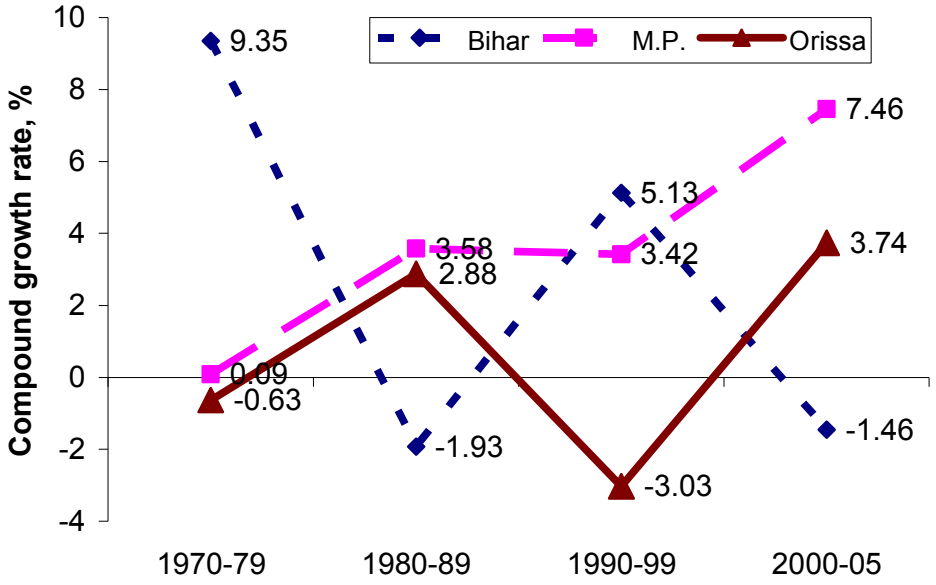

Fig 15. Growth in foodgrain production in selected states

5.5. Production trends of major crops in selected states

Crop-wise growth in area and yield of major crops grown in the selected states give better picture for the entire period. Due to lack of data on fruits and vegetables for quite long period for the selected states, growth analysis for only last period has been included in the report. From Table 5.7, it can be observed that rice-wheat is the most dominating cropping system in Bihar state. Though, during early Seventies, crops like ragi, jute, etc. had very good share in the cropping pattern. During last 5 years (2000-05), the growth in crop yield has become stagnant or negative in case of most of the crops including wheat and rice. Not only this, considerable deceleration in area under rice, maize, arhar, total foodgrains, rapeseed & mustard is eminent during this period. Crops like ragi, gram, linseed and jute are continuously loosing cropping area. These kinds of trends may also be due to the severe draught and flood situations in regular basis in the states. In the recent years, therefore, total foodgrain production has also declined in the state. Several research studies have reported the plight of small and marginal farmers to other states in search of employment due to incessant uncertainties in agriculture during such vagaries of nature in the state. Horticultural crops particularly, vegetables showed significant improvement in the recent years as the area as well as yield of these crops have considerably improved.

Table 5.7. Production performance of major crops in Bihar state

CROPS		A: '000ha Y: kg/ha (TE 2005-06)	Growth in % p.a.			
			1970-79	1980-89	1990-99	2000-05
Rice	Area	3405	1.30	0.07	0.17	-0.51
	Yield	1296	0.08	5.10	4.58	0.85
Ragi	Area	15.45	0.99	-8.35	-2.94	-3.42
	Yield	753	7.61	1.37	2.02	-6.03
Wheat	Area	2061	7.13	2.65	0.81	0.37
	Yield	1700	2.72	2.55	2.10	-2.42
Maize	Area	628	-1.95	-2.66	0.51	-0.33
	Yield	2236	3.39	5.45	1.80	-0.57
Gram	Area	63	-3.94	-1.58	-4.51	-7.31
	Yield	975	3.60	1.53	-0.63	1.30
Arhar	Area	36	-4.07	-3.44	-0.07	-2.08
	Yield	1238	1.77	3.56	-1.08	-2.05
Total Foodgrains	Area	6794	5.64	-5.62	5.06	-0.58
	Yield	1475	3.71	3.69	0.07	-0.88
Linseed	Area	35	0.46	-2.97	-2.26	-2.67
	Yield	714	-2.84	0.64	2.38	2.45
Rapeseed & Mustard	Area	94	0.97	1.85	0.01	-1.79
	Yield	830	-0.73	7.18	-0.93	-2.40
Edible Oilseeds	Area	139	1.12	1.30	1.51	-1.65
	Yield	982	-1.32	7.09	-1.10	-2.31
Sugarcane	Area	102	-2.74	-0.71	-4.30	1.48
	Yield	41906	-3.11	5.65	-0.85	-0.41
Jute	Area	144	4.85	-4.81	-1.26	1.83
	Yield	1590	-0.02	3.79	-0.09	-1.63
Potato	Area	151	3.54	-0.03	1.06	1.10
	Yield	9180	-0.54	2.96	-0.72	0.02
Fruits	Area	292.70	n.a.	n.a.	n.a.	1.79
	Yield	10548	n.a.	n.a.	n.a.	-1.28
Vegetables	Area	747	n.a.	n.a.	n.a.	6.48
	Yield	15585	n.a.	n.a.	n.a.	4.20

n.a.= Data for respective periods not available.

Table 5.8. Production performance of major crops in Madhya Pradesh state

CROPS		A: '000ha Y: kg/ha (TE 2005-06)	Growth in % p.a.			
			1970-79	1980-89	1990-99	2000-05
Rice	Area	1688	2.15	-0.61	1.24	-1.50
	Yield	982	-12.85	0.35	1.53	2.25
Jowar	Area	667	-0.18	-2.79	-9.22	1.04
	Yield	1091	-2.14	1.93	-0.37	5.76
Wheat	Area	3995	1.29	0.56	3.38	3.58
	Yield	1771	-0.40	3.33	2.35	3.09
Gram	Area	2682	1.51	1.22	2.21	8.45
	Yield	925	-3.73	1.14	2.55	1.18
Soybean	Area	4354	18.64	25.72	7.89	-0.58
	Yield	994	-3.79	6.70	1.96	3.40
Maize	Area	885	3.06	1.64	0.28	1.29
	Yield	1642	1.30	3.98	1.01	0.11
Total Foodgrains	Area	12332	1.58	2.02	0.55	3.71
	Yield	1173	-1.49	1.56	2.87	3.75
Cotton	Area	592	-0.33	-3.27	-1.08	3.54
	Yield	567	1.38	4.19	5.32	17.53
Arhar	Area	318	-0.39	-0.56	-2.52	0.86
	Yield	773	-4.15	3.31	0.53	2.10
Groundnut	Area	214	-3.79	0.07	-1.89	-1.85
	Yield	1138	-1.45	4.94	3.35	1.72
Sesamum	Area	152	-4.49	-1.98	-4.36	-1.82
	Yield	381	-12.05	6.79	1.33	5.78
Linseed	Area	136	-7.52	-0.01	-2.09	-5.27
	Yield	425	-7.97	3.34	2.83	4.88
Rapeseed & Mustard	Area	702	-2.19	10.62	2.49	6.29
	Yield	1042	-12.56	4.11	-0.10	4.45
Nigerseed	Area	103	-6.07	-1.26	-1.25	-0.71
	Yield	230	-14.07	2.58	3.84	5.63
Fruits	Area	47.56	n.a.	n.a.	n.a.	0.96
	Yield	21417	n.a.	n.a.	n.a.	-5.85
Vegetables	Area	161.74	n.a.	n.a.	n.a.	9.12
	Yield	13973	n.a.	n.a.	n.a.	0.61

n.a.= Data for respective periods not available.

Agriculture in Madhya Pradesh state has experienced sea-change during last 3-4 decades. After getting the introduction of soybean, a wonder crop, during mid-seventies, the attention of all stake-holders got diverted towards this crop. Resultantly, not only area under this crop zoomed by 19-25 per cent annually during Seventies and Eighties, but many erstwhile important crops like jowar, cotton, arhar, almost all kharif season oilseed crops started loosing their grip over cropping pattern (Table 5.8). In fact, negligence towards these crops also affected their yield drastically. Trend continued till recently until the yield of soybean crop fluctuated violently during Nineties, after which area under it seized to expand. Paddy and maize are the two kharif crops, which kept the farmers buoyant on account of home consumption need and stability in price and yield, due to which the area under these crops not declined much. Together with this, their yield in the state has consistently improved. Another important change in M.P. agriculture observed was increase in area under wheat crop due to expansion of irrigation after 1990-91. In several pockets of M.P. state, sprinkler irrigation in wheat crop gave big boost to the farmers' confidence as well as crop area and yield. Subsequently, area under and yield of wheat has grown by more than 3 % p.a. since 1990. Similarly, yield of cotton has improved significantly in Khargone, Khandwa and Dewas district, particularly. On net-net basis, area under foodgrains has consistently improved in the state and there is more reason to cheer that yield of most of the crops have steadily improved due to increase in input use- fertilizer, irrigation and quality seeds backed with public investment in agriculture.

In Orissa state, as indicated in Table 5.9, the agriculture is highly diversified as except rice, no single crop occupies more than 2 per cent of GCA. During Seventies, many crops like jowar, ragi, maize, groundnut, rapeseed & mustard, sesamum, edible oilseed, nigerseed & chillies etc. had very good share in the cropping pattern. If the area were compared with present status, there was decline in area under these crops by 121 per cent for ragi, 155 per cent for wheat, around 500 per cent for small millets, 105 per cent for sugarcane, 245 per cent for rapseed & mustard, 141 per cent for sesamum, 182 per cent for potato crops. Besides, area under jute crop has declined drastically to one-sixteenth (-1592%) as compared to early Seventies level.

Unfortunately, the state has experienced Nineties as worst decade, as frequent cyclone and super-cyclone has completed destroyed all the crops in coastal districts during 1994 and 1999. The effect didn't remain limited during those years, but its damaging effect on rural infrastructure catapulted several crops. The yield of crops like ragi and almost all

Table 5.9. Production performance of major crops in Orissa state

CROPS		A: '000ha Y: kg/ha (TE 2005-06)	Growth in % p.a.			
			1970-79	1980-89	1990-99	2000-05
Rice	Area	4465	-1.79	0.40	0.16	0.25
	Yield	1532	-0.25	3.56	-1.44	6.10
Jowar	Area	10	3.87	-2.44	-8.59	-7.69
	Yield	996	-1.84	-0.85	-3.77	-1.05
Ragi	Area	70	8.26	-3.10	-10.51	-4.18
	Yield	634	-3.17	1.88	-2.79	2.25
Maize	Area	55	7.19	-0.36	-11.45	2.27
	Yield	1417	-2.32	0.75	3.72	7.06
Wheat	Area	5	0.86	-6.97	-7.24	-24.20
	Yield	1471	1.47	-1.52	-3.46	3.41
Arhar	Area	125	5.40	6.09	-0.75	-1.57
	Yield	672	-2.16	4.43	-8.63	0.54
Total Foodgrains	Area	5423	1.18	-0.10	-2.67	0.02
	Yield	1345	-1.81	2.98	-0.36	3.72
Groundnut	Area	77	9.79	8.43	-14.07	4.28
	Yield	1207	-7.84	-0.02	-4.40	7.07
Sesamum	Area	38	11.46	6.93	-16.50	-3.10
	Yield	207	-6.17	1.51	-14.38	6.76
Nigerseed	Area	130	7.11	3.78	-3.23	7.51
	Yield	245	-5.49	0.71	-4.86	-9.81
Rapeseed & Mustard	Area	16	12.76	-0.06	-20.92	4.28
	Yield	195	-6.01	0.68	-11.71	5.57
Edible Oilseeds	Area	261	11.28	5.84	-16.13	1.59
	Yield	521	-7.65	1.48	-5.56	8.93
Chillies	Area	75	9.80	4.00	0.93	1.59
	Yield	839	-1.84	0.28	-0.29	-0.11
Jute	Area	3	-1.17	-5.08	-17.56	-9.94
	Yield	1260	2.06	2.58	-8.22	-5.31
Fruits	Area	231.73	n.a.	n.a.	6.92	1.72
	Yield	6103	n.a.	n.a.	-1.77	0.01
Vegetables	Area	642.67	n.a.	n.a.	0.91	-1.18
	Yield	12035	n.a.	n.a.	2.65	1.85

n.a.= Data for respective periods not available.

the edible oilseeds has declined significantly over the years, since these crops have been pushed to marginal land. Fortunately, during last 5 years (2000-05), the growth in crop yield has increased or remained positive in case of rice, maize, groundnut, sesamum, rapeseed & mustard (R/M), edible oilseeds etc. Adding further agony to the state agriculture, growth in production (i.e. sum of growth in area and yield) of wheat, though minor crop for the state, has declined sequentially since 1980. Production of groundnut, sesamum, R/M and jute has decelerated to the extent of 20-30 per cent during nineties, which means even the growths during 2000-05 were positive for these crops, but still lower than the production level achieved 15 years before.

Table 5.10. Crops under different growth performance in Bihar

	Seventies	**Eighties**	**Nineties**	**2000-05**
AREA				
Negative	Maize, Gram, Arhar, Sugarcane	Maize, Ragi, Gram, Arhar, Linseed, Sugarcane, Potato, Jute, **Foodgrains**	Ragi, Arhar, Linseed, Sugarcane, Jute	Rice, Wheat, Ragi, Gram, Arhar, Rapeseed-mustard, Linseed, Sugarcane, Jute, **Foodgrains**
Low (<2%)	Rice, Ragi, Rapeseed-mustard, Linseed	Rice, Rapeseed-mustard	Rice, Maize, Wheat, Rapeseed-mustard, Potato	Maize, Potato
Medium (2-5%)	Potato, Jute	Wheat	Gram	
High (>5%)	Wheat, **Foodgrains**		**Foodgrains**	
YIELD				
Negative	Rapeseed-mustard, Linseed, Sugarcane, Potato, Jute		Gram, Arhar, Rapeseed-mustard, Sugarcane, Potato, Jute	Rice, Maize, Wheat, Ragi, Gram, Arhar, Sugarcane, Potato, **Foodgrains**
Low (<2%)	Rice, Arhar	Ragi, Gram, Linseed	Maize, **Foodgrains**	Rapeseed-mustard
Medium (2-5%)	Maize, Wheat, Gram, **Foodgrains**	Wheat, Arhar, Potato, Jute, **Foodgrains**	Rice, Wheat, Ragi, Linseed	Jute
High (>5%)	Ragi	Rice, Maize, Rapeseed-mustard, Sugarcane		Linseed

Table 5.11. Crops under different growth performance in Madhya Pradesh

	Seventies	Eighties	Nineties	2000-05
AREA				
Negative	Jowar, Bajra, Arhar, Groundnut, R-M, Sesamum, Linseed, Nigerseed, Cotton	Rice, Jowar, Bajra, Barley, Arhar, Sesamum, Linseed, Nigerseed, Cotton	Jowar, Bajra, Arhar, Linseed, Groundnut, Sesamum, Nigerseed, Cotton	Rice, Jowar, Barley, Linseed, Soybean, Groundnut, Nigerseed
Low (<2%)	Wheat, Barley, Gram, **Foodgrains**	Maize, Wheat, Gram, Groundnut, Potato	Rice, Maize, Barley, **Foodgrains**	Maize, Arhar, Sesamum
Medium (2-5%)	Rice, Maize, Potato	**Foodgrains**	Wheat, Gram, R-M	Bajra, Wheat, Cotton, Potato, **Foodgrains**
High (>5%)	Soybean,	Soybean, R-M	Soybean, Potato	Gram, R-M
YIELD				
Negative	Rice, Jowar, Bajra, Wheat, Barley, Gram, Arhar, Nigerseed, Groundnut, Soybean, R-M, Sesamum, Linseed, **Foodgrains**	Barley, Potato	Jowar, R-M	Maize
Low (<2%)	Maize, Potato	Rice, Jowar, Gram, **Foodgrains**	Rice, Maize, Barley, Arhar, Soybean, Sesamum	Barley, Arhar, Groundnut, Potato
Medium (2-5%)		Bajra, Maize, Wheat, Arhar, Groundnut, R-M, Linseed, Nigerseed, Cotton	Bajra, Wheat, Gram, Potato, Groundnut, Linseed, Nigerseed, **Foodgrains**	Bajra, Wheat, Gram, Rice, **Foodgrains**
High (>5%)	Cotton	Soybean, Sesamum	Cotton	Jowar, Soybean, R-M, Sesamum, Linseed, Nigerseed, Cotton (16.80%)

R-M means Rapeseed-Mustard

Table 5.12. Crops under different growth performance in Orissa

	Seventies	Eighties	Nineties	2000-05
AREA				
Negative	Rice	Jowar, Maize, Wheat, Ragi, Gram, R-M, Sugarcane, Sweet Potato, Mesta, **Foodgrains**	Jowar, Maize, Wheat, Ragi, Gram, Arhar, Other pulses, Groundnut, R-M, Sesamum, Niger-seed, Mesta, Sugar-cane, S.potato, **Foodgrains**	Jowar, Wheat, Ragi, Arhar, Mesta
Low (<2%)	Wheat, Mesta, Sugarcane, **Foodgrains**	Rice, Onion	Rice, Chillies, Onion	Rice, Sesamum, Chillies, **Foodgrains**
Medium (2-5%)	Jowar	Other pulses, Nigerseed, Chillies		Other pulses, Nigerseed, Sugarcane, S.potato
High (>5%)	Maize, Ragi, Gram, Arhar, Other Pulses, Groundnut, R-M, Sesamum, Niger-seed, Chillies, Onion	Arhar, Groundnut, Sesamum		Maize, Gram, Groundnut, R-M, Onion
YIELD				
Negative	Rice, Jowar, Ragi, Maize, Gram, Arhar, Other Pulses, R-M, Groundnut, Sesa-mum, Nigerseed, Sugarcane, Chillies, Onion, **Foodgrains**	Jowar, Wheat, Other pulses, Groundnut	Rice, Jowar, Wheat, Ragi, Gram, Arhar, Other pulses, Mesta, Onion, Chillies, Groundnut, R-M, Sesamum, Niger-seed, Sugarcane, **Foodgrains**	Jowar, Nigerseed, Chillies
Low (<2%)	Wheat, Mesta	Maize, Ragi, Gram, Chillies, S.potato, R-M, Niger-seed, Sugarcane	Sweet potato,	Wheat, Gram, Sugarcane, S.potato
Medium (2-5%)		Rice, Mesta, Onion, **Foodgrains**	Maize,	Ragi, Other pulses, Mesta
High (>5%)		Arhar		Rice, Maize, Arhar, Groundnut, R-M, Sesamum, Onion, **Foodgrains**

R-M means Rapeseed-Mustard

Summarizing these growth performances, one can clearly see that few crops in the 3 states have continuously remained laggard (Table 5.10 to 5.12 above). From the aforesaid discussion, it is apparent that the agriculture in M.P. state is poised to do well, while that in Bihar needs little more attention to make the turn around possible, though current year SDP growth has already shown some sign of resilience. Orissa state needs to carefully tread into the reasons and their corrective mechanism to support the large portion of the population depending on agriculture. The selection of crop, variety, supply of critical inputs like seed, fertilizer, credit, etc. call for special attention.

5.6. Relationship between agricultural production and critical inputs

The decline in growth of crops' production should not be seen in isolation, as it depends on not only the various types of inputs used by the farmers and vagaries of nature, but also to institutional arrangements related to rural infrastructure in these states. In this section, correlation was established among various variables related to agricultural production for the 15 years period (1990-2005). In absence of data for Bihar and M.P. alone for the period before the year 2000, when two states were carved out from these two, these analysis are based on combined data of Bihar+Jharkhand and M.P.+Chhattisgarh states. In all three selected states, disbursement of agricultural credit was positively and significantly correlated with total value of agricultural output (Table 5.13).

Similarly, fertilizer consumption in Bihar and Orissa state, public investment in agriculture in M.P. and Orissa states were highly correlated and moved in same direction. Expansion of area under irrigation was important variable in Bihar state, while expansion in cropped area was important in M.P. state. Electricity consumption in agriculture and road density were either inversely related or weakly related with agriculture output in these states. Thus, the selected variables have different trend in three states under study. But, one important aspect came out from this analysis that the current agriculture production needs capital at cheaper rate and wherever the financial institutions gave emphasis on disbursement in priority sector like crop loan, it has helped the farmers in raising crop production and productivity.

Table 5.13. Correlation coefficient between different infrastructure variables & input use in 3 states- (1990-2005)

	VOA	GCA	CI	FERT	RDDEN	ECA	GIA	CREDIT
			Bihar					
VOA	1							
GCA	-0.509	1						
CI	-0.070	0.462	1					
FERT	0.789**	-0.348	0.026	1				
RDDEN	-0.325	0.367	0.188	-0.251	1			
ECA	-0.524	0.486	0.200	-0.111	0.029	1		
GIA	0.857**	-0.271	0.315	0.858**	-0.277	-0.348	1	
CREDIT	0.567	-0.773*	-0.570	0.432	-0.151	-0.472	0.248	1
PEXP	-0.206	-0.222	-0.082	0.245	-0.051	0.338	-0.064	0.282
			M.P.					
VOA	1							
GCA	0.627	1						
CI	0.841**	0.930**	1					
FERT	0.458	0.736*	0.675*	1				
RDDEN	-0.009	0.348	0.204	0.204	1			
ECA	0.462	0.794**	0.693*	0.790*	0.544	1		
GIA	0.411	0.634	0.562	0.764*	0.515	0.876**	1	
CREDIT	0.867**	0.345	0.617	0.200	-0.226	0.118	0.216	1
PEXP	0.869**	0.443	0.643	0.527	-0.158	0.493	0.526	0.776*
			Orissa					
VOA	1							
GCA	-0.553	1						
CI	-0.151	0.876**	1					
FERT	0.896**	-0.671*	-0.339	1				
RDDEN	0.568	-0.802**	-0.734*	0.613	1			
ECA	-0.486	0.227	-0.030	-0.522	0.077	1		
GIA	-0.258	0.547	0.483	-0.161	-0.315	0.174	1	
CREDIT	0.868**	-0.416	0.014	0.823**	0.352	-0.510	-0.026	1
PEXP	0.919**	-0.694*	-0.357	0.918**	0.621	-0.418	-0.312	0.832**

** and * indicate that Correlations are significant at the 0.01 and 0.05 level (2-tailed), respectively.

VOA= Value of output from agriculture at current prices (Rs. lakh), GCA= Gross cropped area ('000ha), CI= Cropping intensity (per cent), FERT= Fertilizer consumption ('000 MT)), RDDEN= Road Density (km/'000sqkm), ECA= Electricity consumption in agriculture (million Kwh), GIA= Gross irrigated area ('000ha), CREDIT= Disbursement of agricultural credit (Rs. Crore), PEXP= Public investment in agriculture (Rs. Crore)

The results for the production function are highly varied across three states. In Bihar, no variable was significant, except that of public expenditure on agriculture, that too, was negative. This explains that whatever growth in agriculture has occurred in the states, that was mainly due to efforts of individual farmers and the government has not played any proactive role. Surprisingly in Orissa, even with lowest dose of fertilizer, it appeared as positively significant, which reflects its extent of underutilization.

In M.P., gross cropped area and public expenditure on agriculture were highly significant. Obviously, the state has started showing resilience in public investment in pace with the demand and output growth. However, fertilizer application, agricultural credit and electricity consumption in agriculture emerged as dragging variables. The

reason behind this may be that while fertilizer application over the years remained stagnant or even declined due to large expansion of soybean crop in which, very less fertilizer are required, but still add significantly into the value of output. On the other hand, agricultural credit and electricity consumption in agriculture has increased at the rate of 4.71 and 11.75 per cent annually, respectively, while overall agriculture in the state has hardly grown by 2-3 per cent.

Table 5.14. Estimated production function in selected states, 1990-2005

Variable	Bihar		M.P.		Orissa	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
Intercept	-31219.50	-0.713	-113355.53	-2.390	-45532.776	-3.143
Gross cropped area	-0.694	-0.230	-1.067	-0.373	-1.841	-0.821
Gross irrigated area	11.424	1.308	-2.255	-1.278	-0.878	-0.700
Cropping intensity	-10.180	-0.026	1158.357	1.540	355.115*	2.051
Fertilizer application	10.872	0.788	-0.994	-0.136	7.326	0.509
Electricity consumption	0.197	0.055	-0.152	-0.166	-3.253	-1.177
Agricultural credit	2.972**	2.586	0.720	0.914	-0.100	-0.079
Public expenditure	-20.910***	-3.326	18.997**	2.719	11.634*	1.782
Road density	-0.389	-0.706	17.169*	1.685	11.107**	2.597
Adjusted R^2	0.918		0.932		0.895	
Dependent variable:	Value of output from agriculture (1990-2005)					

***, ** and * indicate statistically significant at 0.01, 0.05 and 0.10 probability level, respectively.

It is with this background also necessary to remember that Bihar is India's most flood-prone State, with 76% of the population in the north Bihar living under the recurring threat of flood devastation. According to some historical data, 16.5% of the total flood affected area in India is located in Bihar while 22.1% of the flood affected population in India lives in Bihar. Floods in Bihar are a recurring disaster which on an annual basis destroys thousands of human lives apart from livestock and assets worth millions (Appendix). Similarly, Orissa state is also facing natural thrashes on regular basis in the form of flood, cyclone or hailstorms (Appendix). Therefore, these states need to be more prepared and need much more investment in social and physical infrastructure to match the growth pattern with other states of the country.

5.7. Forecasts of production and productivity of major crops

The results obtained from the analysis of ARIMA model depict mixed observations. It can be observed from Table 5.15, that during next one decade (2005-15), the production growth of quite good number of crops are going to be negative in Madhya Pradesh and Orissa, if the production environment are kept constant. On the other hand, the foodgrain production would like to grow between 1-2 per cent annually in the selected 3 states. This pose serious questions for the food and nutritional security to these states where already more than 50 percent of rural population are below poverty line and population growth is more than 2 percent. Thus, even to feed their own population, these states have to remain dependent on other states for staple foods, while in other conventional food growing states, a lot of non-agricultural activities are taking place due to which sizeable area of agricultural land are being converted into non-agricultural land. There are other few crops like rapeseed-mustard in Bihar and M.P.; soybean and cotton in M.P. and; arhar and groundnut in Orissa, which are expected to grow by faster rate (>2% p.a.). The high growths in production of these crops are mainly expected from high growth in their yields (Table 5.16). The forecasted figures of production and yield of individual crops in 3 states are given Appendix I – III.

Table 5.15. Growth in major crops' PRODUCTION forecasts: 2005-2015

Expected growth rate	Bihar	Madhya Pradesh	Orissa
Negative	Gram, Arhar, Linseed, Potato,	Jowar, Maize, Barley, Arhar, Groundnut, Linseed, Nigerseed	Ragi, Other pulses, Sesamum, Mesta, Wheat, Rapeseed-Mustard
Very low (<1%)		Gram, Sesamum,	Maize, Sugarcane, Onion
Low (1-2 %)	Rice, Maize, Sugarcane, Jute, **Foodgrains**	Rice, Bajra, Wheat, Potato, **Foodgrains**	Rice, Jowar, Gram, Linseed, Nigerseed, Chillies, Potato, **Foodgrains**
Medium (2-4 %)	Wheat, Rapeseed-mustard	Rapeseed-mustard, Soybean, Cotton	Arhar
High (>4%)			Groundnut

Table 5.16. Growth in major crops' YIELD forecasts: 2005-2015

Expected growth rate	Bihar	Madhya Pradesh	Orissa
Negative		Arhar	Wheat, Ragi, Sesamum, Other pulses, Rapeseed-Mustard, Nigerseed
Very low (<1%)	Gram, Arhar, Potato	Rice, Jowar, Barley, Linseed, Sesamum, Nigerseed, Potato	Gram, Sugarcane, Chillies, Potato, Onion
Low (1-2 %)	Maize, Wheat, Sugarcane, Linseed, Jute, **Foodgrains**	Bajra, Maize, Wheat, Gram, Groundnut, Rapeseed-mustard, Soybean, **Foodgrains**	Rice, Groundnut, Linseed, Mesta
Medium (2-4 %)	Rice, Rapeseed-mustard	Cotton	Maize, Arhar, **Foodgrains**
High (>4%)			Jowar

Keeping the above-mentioned facts in perspective, it can be concluded that there is need to break the yield barrier of most of the crops in these 3 poor states, not only to maintain food and nutritional security but also to provide considerable operating surplus to the farming community. The further growth in crop production can only be achieved by adopting multi-pronged strategies: improvements in social and physical infrastructure, expansion in irrigated area, assured electricity for agriculture, timely and economical supply of quality seeds, optimum use of chemical fertilizer based on soil nutrient status and crops need and last but not the least, providing institutional credit timely and at the (subsidized) rates announced by the government. Many government initiatives to boost agriculture in these states are not percolating to the farmers. Those practical problems faced by the poor farmers are discussed in the subsequent sections which are based on field survey data.

6

Evidences from Farmers' Fields

The selected states under study are known for their small holding farmers. Among the sample households, 60 to 78 per cent farmer households in Bihar and Orissa were marginal farmers having less than 2 hectares of land, while only 8 to 10 percent of farmers were large farmers owning more than 4 ha% of lands. In Madhya Pradesh, the distribution of households was a bit better (Table 6.1).

Table 6.1. Distribution of farmers in the study area

Districts	Per cent distribution			Overall (No. of sample households)
	< 2ha	2-4 ha	> 4ha	
Bihar				
Bhojpur	53	37	10	100
Purnea	67	22	11	100
Total	*60.0*	*29.5*	*10.5*	*200*
Madhya Pradesh				
Ujjain	42	29	29	100
Rewa	52	34	14	100
Total	*47.0*	*31.5*	*21.5*	*200*
Orissa				
Bargarh	75	13	12	100
Nayagarh	80	16	4	100
Total	77.5	14.5	8.0	*200*

6.1. Land holding and farm assets

As discussed earlier, the distribution of agricultural land is highly skewed in the 3 states. From Table 6.2 to 6.4, it is clear that marginal farmers have hardly 1 ha of operational holding in all three states, medium farmers have less than 3 ha of operational holding while large farmers have 5.25 to 8.64 ha of lands. In Bihar, in both the districts, more than 95 percent of operational holding was irrigated, mostly by private tubewells, while in M.P., 20 to 30 percent holding was unirrigated and in Orissa more than 50 percent holdings were unirrigated.

Table 6.2. Average operational holding and extent of irrigation in Bihar state

(% of total irrigated area)

Particulars	Bhojpur			Purnea			Overall		
	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha
Operational holding (ha)	1.06	2.57	5.61	1.07	2.89	6.88	1.07	2.69	6.28
Irrigated, %	94.61	99.09	90.93	98.21	98.58	99.00	96.42	98.82	95.37
Un-irrigated, %	5.39	0.91	9.07	1.79	1.42	1.00	3.58	1.18	4.63

Table 6.3. Average operational holding and extent of irrigation in M.P. state

(% of total irrigated area)

Particulars	Ujjain			Rewa			Overall		
	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha
Operational holding (ha)	0.93	2.82	9.44	1.06	2.79	7.83	1.00	2.81	8.64
Irrigated, %	67.74	81.91	66.45	77.36	74.89	63.45	72.86	78.43	65.14
Un-irrigated, %	32.26	18.09	33.55	22.64	25.11	36.55	27.14	21.57	34.86

Table 6.4. Average operational holding and extent of irrigation in Orissa state

(% of total irrigated area)

Particulars	Baragarh			Nayagarh			Overall		
	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha
Operational holding (ha)	1.07	2.74	6.34	1.06	2.63	4.15	1.07	2.69	5.25
Irrigated, %	65.42	54.38	73.50	32.08	32.32	6.99	48.75	43.35	40.25
Un-irrigated, %	34.58	45.62	20.50	67.92	67.68	93.01	51.25	56.65	56.76

As far as farm assets with farmer households were concerned, it is fast depleting in Bihar state. One can see from Table 6.5 to 6.7, there are hardly 2 adult animals (cattle+ buffaloes) per household in Bihar state, which would ultimately affects the supply of farm yard manure to the field for crop production. Interestingly, farmers of M.P. and Orissa maintained relatively larger livestocks. Similarly, the ownership of tractors or other machineries were higher in M.P. than Bihar and Orissa. One interesting observation emerged during the survey that there was not a single tubewell possessed by the sample farmers of Orissa state.

Table 6.5. Per household farm assets in Bihar state

Particulars	Bhojpur			Purnea			Overall		
	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha
Adult cattle+ buffalo	2.0	1.95	4.2	1.91	1.68	2.18	1.96	1.82	3.19
Tractor	0.04	0.16	0.2	nil	0.27	0.45	0.02	0.22	0.33
Power tiller	nil	nil	nil	0.01	0	0.09	0.01	0.00	0.05
Seed drill	nil	0.03	nil	nil	nil	nil	nil	0.02	nil
Cultivator	0.11	0.22	0.2	0.03	0.27	0.55	0.07	0.25	0.38
Thresher	0.08	0.14	0.4	nil	0.09	0.36	0.04	0.12	0.38
Diesel engine	0.45	0.78	1	0.4	0.59	1.09	0.43	0.69	1.05
Electric motor	nil	nil	nil	0.03	0.05	0.09	0.02	0.03	0.05
Tube well	0.43	0.84	1.6	0.9	2.05	3.45	0.67	1.45	2.53
Sprayer	0.25	0.38	0.5	0.58	0.73	0.45	0.42	0.56	0.48

Table 6.6. Per household farm assets in Madhya Pradesh state

Particulars	Ujjain			Rewa			Overall		
	<2ha	2-4 ha	>4ha	<2ha	2-4 ha	>4ha	<2ha	2-4 ha	>4ha
Adult cattle+ buffalo	2.21	4.1	6.76	3.02	4.26	6.86	2.62	4.18	6.81
Tractor	0.02	0.28	0.69	0.06	0.29	0.86	0.04	0.29	0.78
Power-tiller	nil	0.14	0.14	nil	nil	0.07	nil	0.07	0.11
Seed-driller	0.02	0.28	0.76	0.06	0.24	0.57	0.04	0.26	0.67
Cultivator/ M.B. Plough	0.02	0.31	0.66	0.02	0.12	0.86	0.02	0.22	0.76
Thresher	0.1	0.24	0.59	0.08	0.15	0.43	0.09	0.20	0.51
Diesel engine	0.02	0.28	0.31	0.04	0.06	0.14	0.03	0.17	0.23
Electric motor	0.17	0.83	1.62	nil	0.21	1.07	0.09	0.52	1.35
Tube-wells	0.26	1.07	1.62	0.13	0.35	1.00	0.20	0.71	1.31
Sprayer	0.17	0.66	1.1	0.13	0.44	1.00	0.15	0.55	1.05

Further, in Bihar, there was negligible number of electric motors as compared to diesel engine, which mainly served the purpose of irrigation or other agricultural operations, as the supply of electricity in the rural areas were highly uncertain and unereliable. In Orissa, small kerosene pump which are portable in size and weight were more popular for irrigating the field from ponds or other surface water-source.

Table 6.7. Per household farm assets in Orissa state

Particulars	Baragarh			Nayagarh			Overall		
	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha	< 2ha	2-4 ha	> 4ha
Adult cattle+ buffalo	2.13	3.15	3.42	2.58	3.69	3.75	2.36	3.42	3.59
Small ruminants	0.07	0.46	nil	0.77	0.56	Nil	0.42	0.51	Nil
Tractor	0.01	Nil	0.5	0.01	nil	nil	0.01	Nil	0.25
Power-tiller	0.04	0.15	0.08	nil	nil	nil	0.02	0.08	0.04
Diesel engine	0.08	0.38	0.17	0.09	0.31	0.25	0.09	0.35	0.21
Electric motor	0.09	0.08	0.42	0.1	0.25	0.25	0.10	0.17	0.34
Tube-wells	nil	nil	nil	nil	nil	nil	nil	nil	nil
Sprayer	0.41	0.77	1.83	0.11	0.31	0.25	0.26	0.54	1.04
Others (Kerosene pump)	0.09	0.08	0.17	0.08	0.13	nil	0.09	0.11	0.09

6.2. Soil fertility test

Soil testing and associated soil and water analysis helps to characterize the soil fertility, in terms of available plant nutrients and any other soil related constraint problem. Balanced nutrition and integrated plant nutrient supply systems are essential tools to raise crop yields, improve soil fertility, crop quality and stress tolerance of crops. The Government has also taken a number of measures to improve fertilizer application, which includes a new scheme, the National Project on Management of Soil Health & Fertility (NPMSF), has been introduced in 2008-09 with a view to setting up of 500 new Soil Testing Laboratories (STLs) and 250 Mobile Soil Testing Laboratories (MSTLs) and strengthening of the existing State STLs for micronutrient analysis. However, its response at farmers' level in these poor states is very poor. Table 6.8 to 6.10 show that very few farmers in Bihar and Orissa had gone for soil testing, while in M.P., the

response was relatively better. Not only this, the farmers who went for the soil testing, they were reportedly not satisfied with the reports and recommendations. Such trends shake the confidence of the farmers on soil testing services as well as agencies and feel that without the test also, they could harvest same yields. Thus, there is a need to break the jinx and inform about the advantages by showing the soil-test based demonstration.

Table 6.8. Soil fertility test carried out by the farmers in Bihar state

District/ Blocks	No. of farmers who got soil tested	% of sample farmers who got soil tested	Soil testing agency
Bhojpur			
Charpokhari	0/25	0.0	
Arah	0/25	0.0	
Jagdishpur	2/25	8.0	State Govt.
Sandesh	2/25	8.0	State Govt.
Purnea			
Banmankhi	0/25	0.0	
Dhamdaha	0/25	0.0	
Purnea East	1/25	4.0	State Govt.
Jalalgard	1/25	4.0	State Govt.

Table 6.9. Soil fertility test carried out by the farmers in M.P. state

District/ Blocks	No. of farmers who got soil tested	% of sample farmers who got soil tested	Soil testing agency
Ujjain			
Ghattia	1/25	4.0	State Govt.
Baidhnager	0/25	0.0	State Govt.
Tarana	10/25	40.0	State Govt.
Ujjain	2/25	8.0	State Govt.
Rewa			
Mauganj	4/25	16	State Govt.
Raipur-Kal	4/25	16	State Govt. & Co-operative
Tyother	6/25	24	State Govt.
Sirmor	3/25	12	State Govt.

Table 6.10. Soil fertility test carried out by the farmers in Orissa state

District/ Blocks	No. of farmers who got soil tested	% of sample farmers who got soil tested	Soil testing agency
Bargarh			
Barapali	0/25	0.0	
Bijepur	1/25	4.0	Agril. Deptt.
Baragarh	1/25	4.0	Soil Cons. Deptt.
Attabira	0/25	0.0	
Nayagarh			
Bhapur	0/25	0.0	
Nuagaon	0/25	0.0	
Daspalla	2/25	8.0	IFFCO
Nayagarh	1/25	4.0	IFFCO

6.3. Cropping pattern in the study area

Cropping pattern is one of the most important factors, which determines the level of investment by a farmer as well as farm income. From the analysis of survey data collected in two districts of Bihar, M.P. and Orissa states, per farm cropping pattern was examined and presented in Table 6.11 to 6.16.

In Bihar, paddy was the most prevalent kharif season crop occupying more than 40 percent of cropped area in both the districts across different farm sizes. However, large farmers have diversified farming with potato and banana cultivation on sizeable portion of land in Bhojpur and Purnea district, respectively. During rabi season, choice of crops are entirely different in both the districts as wheat occupied 35-40 percent of cropped area in Bhojpur followed by lentil and gram with 2- 11 percent area, while in Purnea district, wheat, maize and sunflower occupied almost similar portion (10-15% each) of cropped area. Similarly, during summer season, good number of farmers cultivated moong and boro rice in Purnea district. Thus, though, Bhojpur is considered to be agriculturally prospering district, but the cropping intensity is higher in Purnea district. It is in the same way as small and marginal farmers have more intensive farming than the large farmers, which is true for all 3 states.

Table 6.11. Cropping pattern & intensity of cropping in Bhojpur district, Bihar

(Per cent of GCA)

Crop	Small farmers (< 2ha)	Medium farmers (2-4 ha)	Large farmers (> 4ha)	Overall
Kharif	**49.15**	**42.55**	**49.20**	**46.97**
Paddy	44.91	37.98	39.00	40.63
Potato	2.12	3.37	10.20	5.23
Maize	2.12	0.24	0.00	0.79
Rabi	**50.85**	**57.45**	**50.59**	**52.96**
Wheat	40.26	34.86	37.41	37.51
Lentil	6.36	10.82	1.70	6.29
Gram	2.12	6.25	7.76	5.38
Khesari	0.85	2.40	3.19	2.15
Potato	0.42	1.92	0.00	0.78
Summer (Onion)	**0.00**	**0.00**	**0.21**	**0.07**
Cropping intensity	**222.64**	**161.87**	**167.74**	**184.08**
Gross cropped area	**100 (2.36)**	**100 (4.16)**	**100 (9.41)**	**100 (5.31)**
Net sown area (Ha)	**1.06**	**2.57**	**5.61**	**3.08**

Figures in parenthesis are area in hectares per farm household.

Table 6.12. Cropping pattern & intensity of cropping in Purnea district, Bihar

(Per cent of GCA)

Crop	Small farmers (< 2ha)	Medium farmers (2-4 ha)	Large farmers (> 4ha)	Overall
Kharif	**43.33**	**45.96**	**44.35**	**44.55**
Paddy	41.24	43.65	38.99	41.29
Vegetable	1.25	0.33	0.00	0.53
Banana	0.42	1.98	5.36	2.59
Rabi	**39.17**	**40.53**	**38.98**	**39.56**
Wheat	18.34	13.51	16.01	15.95
Maize	12.50	13.51	10.35	12.12
Sunflower	6.25	12.52	11.45	10.07
Vegetable	1.25	0.33	0.00	0.53
Mustard	0.83	0.66	1.17	0.89
Summer	**17.50**	**13.51**	**16.67**	**15.89**
Moong	12.50	8.40	14.10	11.67
Boro	2.50	5.11	2.57	3.39
Cropping intensity	**224.30**	**210.03**	**197.96**	**210.76**
Gross cropped area	**100 (2.4)**	**100 (6.07)**	**100 (13.62)**	**100.00 (7.36)**
Net sown area (Ha)	**1.07**	**2.89**	**6.88**	**3.61**

Figures in parenthesis are area in hectares per farm household.

In Madhya Pradesh, the average land holding in Ujjain and Rewa districts were 3.95 and 2.60 hectares per household, which varied from 0.93 ha to 9.44 ha for small and large farmers, respectively in Ujjain district while those varied from 1.06 ha to 7.86 ha in Rewa district. There was distinct difference in crop choice for kharif season in both the districts as soybean ruled the roost in Ujjain with about 50 per cent of cropped area covered alone under this crop across different farm sizes, but paddy was the most preferred kharif season crop in Rewa district followed by soybean. During rabi season, wheat was the first choice among the farmers in both the districts followed by pulse crops like gram. One more distinct feature was cultivation of vegetables by marginal farmers in good proportion (8% of GCA) in Rewa district. From table 6.13 & 6.14, it is also clear that the cropping intensity were significantly higher in Ujjain district across all 3 categories of farmers as compared to that in Rewa district.

Table 6.13. Cropping pattern & intensity of cropping in Ujjain district, M.P.

(Per cent of GCA)

Crop	Small farmers (< 2ha)	Medium farmers (2-4 ha)	Large farmers (> 4ha)	Overall
Kharif	**49.89**	**50.53**	**50.95**	**50.75**
Soybean	49.74	49.78	50.12	50.00
Maize	0	0.75	0.61	0.57
Tur	0.15	0	0.22	0.17
Rabi	**49.18**	**48.15**	**48.85**	**48.74**
Wheat	29.94	38.55	29.14	31.21
Gram	17.60	8.80	18.72	16.50
Potato	1.49	0.62	0.75	0.81
Other cash crops	0.15	0.18	0.24	0.22
Summer	**0.93**	**1.32**	**0.20**	**0.51**
Vegetables (Onion, Bhindi)	0.93	1.32	0.20	0.51
Cropping intensity	**209.03**	**193.55**	**186.73**	**190.35**
Gross cropped area	**100 (1.94)**	**100 (5.46)**	**100 (17.63)**	**100 (7.51)**
Net sown area (Ha)	**0.93**	**2.82**	**9.44**	**3.95**

Figures in parenthesis are area in hectares per farm household

Table 6.14. Cropping pattern & intensity of cropping in Rewa district, M.P.

(Per cent of GCA)

Crop	Small	Medium	Large	Overall
Kharif	**47.67**	**51.56**	**54.14**	**51.59**
Soybean	15.87	9.50	4.97	9.34
Paddy	24.91	34.99	32.15	31.52
Tur	2.68	2.26	1.54	2.10
Other cash crops	4.21	4.81	15.48	8.64
Rabi	**44.07**	**48.16**	**45.62**	**46.24**
Wheat	36.91	38.33	26.47	33.58
Gram	6.42	8.13	9.73	8.32
Other cash crops	0.74	1.70	9.42	4.33
Summer	**8.26**	**0.28**	**0.24**	**2.17**
Vegetables (Onion, Bhindi, etc.)	8.26	0.28	0.24	2.17
Cropping intensity	**196.60**	**186.56**	**154.07**	**174.97**
Gross cropped area	**100 (2.08)**	**100 (5.21)**	**100 (12.06)**	**100.00 (4.54)**
Net sown area (Ha)	**1.06**	**2.79**	**7.83**	**2.60**

Figures in parenthesis are area in hectares per farm household.

Table 6.15. Cropping pattern & intensity of cropping in Bargarh district, Orissa

(Per cent of GCA)

Crop	Small farmers (< 2ha)	Medium farmers (2-4 ha)	Large farmers (> 4ha)	Overall
Kharif	**59.44**	**59.57**	**55.70**	**58.24**
Paddy	57.78	59.57	54.39	57.25
Groundnut	1.11	0.00	0.61	0.57
Brinjal	0.55	0.00	0.70	0.42
Rabi	**40.56**	**40.43**	**44.30**	**41.76**
Paddy	30.00	25.22	41.40	32.21
Groundnut	4.44	7.17	1.14	4.25
Brinjal	1.67	1.30	0.70	1.22
Moong	2.22	4.35	0.26	2.28
Mustard	0.56	1.09	0.00	0.55
Tomato	0.56	0.65	0.62	0.61
Other cash crop (Pumpkin, Chillies)	1.11	0.65	0.18	0.65
Cropping intensity	**168.22**	**167.88**	**179.81**	**171.97**
Gross cropped area	**100 (1.80)**	**100 (4.60)**	**100 (11.40)**	**100.00 (5.93)**
Net sown area (Ha)	**1.07**	**2.74**	**6.34**	**3.38**

Figures in parenthesis are area in hectares per farm household.

Orissa state has unique cropping pattern as most of the farmers are taking paddy as kharif as well rabi main crop in some districts like Bargarh. During kharif season, very few farmers cultivated on small patches of land other crops like groundnut, brinjal or arum. Though, in rabi season, the agriculture is very much diversified, among which vegetables constitute main composition in both the districts. In Nayagarh district, moong was the most important crop followed by sugarcane.

Table 6.16. Cropping pattern & intensity of cropping in Nayagarh district, Orissa

(Per cent of GCA)

Crop	Small farmers (< 2ha)	Medium farmers (2-4 ha)	Large farmers (> 4ha)	Overall
Kharif	**49.83**	**54.26**	**67.24**	**57.11**
Paddy	49.02	54.26	67.24	56.84
Arum (Arabi)	0.58	0.00	0.00	0.19
Groundnut	0.23	0.00	0.00	0.08
Rabi	**50.17**	**45.74**	**32.76**	**42.89**
Moong	21.92	17.82	23.21	20.98
Sugarcane	12.11	14.63	3.58	10.11
Brinjal	4.61	4.52	1.53	3.55
Groundnut	1.73	1.33	0.00	1.02
Gram	1.73	1.33	4.44	2.50
Biri (Black gram)	4.61	2.13	0.00	2.25
Other cash crops (Pumpkin, Arum, Cauliflower)	3.46	3.98	0.00	2.48
Cropping intensity	**163.58**	**142.97**	**141.20**	**149.25**
Gross cropped area	**100 (1.73)**	**100 (3.76)**	**100 (5.86)**	**100 (3.78)**
Net sown area (Ha)	**1.06**	**2.63**	**4.15**	**2.61**

Figures in parenthesis are area in hectares per farm household.

Thus, Paddy-Wheat is widely adopted cropping system in Bihar, while Soybean-Wheat is famous in Ujjain district but Paddy-Wheat in Rewa district. In Orissa, Paddy-Paddy is the most popular cropping system across different categories of farmers. Therefore, the farm income or say farmers' economic capacity of the region would largely depend on the profitability from the cultivation of these crops.

6.5. Farmers' economic capacity and willingness

The ability to generate an adequate income from farming enables farmers to devote resources to quality food production and to land stewardship that is essential to maintaining the value of natural capital in agriculture. An *inadequate* return on investment can produce a wide range of negative social and environmental effects, each of which carries significant costs. In extreme cases, when farmers cannot make ends meet, prime agricultural land may be sold and converted to other uses, resulting in the loss of a valuable natural capital asset and a decline in food security for future generations. An inadequate return on investment is therefore not sustainable in the long run from *either* an economic *or* an ecological perspective. From discussion with farmers during field survey it emerged that although total farm cash receipts have risen over the years, the expenses on all the inputs has outnumbered the gains. If these trends continue, we are likely to see the virtual demise of several agricultural sectors in the economically poor regions like Bihar, M.P. and Orissa. To examine the farmers' economic capacity net income from major crops' cultivation in all 3 states have been calculated by deducting the paid out costs from total revenue from these crops, which are presented in subsequent sections. The varieties grown by the farmers in states under study for different crops are given in Appendices VII-IX.

6.5.1. Economics of major crops' cultivation in Bihar state

Paddy and wheat are the two major crops in Bihar state, therefore farmers' income or economic capacity has been judged by the profitability from the cultivation of these two crops.

Paddy

Application of critical inputs:

Table 6.17 presents the extent of various inputs used in paddy cultivation by the farmers in Bihar. There is considerable difference in use of seed, organic manure as well as chemical fertilizer in both the districts and that's why difference in yield realization. Overall, paddy yield is the highest among small and marginal farmers as they applied more organic manure as well as near to balanced NPK fertilizers. Bhojpur district having good network of irrigation canals, farmers across all categories applied 2-3 irrigations, whenever there was deficit in rainfall.

Cost and return:

The economics of paddy cultivation was calculated for both the districts and presented in Table 6.18. It was surprising to observe and note that by and large, the wage cost of hired labor was the major expenses among all the categories of farmers. Though, in Bhojpur district, irrigation cost was the highest among small and medium farmers. There are two reasons for such trend- one, most of the farmers in Bihar now are hiring more and more labours for the agricultural operations, not due to economic prosperity, but due to reluctance of family members to work in the field or absence of family farm workers, two, irrigation cost for small and medium farmers are high, though they were applying less no. of irrigation due to custom hiring from large farmers. Furthermore, in the year 2007-08, the government announced minimum support price (MSP) for common paddy at Rs. 645 per quintal with bonus of Rs. 50 per quintal payable over MSP. In contrast to this, all the farmers sold their produce much below the MSP in the lack of procurement agency in study area (Fig 16). Therefore, their operating profit from paddy cultivation varied from about Rs. 5000 to Rs. 8000 per hectare.

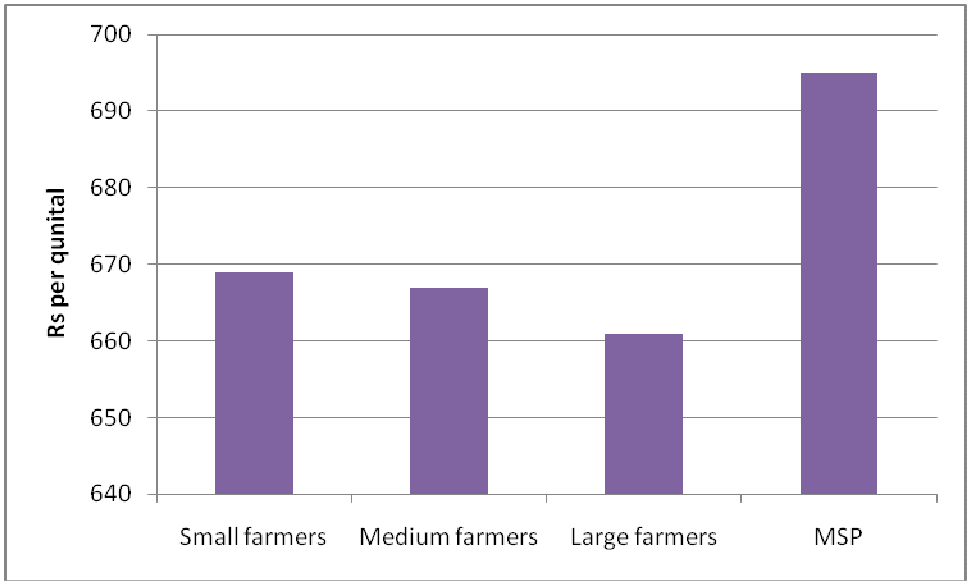

Fig 16. Selling price of paddy by different category of farmers in Bihar w.r.t. to Minimum Support Price (MSP), 2007-08

Table 6.17. Inputs used in cultivation of PADDY crop on sample farms in BIHAR

(Kg per ha)

Particulars	Bhojpur			Purnea			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
No. of sample farmers	55	35	10	67	22	11	122	57	21
No. of sample farmers growing paddy	51	30	9	65	22	11	116	52	20
Average area under the crop (ha per farm)	1.05	1.56	3.66	0.99	2.53	5.31	1.02	2.05	4.49
Seed	53.21	56.55	53.75	57.22	54.43	52.96	55.22	55.49	53.36
Organic manure (Q/ha)	19.78	3.79	6.72	7.05	2.06	4.62	13.42	2.93	5.67
N	89.72	100.19	97.62	76.41	68.68	60.44	83.07	84.44	79.03
P_2O_5	31.18	46.75	41.86	34.76	26.37	34.01	32.97	36.56	37.94
K_2O	7.23	14.98	8.49	19.56	14.04	17.47	13.40	14.51	12.98
NPK total	128.13	161.92	147.97	130.73	109.09	111.92	129.44	135.51	129.95
S	0.40	1.46	0.56	0.75	0.52	0.24	0.58	0.99	0.40
Zn	0.76	2.76	0.69	1.44	0.99	0.46	1.10	1.88	0.58
Average no. of irrigation	2.06	3.24	2.37	0.43	0.27	0.36	1.25	1.76	1.37
Yield (Q/ha)	38.51	36.03	35.98	21.65	18.92	17.61	30.08	27.48	26.80

Table 6.18. Cost of and return from cultivation of PADDY on sample farms in BIHAR

(Rupees per ha)

Particulars	Bhojpur			Purnea			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Seed	752	790	770	738	738	674	745	764	722
Fertilizers	1949	2858	3324	2155	1752	1708	2052	2305	2516
Organic manure	396	76	134	186	52	116	291	64	125
Irrigation cost	4593	5540	1807	1308	856	951	2951	3198	1379
Plant Protection	662	565	660	224	226	130	443	396	395
Wage cost	4110	5111	6564	3753	4859	5425	3932	4985	5995
Hired Animal Exp.	34	95	69	269	169	0	152	132	35
Hired Machine Exp.	1888	1834	1467	1724	1648	1841	1806	1741	1654
Total paid out cost	14384	16869	14795	10357	10300	10845	12372	13585	12821
Cost of production (Rs./Q)	374	468	411	479	545	616	427	507	514
Selling price (Rs./Q)	690	679	663	647	654	659	669	667	661
Total revenue	26575	24464	23858	14005	12373	11604	20290	18419	17731
Operating profit	**12191**	**7595**	**9063**	**3648**	**2073**	**759**	**7920**	**4834**	**4911**
Benefit-cost ratio	1.85	1.45	1.61	1.35	1.20	1.07	1.60	1.33	1.34

Wheat

Application of critical inputs:

Application of different critical inputs in cultivation of wheat crop in both the districts of Bihar is again quite different. Most importantly, Purnea being flood-prone district, farmers were applying organic manure during rabi season, while in Bhojpur, it was applied mainly during kharif season (Table 6.19). There was little difference in seed quantity. Except that, there was not much marked difference in application of other inputs. Even then, the yield of wheat was 10-15% less in Purnea district as compared to Bhojpur district. Overall wheat yield varied from 19 to 27 Q/ha in two districts.

Cost and return:

The expenses on different inputs made during wheat cultivation in Bihar are given Table 6.20, which gave again a contrasting picture for both the districts. There is huge difference in irrigation costs in both the districts due to two reasons: one, farmers in Bhojpur district applied more number of irrigations in wheat and secondly, water table being lower in the district, irrigation charge was also higher as compared to Purnea district. Thus, even if, the yield of wheat was low in Purnea district, the operating profit from wheat cultivation was significantly higher than its counterpart. Overall, the operating profit from wheat cultivation in Bihar was Rs. 4500 to Rs. 6500 per hectare. Although, most of the farmers sold their wheat below MSP announced by the government (Fig 17).

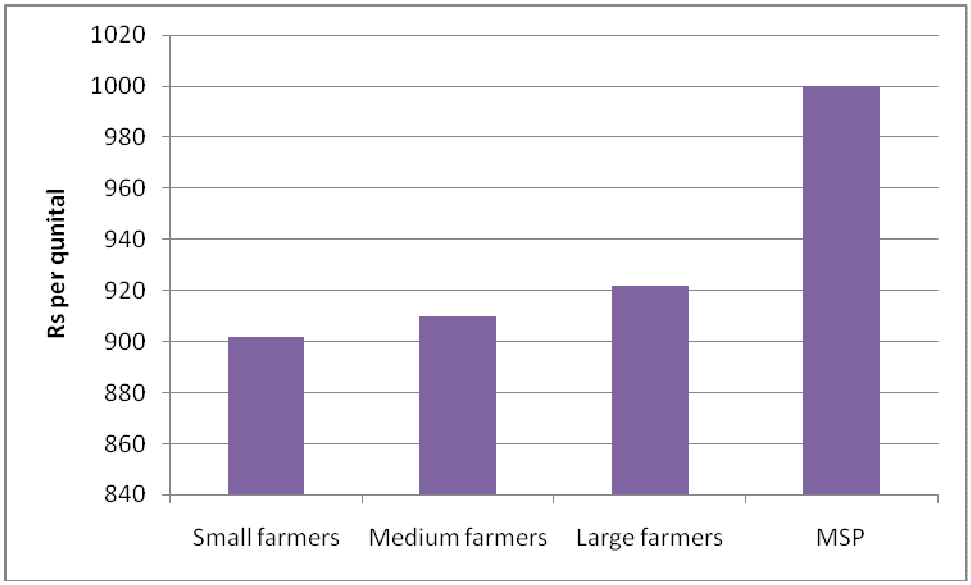

Fig 17. Selling price of wheat by different category of farmers in Bihar w.r.t. to Minimum Support Price (MSP), 2007-08

Table 6.19. Inputs used in cultivation of WHEAT crop on sample farms in BIHAR

(Kg per ha)

Particulars	Bhojpur			Purnea			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
No. of sample farmers	55	35	10	67	22	11	122	57	21
No. of sample farmers growing wheat	55	35	10	54	17	8	109	52	18
Average area under the crop (ha per farm)	0.96	1.45	3.52	0.44	0.82	2.17	0.70	1.14	2.85
Seed	134.25	129.14	129.54	118.33	119.99	116.54	126.29	124.57	123.04
Organic manure (Q/ha)	0	0	0	54.04	21.58	17.43	27.02	10.79	8.72
N	95.52	96.82	98.41	92.60	75.55	78.25	94.06	86.19	88.33
P_2O_5	50.39	47.80	54.92	45.81	41.20	52.14	48.10	44.50	53.53
K_2O	22.08	12.19	8.07	25.12	18.46	32.45	23.60	15.33	20.26
NPK total	167.99	156.81	161.4	163.53	135.21	162.84	165.76	146.02	162.12
S	0.01	0.31	0.02	0.86	0.56	0.25	0.44	0.44	0.14
Zn	0.02	0.50	0	1.64	1.08	0.48	0.83	0.79	0.24
Average no. of irrigation	2.58	3.18	2.71	2.26	2.23	2.50	2.42	2.71	2.61
Yield (Q/ha)	22.89	26.68	23.05	22.28	18.63	19.22	22.59	22.66	21.14

Table 6.20. Cost of and return from cultivation of WHEAT on sample farms in BIHAR

(Rupees per ha)

Particulars	Bhojpur			Purnea			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Seed	2551	2587	2241	2490	2640	2409	2521	2614	2325
Fertilizers	2438	2567	2535	2667	2204	2479	2553	2386	2507
Organic manure	0	0	0	1426	567	465	713	284	233
Irrigation cost	7791	8061	7568	1308	1697	1976	4550	4879	4772
Plant Protection	35	131	46	131	66	193	83	99	120
Wage cost	2183	2820	4875	1389	2153	2236	1786	2487	3556
Hired Animal Exp.	32	50	50	201	164	0	117	107	25
Hired Machine Exp.	1633	1698	1362	1604	1338	1420	1619	1518	1391
Total paid out cost	16663	17914	18677	11216	10829	11178	13942	14374	14929
Cost of production (Rs./Q)	728	672	810	504	581	582	616	627	696
Selling price (Rs./Q)	928	920	964	875	900	879	902	910	922
Total revenue	21243	24543	22223	19495	16765	16897	20369	20654	19560
Operating profit	**4580**	**6629**	**3546**	**8279**	**5936**	**5719**	**6430**	**6283**	**4633**
Benefit-cost ratio	1.27	1.37	1.19	1.74	1.55	1.51	1.51	1.46	1.35

6.5.2. Economics of major crops' cultivation in Madhya Pradesh state

Soybean and wheat are the two major crops in Ujjain district while paddy, wheat, gram and tur are important crops in Rewa district of M.P. state, therefore farmers' income or economic capacity has been judged by the profitability from the cultivation of these crops.

Soybean

Application of critical inputs:

As discussed earlier in the cropping pattern, soybean is the major kharif crop in Ujjain district, which was cultivated by all the sample farmers on about of half of their gross cropped area, while in Rewa district, the crop was cultivated by only one-third of the sample farmers. Application of all the critical inputs i.e. seed, chemical fertilizers and even organic manure in the crop was significantly higher in Ujjain as compared to that in Rewa district, but the crop yield was just opposite (Table 6.21). The farmers in Ujjain district harvested 14-16 quintal per hectare (q/ha) of soybean while farmers of Rewa could get 18-21 q/ha of soybean. The reason for this trend may be due to the application of even single irrigation to the crop while at critical stage. Since only select farmers (35%) were growing this crop in Rewa district and that too on less area, they might be more concerned for irrigation and balanced use of nutrients, which ultimately resulted into better crop yield. It is interesting to note that in comparison to farmers of Rewa district, those of Ujjain district were applying significantly higher doses of all the plant nutrients such as N, P_2O_5 and S, even organic manure, but the crop's yield was lower.

Cost and return:

The economics of soybean cultivation was calculated for both the districts and presented in Table 6.22. As the seeds, fertilizer and organic manure applications were higher in Ujjain district, the expenses thereon also increased as compared to their counterpart. From the survey, it was observed that farm mechanization in M.P. has replaced the farm labour and the expenditure on machine labour in soybean cultivation was estimated to be one of the most important components. The sample farmers in Ujjain district not only applied more human labour but also the animal labour, opposite to it, farmers in Rewa district depended more on machine labour, charges of which also varied according to farm-size categories. Interestingly, the selling price of soybean in Rewa district was 10-20 per cent lower than those of in Ujjain district may be due to better market condition in Ujjain district alongwith the bold size of grain in Ujjain district

due to better nutrient application. However, significantly higher crop yield in former district, the total revenue, operating profit and the benefit-cost ratio were better in Rewa district. Overall in M.P. state, farmers could get an operating profit to the tune of Rupees 16 thousand per hectare from soybean cultivation. Fortunately, farmers of M.P. state were able to sell their soybean produce in open market at much higher price than the MSP announced by the government, which were Rs. 910 per Q for black and Rs. 1050 per Q for yellow soybean during study period (Fig 18). This was due to high domestic as well international price of edible oils.

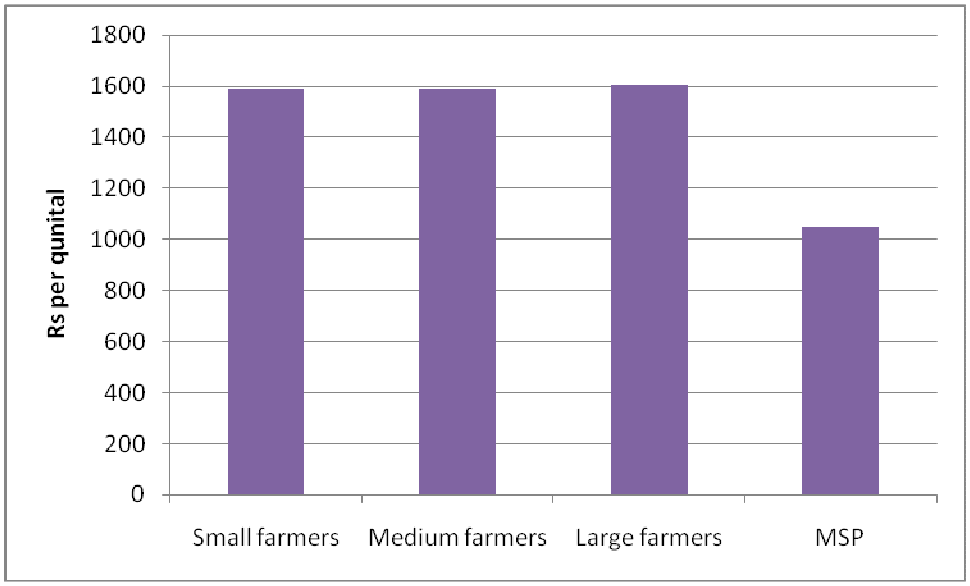

Fig 18. Selling price of soybean by different category of farmers in M.P. w.r.t. to Minimum Support Price (MSP) of yellow soybean, 2007-08

Wheat

Use of critical inputs:

Wheat is the widely cultivated rabi season crop in M.P. state, in general and in both the selected districts, in particular. In general, farmers in Ujjain district used higher seed rate for wheat cultivation (Table 6.23). Similarly, application of organic manure in the district was several times higher than that in Rewa district. Although, there was not significant difference in nitrogenous fertilizer application, but the use of phosphatic, potassic and sulphur fertilizer significantly high in Ujjain. On the other hand, farmers of Rewa district applied small doses of Zinc in their wheat field. In Ujjain, farmers applied 3-5 irrigations in wheat field, while in Rewa, they applied about 3 irrigations. Thus, with high inputs uses and relatively assured irrigation, the wheat yield in Ujjain district was about 30-40 per cent higher than that in Rewa district.

Table 6.21. Inputs used in cultivation of SOYBEAN crop on sample farms in M.P.

(Kg per ha)

Particulars	Ujjain			Rewa			M.P. (Overall)		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
No. of sample farmers	42	29	29	52	34	14	94	63	43
No. of sample farmers growing soybean	42	29	29	21	11	3	63	40	32
Average area under the crop (ha per farm)	0.92	2.75	8.82	0.87	1.62	2.16	0.90	2.19	5.49
Seed	108	108	121	85.44	101.61	77.96	101.83	107.34	117.95
Organic manure (q/ha)	20.00	49.00	51.00	4.52	3.14	0.00	15.11	45.83	61.03
N	16.37	19.18	18.08	12.25	15.66	14.73	14.31	17.42	16.405
P_2O_5	44.02	45.87	51.74	31.31	40.03	37.64	37.665	42.95	44.69
K_2O	0	0	7.04	0.65	0	0	0.325	0	3.52
NPK total	60.39	65.05	76.86	44.21	55.69	52.37	52.3	60.37	64.62
S	4.57	6.02	7.19	0.00	0.00	0.00	3.08	4.42	6.59
Zn	0.00	0.00	1.41	0.00	0.00	0.00	0.00	0.00	1.30
No. of irrigation	0.00	0.00	0.00	0.29	0.18	0.33	0.11	0.05	0.03
Yield (q/ha)	14.06	16.41	14.45	19.20	18.36	21.46	15.96	17.15	15.29

Table 6.22. Cost of and return from cultivation of SOYBEAN on sample farms in M.P.

(Rupees per ha)

Particulars	Ujjain			Rewa			M.P. (Overall)		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Seed	2632	2588	3160	1798	2310	2001	2215	2449	2581
Fertilizers	1098	1127	1347	751	905	845	925	1016	1096
Organic manure	403	972	1023	90	94	0	247	533	512
Irrigation cost	0	0	0	430	480	766	215	240	383
Plant Protection	1857	1857	2780	847	1776	1173	1352	1817	1977
Wage cost	1509	2583	2801	905	1039	568	1207	1811	1685
Hired Animal Expenses	570	335	176	149	0	0	360	168	88
Hired Machine Expenses	3227	3217	3178	2536	3256	4273	2882	3237	3726
Total paid out cost	11296	12679	14465	7506	9860	9626	9403	11271	12048
Cost of production (Rs./Q)	803.43	772.61	1001.05	391.05	537.11	448.64	597	655	725
Selling price (Rs./Q)	1699	1730	1678	1477	1450	1533	1588	1590	1605
Total revenue	23890	28390	24247	28355	26617	32895	26123	27504	28571
Operating profit	**12592**	**15711**	**9782**	**20847**	**16758**	**23268**	**16720**	**16235**	**16525**
Benefit-cost ratio	2.11	2.24	1.68	3.78	2.70	3.42	2.95	2.47	2.55

Cost and return:

The component-wise costs incurred in wheat cultivation in both the districts are presented in Table 6.24, which is also a reflection of inputs used in wheat crop. Accordingly, there was higher expenditure on almost all the critical inputs in Ujjain district as compared to Rewa district. Furthermore, there was higher expense on human as well as animal labour by Ujjain farmers. On the other hand, the charges of machine labour being high in Rewa district, the expenses on machine labour was higher or almost same, when compared to Ujjain district. Overall, total paid out cost in Ujjain district varied from Rs. 16504/ha to 22625/ ha, while in Rewa district, it varied from Rs. 13729/ ha to Rs. 15983/ ha. One important observation was that the selling price of wheat realized by the large farmers was the lowest in both the districts. This may be due to selling the product in bulk to any specific agency particularly government agency. Therefore, the operating profit though was comfortably high as compared to soybean crop, but declined with increase in farm-size, which varied from Rs. 16-22 thousand in Ujjain and Rs. 12-14 thousand per hectare in Rewa district. Thus, the benefit-cost ratio of wheat cultivation was nearly close to two in both the districts. For wheat also, the open market price was higher than the MSP, because the demand of wheat grown in M.P. among private food companies are very high.

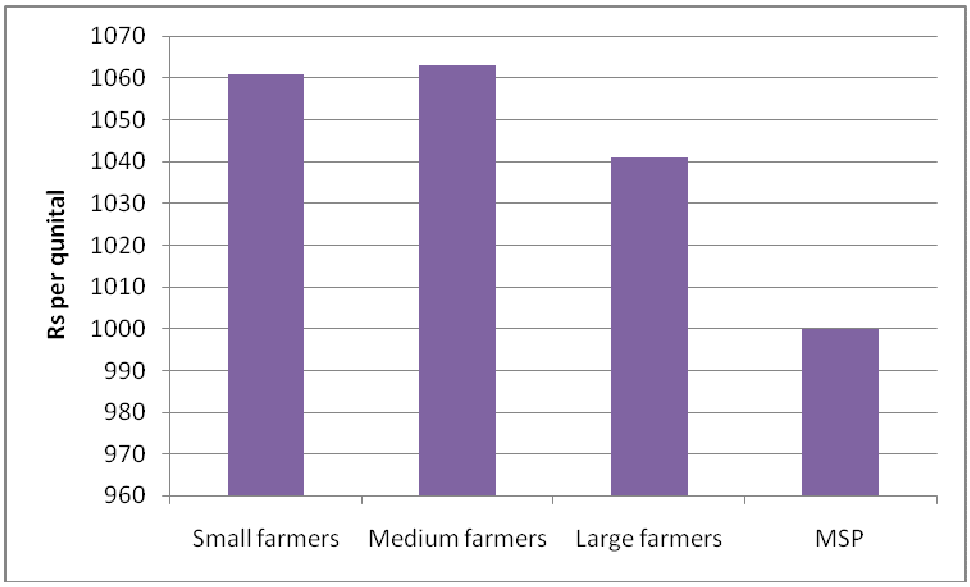

Fig 19. Selling price of wheat by different category of farmers in M.P. w.r.t. to Minimum Support Price (MSP), 2007-08

Table 6.23. Inputs used in cultivation of WHEAT crop on sample farms in M.P.

(Kg per ha)

Particulars	Ujjain			Rewa			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
No. of sample farmers	42	29	29	52	34	14	94	63	43
No. of sample farmers growing wheat	31	28	29	50	33	13	81	61	42
Average area under the crop (ha per farm)	0.80	2.21	4.62	0.80	2.04	3.48	0.80	2.13	4.05
Seed	147.70	152.62	157.03	115.74	122.34	112.67	131.72	137.48	134.85
Organic manure (Q/ha)	9	37.44	20.39	4.76	3.51	7.78	6.88	20.48	14.09
N	106.98	116.51	114.61	110.38	99.30	107.85	108.68	107.91	111.23
P_2O_5	51.37	61.85	49.93	43.83	42.98	44.94	47.60	52.42	47.44
K_2O	9.43	16.07	22.55	0	0	2.62	4.72	8.04	12.59
NPK total	167.78	194.43	187.09	154.21	142.28	155.41	161	168.37	171.26
S	7.63	11.35	4.46	0.22	0.46	1.27	3.93	5.91	2.87
Zn	0	0	0	0.41	0.88	2.42	0.21	0.44	1.21
Average no. of irrigation	3.3	4.11	3.45	2.86	3.21	3.08	3.08	3.66	3.27
Yield (Q/ha)	35.86	37.34	35.70	27.03	27.49	28.19	31.45	32.42	31.95

Table 6.24. Cost of and return from cultivation of WHEAT on sample farms in M.P.

(Rupees per ha)

Particulars	Ujjain			Rewa			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Seed	2247	2100	2252	2031	1978	1899	2139	2039	2076
Fertilizers	2519	2883	3027	2149	2103	2602	2334	2493	2815
Organic manure	178	749	408	71	88	233	125	419	321
Irrigation cost	6108	9505	10111	5331	6370	5776	5720	7938	7944
Plant Protection	268	806	400	300	467	686	284	637	543
Wage cost	1600	2874	3437	1028	1027	1095	1314	1951	2266
Hired Animal Exp.	408	173	0	343	456	133	376	315	67
Hired Machine Exp.	3176	3159	2990	2476	3022	3559	2826	3091	3275
Total paid out cost	16504	22249	22625	13729	15511	15983	15118	18883	19307
Cost of production (Rs./Q)	460	596	634	508	564	567	484	580	601
Selling price (Rs./Q)	1088	1110	1082	1034	1016	1000	1061	1063	1041
Total revenue	39018	41452	38625	27950	27931	28192	33484	34692	33409
Operating profit	**22514**	**19203**	**16000**	**14221**	**12420**	**12209**	**18368**	**15812**	**14105**
Benefit-cost ratio	2.36	1.86	1.71	2.04	1.80	1.76	2.20	1.83	1.74

Gram

Use of critical inputs:

Gram or chick pea is also widely cultivated in M.P. state. The area under the crop constitutes about 33% of the total gram area in the country and contributes about 38% to the national pool of the production. On the sample farms of the selected districts in M.P., the yield of the crop is significantly higher than the state as well as national average. This may be due to the fact that the farmers cultivating this crop are using good quantity of chemical fertilizer with 60-80 kg/ha NPK in Ujjain district and 35-56 kg/ha NPK in Rewa district along with 1-2 irrigations (table 6.25). Therefore, farmers in both the districts are able to harvest 8-12 quintals/ha of grain. Though, it is interesting to see that the crop yield is better in Rewa district than that in Ujjain district, where NPK dosage is significantly higher. From field survey, one important observation was that the gram crop is more liked by medium and large farmers than the small and marginal. It can be easily verified that only half and one-third of the farmers with less than 2 hectares holding in Ujjain and Rewa district respectively opted for cultivation gram, while almost two-third of large farmers cultivated this crop on a large portion of their holding.

Cost and return:

From Table 6.26, it is evident that the higher dosage of fertilizer but lower crop yield in Ujjain district has impacted the profitability of the farmers. In case of large farmers, the situation even more worse as the crop yield is as low as 8 quintals/ha against about 12 Q/ha for medium farmers. Accordingly, the operating profit from gram cultivation in Ujjain district varied from merely Rs. 1400/ha to Rs. 11000/ha while that in Rewa district varied from Rs. 9000/ha to Rs. 14000/ha. Seed and machine labour were the two most expensive components in cost of cultivation which constituted one-third each in total paid out cost, while irrigation and plant protection constituted about 10-20 per cent each. In case of gram too, farmers were able to sell their produce above MSP of Rs. 1600 per quintal (Fig 20).

Table 6.25. Inputs used in cultivation of GRAM crop on sample farms in M.P.

(Kg per ha)

Particulars	Ujjain			Rewa			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
No. of sample farmers	42	29	29	52	34	14	94	63	43
No. of sample farmers growing gram	23	14	22	17	16	10	40	30	32
Average area under the crop (ha per farm)	0.60	1.03	5.07	0.47	0.73	1.66	0.54	0.88	3.37
Seed	106.16	113.60	126.18	91.97	97.52	107.78	99.07	105.56	116.98
Organic manure (Q/ha)	0	8.68	2.30	2.36	1.32	1.32	1.18	5.00	1.81
N	16.31	17.89	21.56	17.55	15.79	9.85	16.93	16.84	15.71
P_2O_5	46.15	45.81	59.00	25.89	40.35	25.18	36.02	43.08	42.09
K_2O	0	0	0.61	0	0	0	0	0	0.31
NPK total	62.46	63.70	81.17	43.44	56.14	35.03	52.95	59.92	58.11
S	5.25	2.50	3.85	0	0	0	2.63	1.25	1.93
Average no. of irrigation	0.58	1.29	1.05	1.06	1.13	0.90	0.82	1.21	0.98
Yield (Q/ha)	9.38	12.34	8.20	10.60	12.65	11.92	9.99	12.50	10.06

Table 6.26. Cost of and return from cultivation of GRAM on sample farms in M.P.

(Rupees per ha)

Particulars	Ujjain			Rewa			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Seed	3972	4880	5103	3279	2956	2695	3626	3918	3899
Fertilizers	1079	1105	1375	645	922	590	862	1014	983
Organic manure	0	174	46	47	27	27	24	101	37
Irrigation cost	1302	3130	3561	1836	1917	1655	1569	2524	2608
Plant Protection	1490	2144	1964	885	656	771	1188	1400	1368
Wage cost	1211	1497	2174	729	604	234	970	1051	1204
Hired Animal Expenses	239	113	151	366	158	0	303	136	76
Hired Machine Expenses	3245	3024	2582	2681	3356	4029	2963	3190	3306
Total paid out cost	12538	16067	16956	10468	10596	10001	11505	13334	13481
Cost of production (Rs./Q)	1337	1302	2068	988	834	839	1163	1068	1454
Selling price (Rs./Q)	1966	2208	2234	1843	1983	2033	1905	2096	2134
Total revenue	18437	27247	18319	19536	25081	24235	18987	26164	21277
Operating profit	**5899**	**11180**	**1363**	**9068**	**14485**	**14233**	**7484**	**12833**	**7798**
Benefit-cost ratio	1.47	1.70	1.08	1.87	2.37	2.42	1.67	2.04	1.75

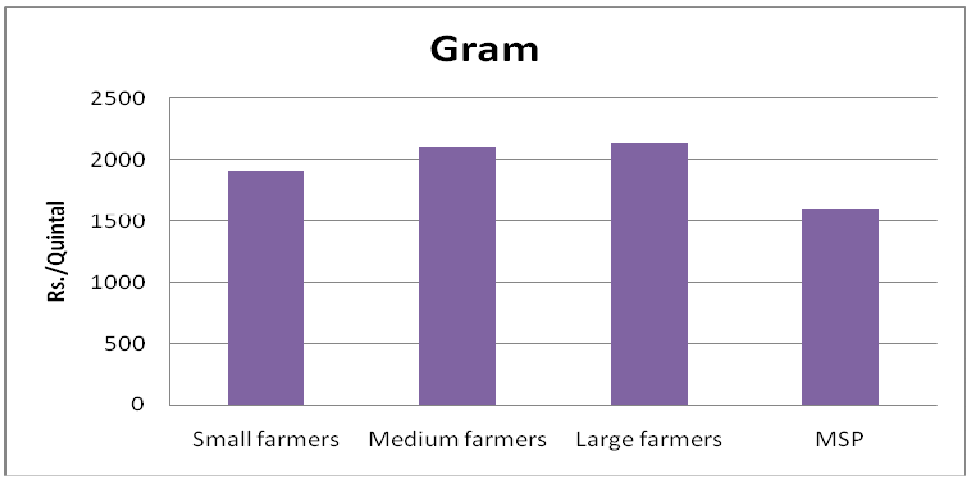

Fig 20. Selling price of gram by different category of farmers in M.P. w.r.t. to Minimum Support Price (MSP), 2007-08

Paddy & Arhar (Tur)

Use of critical inputs:

Paddy although is not important crop for the Madhya Pradesh state as it occupies only 3.8 % of total paddy area in the country, while arhar (tur) has considerable importance for the state, as it contributes more than 9.5% to the total production of the country with about equal percentage of area. Besides, both the crops don't have similar spread within the state. From field survey, it was observed that both the crops are not finding place in the cropping pattern of Ujjain district farmers, while in Rewa districts, more farmers were interested to grow paddy than soybean or tur during kharif season. Therefore, for these two crops, only Rewa district has been covered. By and large, both of the crops are rainfed, wherein only few farmers irrigated paddy for once. Farmers applied 112-125 kg NPK in paddy crop besides applying small quantity of S and Zn. Similarly, small farmers with relatively large livestock holding applied upto 16 Q/ha of organic manure in paddy field. Accordingly, he yield of paddy in Rewa district varied from 23 to 28 Q/ha (Table 6.27).

Contrary to it, arhar is not a favourable crop for even farmers in Rewa district due to high yield risk associated with it with relatively longer duration crop. Therefore, out of 100 surveyed farmer-households, only 14 were cultivating this crop, that too only on small portion of land. Normally, farmers harvested 5-6 Q/ha of grain of the crop with exceptions with large farmers who faced serious failure of crops.

Table 6.27. Input use in PADDY & ARHAR cultivation in Rewa district of M.P.

(Kg per ha)

Particulars	PADDY			ARHAR		
	Small	Medium	Large	Small	Medium	Large
No. of sample farmers growing crop	35	30	13	7	5	2
Average area under the crop (ha per farm)	0.75	2.02	4.38	0.42	0.81	1.82
Seed	56.79	51.92	48.72	25.55	10.74	30.19
Organic manure (Q/ha)	15.85	9.32	3.86	0	0	0
N	89.45	92.37	86.13	2.26	9.90	4.45
P_2O_5	28.16	31.80	25.43	1.76	10.79	11.36
K_2O	0	0	0.79	0	0	0
NPK total	117.61	124.17	112.35	4.02	20.69	15.81
S	0.48	1.01	1.24	0	0	0
Zn	0.91	1.93	2.36	0	0	0
Average no. of irrigation	0.43	0.47	0.38	0	0.2	0
Yield (Q/ha)	23.10	27.78	23.83	5.03	6.20	0.61

Table 6.28. Cost of and return from cultivation of PADDY & ARHAR crops on sample farms in Rewa district of M.P.

(Rs. per hectare)

Particulars	PADDY			ARHAR		
	Small	Medium	Large	Small	Medium	Large
Seed	2171	2444	2301	989	305	1157
Fertilizers	1697	2044	2182	56	320	242
Organic manure	301	196	87	0	0	0
Irrigation cost	705	1271	976	0	277	0
Plant Protection	92	172	235	954	692	0
Wage cost	1046	1280	1254	561	457	380
Hired Animal Expenses	640	726	323	970	1112	428
Hired Machine Expenses	1962	2744	2610	1006	247	1317
Total paid out cost	8614	10877	9968	4536	3410	3524
Cost of production (Rs./Q)	373	392	418	903	550	5733
Selling price (Rs./Q)	751	745	720	3200	3200	3200
Total revenue	17351	20697	17158	16081	19847	1967
Operating profit	**8737**	**9820**	**7190**	**11544**	**16437**	**-1557**
Benefit-cost ratio	2.01	1.90	1.65	3.55	5.82	N.A.

Interestingly, two large farmers who cultivated the crop, expressed extreme displeasure with the crop as it miserably failed due to infestation of disease (Wilt) at the time of flowering stage. Since, they didn't pay needed attention and didn't take plant protection measures, the crop yield has drastically reduced. In general, expenses on account of hired machine constituted maximum in the cost of cultivation of paddy (Table 6.28). In these two crops also, farmers' selling price was higher than the MSP.

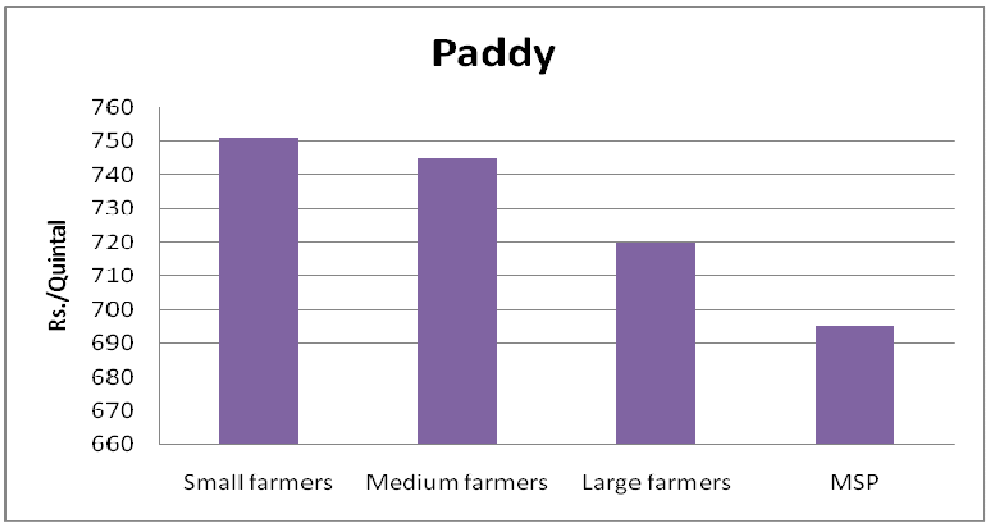

Fig 21. Selling price of paddy by different category of farmers in M.P. w.r.t. to Minimum Support Price (MSP), 2007-08

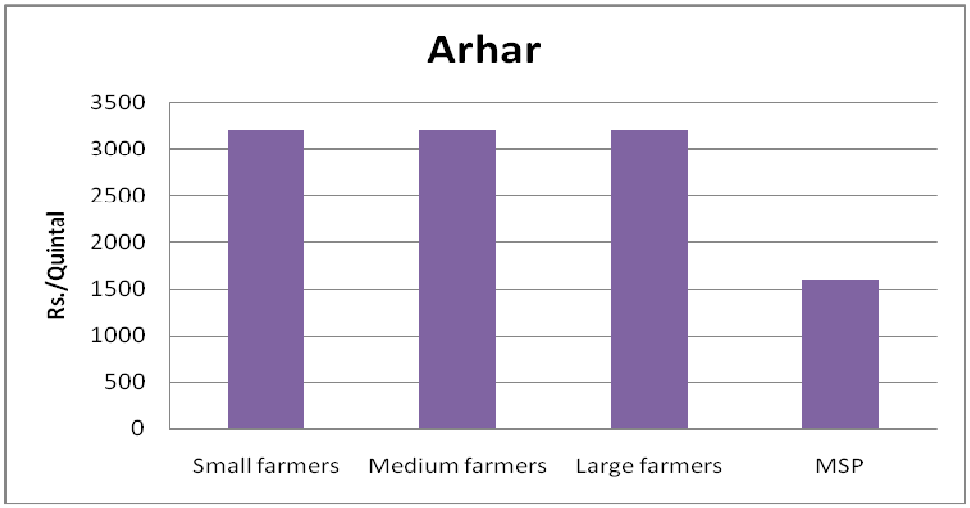

Fig 22. Selling price of arhar by different category of farmers in M.P. w.r.t. to Minimum Support Price (MSP), 2007-08

6.5.3. Economics of major crops' cultivation in Orissa state

More than 90 percent of net sown area is occupied by paddy during kharif season in the selected districts of Orissa state, while during rabi, paddy is the dominant crop in Bargarh district and green gram (moong) is the main crop in Nayagarh district (Appendix). Therefore, these crops have been analysed to examine the profitability of the farmers from agriculture in Orissa state.

Paddy (Kharif)

Application of critical inputs:

Table 6.29 presents the input use in paddy cultivation in both the selected districts of Orissa. Between these two districts, Bargarh is considered agriculturally advanced district, which is also evident from input use in their main crop i.e. paddy during kharif season. Application of chemical fertilizer in Bargarh district is almost double than that in Nayagarh district. However, in general farmers in Orissa don't apply irrigation in kharif paddy, as there is sufficient rainfall in this part of the country. But, there is significant difference in the paddy yield in both the districts. Thus paddy yield varied from 13 to 30 quintals per ha in the state. On an average, small and marginal farmers harvested better crop yield than the medium or large farmers.

Cost and returns:

Cost and return from paddy cultivation in Orissa state revealed very peculiar situation. Among all 3 states studied, wage cost is the maximum and in fact, it alone constituted about 50 percent of the total paid out cost which ranged between Rs. 6000-8000 per hectare (Table 6.30). Such a high cost on human labour made cultivation of kharif paddy highly unremunerative particularly in Nayagarh district. On account of growing demand of labor in non-agricultural enterprises like mines, industry or real estate in urban area, the wage rate of agricultural labour in rural area has increased to Rs. 80 per day. On the other hand, low chemical fertilizer application in Nayagarh led to very poor paddy yield. Therefore, there is net loss of Rs. 4000 per ha in the district mainly borne by the large farmers. From Fig 23, it can be understood that the small or marginal farmers in both the season sold their produce at lower price than the MSP announced. Though, during rabi season, the difference between two were very less.

Table 6.29. Inputs used in cultivation of PADDY(K) crop on sample farms in ORISSA

(Kg per ha)

Particulars	Bargarh			Nayagarh			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
No. of sample farmers	75	13	12	80	16	4	155	29	16
No. of sample farmers growing kharif paddy	75	13	12	80	16	4	155	29	16
Average area under the crop (ha per farm)	1.04	2.74	6.20	0.85	2.04	3.94	0.95	2.39	5.07
Seed	105.45	113.98	93.25	95.56	98.77	96.67	100.51	103.38	94.96
Organic manure (Q/ha)	23.76	25.25	23.62	23.99	22.31	27.36	23.88	23.78	25.49
N	56.82	60.91	68.10	26.83	38.79	33.37	41.83	49.85	50.74
P_2O_5	31.79	33.27	35.91	0	4.97	0	15.90	19.12	17.96
K_2O	31.44	33.50	35.38	21.03	32.74	25.38	26.24	33.12	30.38
NPK total	120.05	127.68	139.39	47.86	76.5	58.75	83.97	102.09	99.08
S	2.18	2.04	2.67	0	0	0	1.09	1.02	1.34
Zn	3.17	2.87	3.60	0	0	0	1.59	1.44	1.80
Average no. of irrigation	0	0	0	0	0	0	0	0	0
Yield (Q/ha)	30.11	25.47	27.99	17.36	15.26	13.48	23.74	20.37	20.74

Table 6.30. Cost of and return from cultivation of PADDY (K) on sample farms in ORISSA

(Rupees per ha)

Particulars	Baragarh			Nayagarh			Overall		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Seed	1122	1201	956	915	917	897	1018	1059	927
Fertilizers	3040	3132	3622	561	927	689	1801	2030	2156
Organic manure	576	573	555	585	558	534	581	566	545
Irrigation cost	0	0	0	0	0	0	0	0	0
Plant Protection	1158	993	812	708	408	418	933	701	615
Wage cost	6862	6446	6362	7105	7303	7950	6984	6875	7156
Hired Animal Exp.	548	1471	1240	427	1336	2250	488	1404	1745
Hired Machine Exp.	0	0	0	0	0	0	0	0	0
Total paid out cost	13306	13816	13547	10301	11449	12738	11805	12635	13144
Cost of production (Rs./Q)	442	542	484	593	750	945	518	646	715
Selling price (Rs./Q)	663	695	720	601	626	645	632	661	683
Total revenue	19965	17703	20151	10435	9552	8692	15200	13628	14422
Operating profit	**6659**	**3887**	**6603**	**134**	**-1897**	**-4046**	**3397**	**995**	**1278**
Benefit-cost ratio	1.50	1.28	1.49	1.01	0.83	0.68	1.26	1.06	1.09

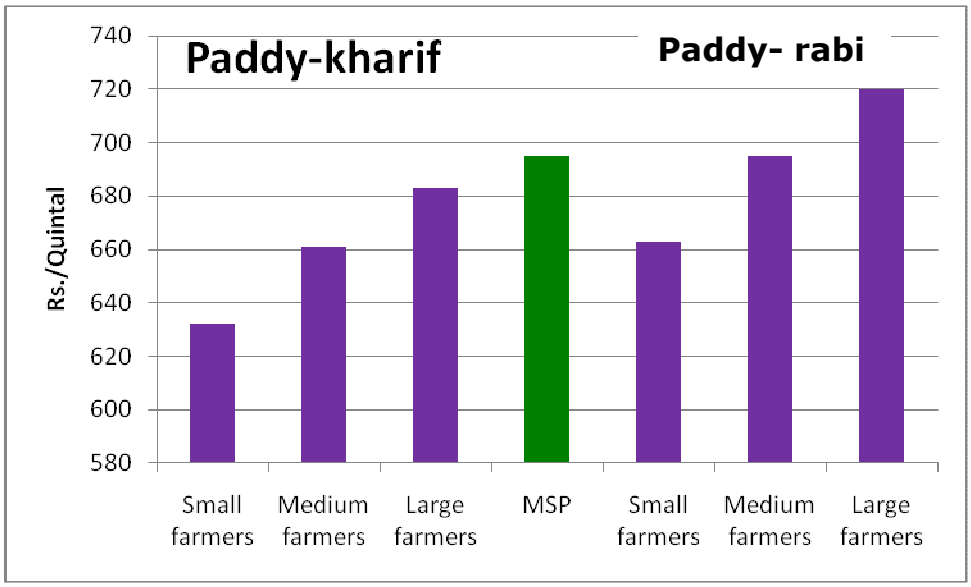

Fig 23. Selling price of kharif and rabi paddy by different category of farmers in Orissa w.r.t. to Minimum Support Price (MSP), 2007-08

Paddy (Rabi)

Application of critical inputs:

As discussed earlier, paddy is only common crop in Bargarh district during rabi season and farmers of Nayagarh district instead cultivates moong or other vegetables crops. The Bargarh farmers cultivate paddy very intensively during winter season, as the application all the inputs- seed, chemical fertilizer, irrigation, etc. were higher than the rabi season paddy crop (Table 6.31). Accordingly, they were able to harvest 10-15 percent more paddy yield. In some cases, the paddy yield reached up to more than 4 tonnes per ha, though the area under such bumper crop were with small/marginal farmers who cultivated on very small parcel of land (0.5 ha).

Cost and returns:

Since the level of input application were higher during rabi season paddy, the expenses on all the inputs also increased proportionately. However, the higher selling price alongwith the better crop yield gave farmers much better return from paddy cultivation during rabi season (Table 6.32).

Table 6.31. Inputs used in cultivation of Rabi-PADDY in Bargarh district and Rabi-MOONG in Nayagarh district in ORISSA

(Kg per ha)

Particulars	Baragarh- Paddy			Nayagarh- Moong		
	Small	Medium	Large	Small	Medium	Large
No. of sample farmers	75	13	12	80	16	4
No. of farmers growing rabi paddy/moong	48	9	11	67	12	4
Average area under the crop (ha per farm)	0.54	1.16	4.72	0.38	0.67	1.36
Seed	102.85	112.19	88.71	37.55	31.92	38.39
Organic manure (Q/ha)	24.68	24.30	26.13	5.03	1.89	8.02
N	70.59	69.92	69.53	7.95	10.42	8.20
P_2O_5	38.04	33.51	36.04	20.07	19.67	20.95
K_2O	39.41	37.98	38.42	0	0	0
NPK total	148.04	141.41	143.99	28.02	30.09	29.15
S	2.66	1.99	2.45	0	0	0
Zn	2.52	2.01	2.51	0	0	0
Average no. of irrigation	5.64	6.11	7.18	0	0	0
Yield (Q/ha)	40.26	33.67	38.57	2.56	3.70	2.65

Moong (Rabi)

Application of critical inputs:

Moong or green gram is the essential crop for farmers of Nayagarh district during rabi season (Appendix), though there are a number of crop combinations like sugarcane, groundnut, biri (Urd or black gram), etc. Moong is the low inputs-requiring crop. Being leguminous crop, many farmers even don't apply smaller amount of nitrogenous fertilizer. Only phosphatic fertilizer mainly in the form of DAP at the time of sowing is the major nutrient added to the soil. Thus, with 30-35 kg/ha of seed and 25-30 kg/ha of phosphatic fertilizer, farmers harvest 2.50 to 3.5 quintal/ha of grain yield (Table 6.31).

Cost and return:

From Table 6.32, it is evident that from moong cultivation, farmers of Nayagarh district are able to earn Rs. 3000-7000 per ha of profit. In fact, for many poor farmers, it serves better than any other crop as they need not to put lot of money to cultivate it. That's why, although its yield is very poor, large number of farmers are going for it.

Table 6.32. Cost of and return from cultivation of Rabi-PADDY in Bargarh district and Rabi-MOONG in Nayagarh district in ORISSA

(Rupees per ha)

Particulars	Baragarh- Paddy			Nayagarh- Moong		
	Small	Medium	Large	Small	Medium	Large
Seed	1080	1150	896	959	959	960
Fertilizers	2729	2455	2614	350	335	501
Organic manure	583	607	648	113	41	176
Irrigation cost	790	790	790	0	0	0
Plant Protection	1087	916	799	468	404	503
Wage cost	7594	6578	6723	1320	1292	1538
Hired Animal Exp.	1191	1446	1458	202	188	188
Hired Machine Exp.	0	0	0	0	0	0
Total paid out cost	15054	13942	13928	3412	3219	3866
Cost of production (Rs./Q)	374	414	361	1333	870	1459
Selling price (Rs./Q)	663	695	720	2639	2738	2750
Total revenue	26691	23403	27767	6769	10138	7279
Operating profit	**11637**	**9461**	**13839**	**3357**	**6919**	**3413**
Benefit-cost ratio	1.77	1.68	1.99	1.98	3.15	1.88

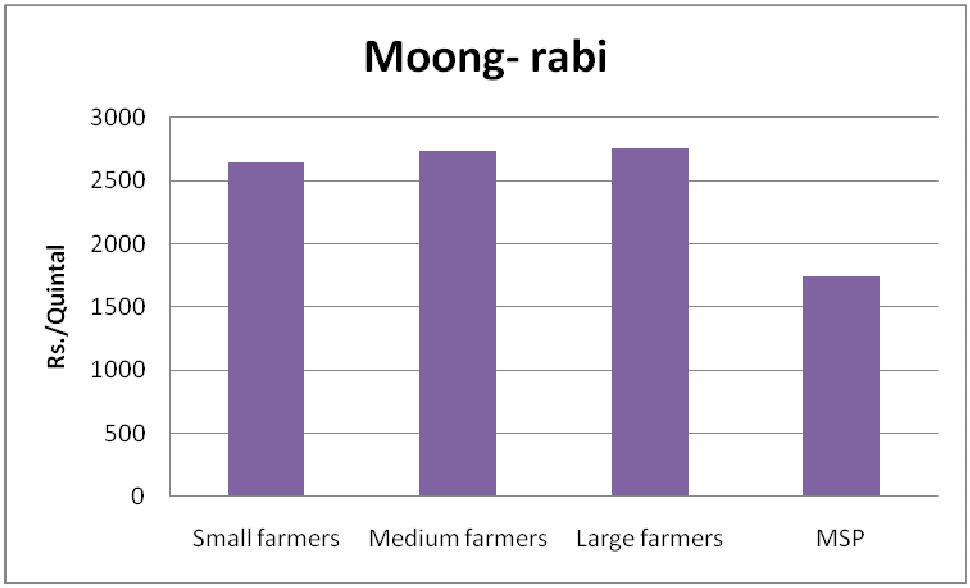

Fig 24. Selling price of moong by different category of farmers in Orissa w.r.t. to Minimum Support Price (MSP), 2007-08

6.5.4. Farmers' economic capacity

Economic capacity of the farmers in the study has been determined by estimating net income from the farming after meeting the operational or paid out costs. For this purpose, operating profit from the cultivation of major crops grown by the sample farmers has been considered and extrapolated with the assumptions that remaining cropped area with the farmers will also give at least similar kind of operational profit. This assumption has been made on the pre-text of keeping in mind that the rational farmers would allocate maximum area to such crops which give them maximum and stable profit. The results are presented in Table 6.33 to 6.35.

The **2008 Bihar flood**, which started in the month of August 2007, was described by the United Nations the worst hit flood in the living memory of Bihar. It is believed to be the worst flood in Bihar in last 30 years. The flood affected 19 districts of the state. Fortunately, the two selected districts were not in the list, but in fact these two received less than normal rainfall and were partially draught-hit. The economic capacity of the farmers in Bihar based on paddy-wheat based cropping system shows that small and marginal farmers are able to save merely about Rs. 16000 in a year while large farmers have about Rs. 44000 (Table 6.33). This means farmers in Bihar have hardly Rs. 1500 to Rs. 4000 per month for their livelihood, children's education and healthcare and therefore can't take any risk in agriculture. In fact, without addition in income from non-agriculture enterprises is difficult to sustain descent life for even large farmers.

Unlike their counterpart in Bihar, farmers of Madhya Pradesh are able to have better saving from agriculture which gives them considerable economic capacity to invest in agriculture. From Table 6.35 and earlier discussion shows that the choice of crops and the prevailing economic conditions helped the farmers to realise far better return. The year 2008 being the year of global economic crisis with food inflation touching roof, farmers in M.P. were able to sell their major produce above than procurement price, which helped them save even more than Rs. 1.60 lakh by the large farmers. However, the small and marginal farmers were able to save Rs. 28000 in a year, though the yield of most of the crops were higher with small farmers, they couldn't enjoy the fruits of economy of scale. Such huge difference was due to large farm holding with the large farmers. Overall, the economic capacity of farmers in Madhya Pradesh is getting augmented by about Rs. 72000 every year.

Table 6.33. Economic capacity of farmer households in Bihar state

Particulars		Small farmer	Medium farmer	Large farmer
Bhojpur district/ No. of sample farmers		53	37	10
	Paddy (P)			
a.	Average area under the crop (ha per farm)	1.06	1.58	3.67
b.	Operating profit (Rs./ha)	12191	7595	9063
c.	Total profit (Rs./hhld) = a*b	12921	12000	33260
	Wheat (W)			
d.	Average area under the crop (ha per farm)	0.95	1.45	3.52
e.	Operating profit (Rs./ha)	4580	6629	3546
f.	Total profit (Rs/ hhld) = d*e	4352	9613	12483
g	Farm income from paddy & wheat (Rs/ hhld) = c+f	17273	21613	45743
h.	Share of Paddy+Wheat in GCA, %	85.17	72.84	76.41
A.	**Total farm income/ economic capacity (in Rs/ hhld) = g*100/h*	*20280*	*29672*	*59865*
Purnea district/ No. of sample farmers		67	22	11
	Paddy (P)			
a.	Average area under the crop (ha per farm)	0.99	2.65	5.31
b.	Operating profit (Rs./ha)	3648	2073	759
c.	Total profit (Rs./ hhld) = a*b	3611	5493	4031
	Wheat (W)			
d.	Average area under the crop (ha per farm)	0.44	0.82	2.18
e.	Operating profit (Rs./ha)	8279	5936	5719
f.	Total profit (Rs/ hhld) = d*e	3644	4868	12471
g	Farm income from paddy & wheat (Rs/ hhld) = c+f	7255	10360	16501
h.	Share of Paddy+Wheat in GCA, %	59.58	57.16	55
B.	**Total farm income/ economic capacity (in Rs/ hhld) = g*100/h*	*12176*	*18125*	*30002*
C.	**Economic capacity of farmers in Bihar (Rs/household) = weighted average of A & B**	**15755**	**25366**	**44222**
D.	**Overall economy capacity (Rs per farmer household)= weighted average of C**		**21580**	

*Assuming that rest of the cultivated area would also give at least similar kind of profitability.
hhld is farmer-household

Table 6.34. Economic capacity of farmer households in Madhya Pradesh state

Particulars		Small farmer	Medium farmer	Large farmer
Ujjain district/ No. of sample farmers		42	29	29
	Soybean (S)			
a.	Average area under the crop (ha per farm)	0.96	2.72	8.84
b.	Operating profit (Rs./ha)	12592	15711	9782
c.	Total profit (Rs./hhld) = a*b	12151	42702	86435
	Wheat (W)			
d.	Average area under the crop (ha per farm)	0.58	2.10	5.14
e.	Operating profit (Rs./ha)	22514	19203	16000
f.	Total profit (Rs/hhld) = d*e	13077	40419	82198
	Gram (G)			
g.	Average area under the crop (ha per farm)	0.34	0.48	3.30
h.	Operating profit (Rs./ha)	5899	11180	1363
i.	Total profit (Rs/hhld) = g*h	2014	5372	4498
j.	Farm income from S+W+G crops (Rs/hhld) = c+f+i	27242	88493	173132
k.	Share of S+W+G in GCA, %	97.28	97.13	97.98
A.	**Total farm income/ economic capacity (in Rs/hhld) =j*100/k*	28004	91108	176701
Rewa district/ No. of sample farmers		52	34	14
	Soybean (S)			
a.	Average area under the crop (ha per farm)	0.33	0.49	0.60
b.	Operating profit (Rs./ha)	20847	16758	23268
c.	Total profit (Rs./hhld) = a*b	6882	8294	13946
	Paddy (P)			
d.	Average area under the crop (ha per farm)	0.52	1.82	3.88
e.	Operating profit (Rs./ha)	8737	9820	7190
f.	Total profit (Rs/hhld) = d*e	4527	17902	27878
	Wheat (W)			
g.	Average area under the crop (ha per farm)	0.77	2.00	3.19
h.	Operating profit (Rs./ha)	14221	12420	12209
i.	Total profit (Rs/hhld) = g*h	10918	24803	38975

	Gram (G)			
j.	Average area under the crop (ha per farm)	0.13	0.42	1.17
k.	Operating profit (Rs./ha)	9068	14485	14233
l.	Total profit (Rs/hhld) = j*k	1211	6135	16702
m.	Farm income from 4 crops (Rs/ha) = c+f+i+l	23537	57134	97500
n.	Share of S+P+W+G in GCA, %	84.11	90.95	73.32
B.	**Total farm income/ economic capacity (in Rs/hhld) = m*100/n*	27984	62819	132979
C.	**Economic capacity of farmers in M.P. (Rs/household) = weighted average of A & B**	**27993**	**75841**	**162466**
D.	**Overall economy capacity (Rs per farmer household)= weighted average of C**		**71977**	

*Assuming that rest of the cultivated area would also give at least similar kind of profitability.
hhld is farmer-household

Opposite to this trend, large farmers in Orissa, who are in very few numbers reported operating losses in kharif paddy production, particularly in Nayagarh district, which received less than long term average rainfall during the study year. In Orissa too, the difference between economic capacity of small and large farmers are huge (Table 6.35). Contrary to general perception about wide spread poverty in rural area of the state, the labor cost is the highest in Orissa among all 3 states, which affect the net profit of the farmers very badly. The main reason may be that the medium to large farmers in the state are not doing any agricultural operations themselves or they are the absentee landlords. Overall, the farmers in Orissa are adding hardly Rs. 15000 to their kitty every year for all other purposes, which is further perpetuating their poor economic conditions.

Thus, if one considers the agriculture or farming in broader perspectives, it gives very dismal picture for at least 2 of the 3 states under study. No doubt, among 3 states, in M.P. and Orissa, the difference between the economic capacity of small and large farmers are widening due to year on year economic surpluses (Fig 25), while in Bihar, the difference is very less. Secondly, the farming in the present context of given cropping pattern, basic infrastructure, etc is not viable for small as well as medium farmers of Bihar and Orissa states, which will ultimately lead to further casualization of farming.

Table 6.35. Economic capacity of farmer households in Orissa state

Particulars		Small farmer	Medium farmer	Large farmer
Bargarh district/ No. of sample farmers		75	13	12
	Paddy-Kharif (P-K)			
a.	Average area under paddy-k (ha/ farm)	1.04	2.74	6.20
b.	Operating profit (Rs./ha)	6659	3887	6603
c.	Total profit (Rs./hhld) = a*b	6926	10651	40942
	Paddy-Rabi (P-R)			
d.	Average area under paddy-r (ha/ farm)	0.54	1.16	4.72
e.	Operating profit (Rs./ha)	11637	9461	13839
f.	Total profit (Rs/ hhld) = d*e	6284	10976	65315
g	Farm income from P-K & P-R crops (Rs/ hhld) = c+f	13210	21627	106256
h.	Share of P-K & P-R in GCA, %	87.78	84.79	95.79
A.	**Total farm income/ economic capacity (in Rs/ hhld) = g*100/h*	15049	25507	110926
Nayagarh district/ No. of sample farmers		80	16	4
	Paddy-Kharif (P-K)			
a.	Average area under paddy-k (ha/ farm)	0.85	2.04	3.94
b.	Operating profit (Rs./ha)	134	-1897	-4046
c.	Total profit (Rs./ hhld) = a*b	114	-3870	-15942
	Moong (M)			
d.	Average area under moong (ha/ farm)	0.38	0.67	1.36
e.	Operating profit (Rs./ha)	3357	6919	3413
f.	Total profit (Rs/ hhld) = d*e	1273	4636	4642
g	Farm income from P-K & M crops (Rs/ hhld) = c+f	1387	766	-11300
h.	Share of P-K & M in GCA, %	70.94	72.08	90.45
B.	**Total farm income/ economic capacity (in Rs/ hhld) = g*100/h*	1955	1062	-12493
C.	**Economic capacity of farmers in M.P. (Rs/household) = weighted average of A & B**	**8290**	**12020**	**80071**
D.	**Overall economy capacity (Rs per farmer household)= weighted average of C**		**14574**	

*Assuming that rest of the cultivated area would also give at least similar kind of profitability.
hhld is farmer-household

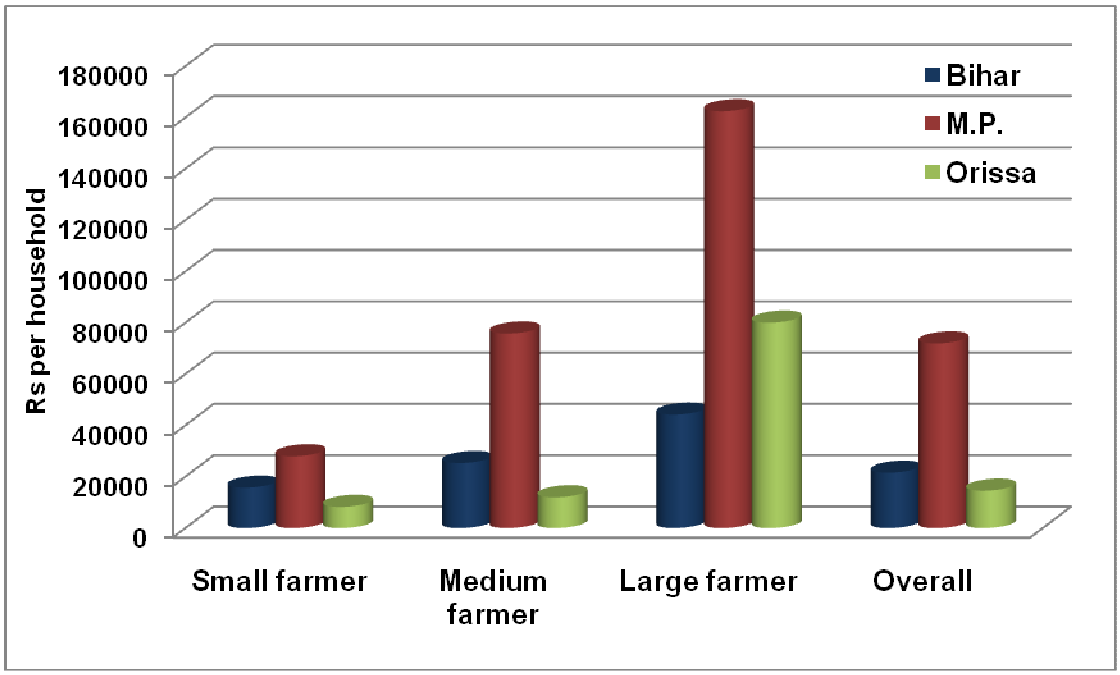

Fig 25. Farmers' economic capacity in 3 selected states

In view of Planning Commission, a family of 5 members with monthly income less than Rs. 1660 per month in rural area is considered BPL family. Thus minimum annual income shouldn't be less than Rs. 19920, which means most of the farmer-households in Bihar and Orissa states, unless don't have any other income from non-farming sources, the farming enterprise is pushing them below poverty line.

6.5.4. Farmers' willingness to use inputs

During field survey of sample farmers in the study area, they were also asked, whether they think that they were using the various inputs like seed, fertilizer, irrigation or plant protection measures in appropriate quantity. Their responses were varied in 3 states. As far as, seed and fertilizer were concerned, majority of the farmers in the study area felt that prices of quality seeds and all fertilizers are very high when compared to the profitability from crop cultivation. The reliability of quality seeds available with local vendors is also questionable as there was no certified agency and the state Government supply certified seeds through block in very small quantity. They also revealed that they never went for soil or plant analysis, so they are not aware about the fertilizer requirement in their field and therefore, they were applying fertilizer on the basis of their existing knowledge.

Thus, from Table 6.36 to 6.38, it can be observed that in Bihar and Orissa, getting quality seeds of the major crops are difficult due to high price, less capital available with the farmers and uncertainty of crop yield in lack of proper irrigations as well as market risks of the produce. In case of irrigation, it was not a problem in general during kharif season crops. Therefore, farmers opinion were asked about the number of irrigations applied to the rabi season crops. Interestingly, farmers of M.P. with sufficiently good cash balance have also reported less number of irrigations applying to rabi season crops, particularly wheat. As far as chemical fertilizer was concerned, several farmers reported that they were neither applying Potassic fertilizer nor Zinc or any other micro-nutrients to the crop. They were mainly small and marginal farmers, who primarily depend on Urea and DAP as source of crop nutrients.

Table 6.36. Willingness to use good quality seeds of major crops

(Percent of farmers*)

States	Criteria	Small farmers	Medium farmers	Large farmers
Bihar	Affordable	35.83	28.57	33.90
	Very high	64.17	71.43	66.10
Madhya Pradesh	Affordable	63.10	70.69	55.17
	Very high	36.90	29.31	44.83
Orissa	Affordable	36.37	28.94	39.36
	Very high	63.63	71.06	60.64

*expressing the price of quality seed, they wish to use

Table 6.37. Willingness to apply adequate irrigations to rabi season crops

(Percent of farmers*)

States	Criteria	Small farmers	Medium farmers	Large farmers
Bihar	Sufficient	56.67	66.67	54.24
	Insufficient	43.33	33.33	45.76
Madhya Pradesh	Sufficient	19.05	48.28	34.48
	Insufficient	80.95	51.72	65.52
Orissa	Sufficient	40.50	81.40	75.20
	Insufficient	59.50	18.60	24.80

*expressing the number of irrigations given to the rabi crops, insufficient means they are willing to apply more.

Table 6.38. Willingness to apply fertilizers to the major crops

(Percent of farmers*)

States	Criteria	Small farmers	Medium farmers	Large farmers
Bihar	Sufficient	65.28	69.84	54.80
	Insufficient	34.72	30.16	45.20
Madhya Pradesh	Sufficient	48.40	54.00	66.70
	Insufficient	51.60	46.00	33.30
Orissa	Sufficient	38.99	50.00	37.84
	Insufficient	61.01	50.00	62.16

*expressing the quantity of fertilizers given to major crops.

6.5.5. Prioritization of constraints faced by the farmers

The selected study area i.e. Bihar, Madhya Pradesh and Orissa being economically fragile region of the country, there are a number of constraints for thriving agriculture. These constraints ranged from hostile ago-climatic conditions, poor infrastructure, poor implementation of government policies, high cost of fertilizer, unreliable quality seeds and even other marketing constraints dissuaded the farmers to go for intensive farming in a big way. The adoption of latest farming technology is like a vehicle having four wheels- institutions, infrastructure, technology transfer and policy, with technology working as a driver. When all these wheels have optimum air, pressing accelerator will pick-up the speed of the vehicle at the desired speed. Less air even in one wheel would limit the speed, irrespective of how good the driver is. This is true for agriculture in Bihar and Orissa, too as agriculture in M.P. has done well in recent years. The absence of appropriate institutional arrangement/ infrastructure is bound to hinder the speed of agricultural growth in the selected states. Some of the most important constraints revealed by the farmers are presented in Table 6.39 and 6.40, which were given by the farmers' higher rank given in terms of their priorities.

Thus, from table, it can be seen that unavailability of quality seed as well as their prices were the major constraints for farmers of Bihar and Orissa. Similarly, lack of information regarding fertilizer recommendation was the reason for not applying recommended dose of fertilizer in all 3 states. Usually, small and marginal farmers depend on large farmers for irrigation during rabi season. On the other hand, the large farmers, who own the tubewells in any village use their monopolistic power and give

irrigation water to others only after meeting their requirement. The situation warrants the small farmers to go for less irrigation than the crops' requirement.

From institutional side, there are several bottlenecks in the study area. Even after so many efforts by the government for providing institutional credit to the farmers at cheaper rate, it remains nightmare for majority of small-holder farmers. Cumbersome procedure, lengthy formalities, unfriendly attitude of bank staffs and commission charges keep the small farmers away from financial institutions and still they prefer to go to moneylenders or arhatiya, who in turn purchase their produce at their door step at lower price. Breaking this nexus remains daunting challenge for the government as well as policy makers in these states.

Table 6.39. Technological constraints faced by the farmers in study area

(Percent of farmers)

State	Reasons for not replacing with quality seeds		Reasons for not applying recommended level of fertilizer			Reasons for not applying recommended irrigations	
	Seed not avail.	Very costly	Not aware	Rising price	Not available	High charge	Source not available
Bihar	65.35	69.33	68.36	26.28	15.18	33.42	63.66
M.P.	22.16	23.48	45.33	17.16	2.65	13.25	33.45
Orissa	45.18	68.50	76.88	35.17	17.33	29.86	48.75

Table 6.40. Institutional constraints faced by the farmers in study area

(Percent of farmers)

State	Availability of institutional credit			Electricity for irrigation		Connectivity to market to sell the produce		
	*Getting difficult	In-adequate	Not having KCC	In-adequate	Un-timely	[1]Difficult in trans-portation	[1]Price difference not remun-erative	No Govt. agency
Bihar	52.50	42.13	72.35	73.33	81.00	68.35	76.45	86.26
M.P.	19.15	14.76	42.50	28.00	22.00	17.33	20.33	15.67
Orissa	18.82	17.28	26.75	66.00	85.00	60.30	66.70	58.00

*lengthy procedure, inadequate own land holding, land ownership not transferred from father, middlemen charges, etc. makes accessibility difficult.

[1]Small quantity of marketable surplus also makes difficult for transporting to bigger market, where the difference between wholesale price and price offered by local arhatiya is less than 10 percent.

7

Conclusions and Policy Implications

The states of Bihar, M.P. and Orissa are since long remained laggard in terms of agricultural growth, however now, being talked about as a sleeping giant of Indian agriculture. The National Commission on Farmers has concluded that Bihar and Eastern India present uncommon opportunities for becoming another “fertile crescent”. Water, the lifeline of agriculture, is abundant in Bihar and Orissa, the real issue is not availability but management. It is becoming increasingly important that more attention needs to be given to less-favoured states like Bihar, Madhya Pradesh and Orissa, with strikingly very high level of poverty in setting priorities for inclusive growth.

Investment in agriculture infrastructure like irrigation, transportation, rural electricity, storage services, and research is crucial for farm growth. But declining government investment in agriculture from 14.9 percent in the first Five Year Plan (FYP) to about 5 percent in the current plan has had cascading impact on the livelihood of rural India. A 10 percent growth rate for the economy over the next FYP is only possible, if the nation cranks up infrastructure capacity particularly in hitherto economically fragile regions. Until these regions are not kept on fast growth tracks, it is not possible to sustain high growth for long with millions of rural poor in these backward regions earning meagerly to meet both ends. The current study therefore, is an attempt to examine the public investment in agriculture, its effect on agriculture performance and relationship between crop output with infrastructure variables and public expenditure. On the basis of field survey of 200 farmers in each state, income from the farming and thereby economic capacities of the farmers were also estimated in Bihar, M.P. and Orissa states.

In these states, large section of the total population (more than 80%) are staying back in rural areas creating huge pressure on agriculture in terms of fragmentation of land holding, under-employment in agriculture, low agricultural wages, etc. Therefore, per capita NSDP in three poorest states; Bihar, Madhya Pradesh and Orissa, which together account for over a fourth of the population of the country, remained languishing. About half of the total population in these states remains below poverty line. In Bihar and Orissa, 70-90 per cent of the farmers have less than 2 hectares of land. Several studies carried out in the past reported that these states have dismal performance on infrastructure development, although road, agricultural research & development and

irrigations have maximum effect on poverty reduction. Surprisingly, the state with high road density has the highest proportion of un-surfaced roads also. Similarly, even with increase in irrigated area in these states were not able to increase the cropping intensity accordingly. These kinds of dichotomy explain the reason for poor economic growth.

On the other flipside, public expenditure in agriculture sector was given least priorities in Bihar and Orissa, which needed the most, as large population depends on it. Except in Madhya Pradesh state, share of the public expenditure on agriculture in total value of agricultural output is declining in both the states i.e. Bihar and Orissa. Among the factors affecting agricultural growth, it was observed that still about 50 percent of the gross cropped area is not under high yielding varieties. Similarly, seed replacement rate varies between 5 to 20 percent depending on the crops. Besides, there is significant volatility in growth of irrigated area in Bihar and Orissa, while in M.P., it is consistent and the growth in fertilizer consumption has slowed down significantly in all 3 states even before peaking out. When compare the growth in irrigated area, it will take another 20-30 years to match the achievement made by Punjab and Haryana where more than 80 percent of NSA is irrigated, unlike 20-50 percent in Bihar, M.P. and Orissa states. Similarly, most of the irrigation in Bihar and M.P. are done by private investment by the farmers which are based on groundwater irrigation showing utter failure of government policy in augmenting irrigation through surface irrigation (canal). The groundwater irrigation has certain limitations like requirement of energy source to draft groundwater. Electricity supply in rural areas of Bihar and Orissa, particularly is very disappointing, as its consumption in agriculture is hardly 100KWh per ha of GCA as compared to more than 1100 KWh/ha in Punjab and Haryana. Under spiraling oil prices, irrigation with diesel operated energy source makes agriculture highly uncompetitive in these states.

Easy, timely and cheaper credit plays very important role in the growth of any sector. It will be blithering to say that the poor farmers of these 3 states have still very less access to cheaper institutional credit which led to collateral damage in the progress of agriculture, as with small saving left with them, it would be difficult to go for capital intensive agriculture with quality seeds, fertilizer and optimum irrigation. The institutional credit disbursed to agriculture varied from about Rs.3000/ha to Rs. 6000/ha as compared to about Rs. 12000/ha of GCA in Punjab and Haryana states. With such kind of institutional support, it was expected that the agriculture would grow with much slower pace in this poverty-striken region.

Cropping pattern in Bihar and M.P. has remained almost static during last 10-15 years, however in Orissa, there has been lot of changes favoring significant crop diversification. Area under rice has increased, along with that fruits and vegetables, in particular has seen tremendous jump. Interestingly, growth in foodgrain production has been see-saw during last 3 decades in Bihar and Orissa (which might be due to frequent occurrence of natural calamities), while in M.P., it is consistently growing. During 2000-05, growth of most of the crops in Bihar has been negative, except that of vegetables. It was not so in M.P. and Orissa, except few exceptions, as yield of major crops in later two states are growing by 2-5 percent per annum.

The relationship between agricultural output and different infrastructural and input variables shows that electricity consumption in agriculture doesn't influence the agriculture in 3 states, as it is used very minimally. Similarly, public expenditure in agriculture and road density in M.P. and Orissa states and institutional credit to agriculture in Bihar has positive and significant influence. This explains that although, there was no growth in these variables, agriculture in Bihar state has grown, which was mainly due to efforts of individual farmers and the government has not played any proactive role.

The forecasts for next one decade (2005-15) using ARIMA model shows that the production growth of quite good number of crops are going to be snubbed in 3 states, if the production environment are kept constant. The foodgrain production (and yield also) is expected to grow between 1-2 per cent annually. This poses serious questions for the food and nutritional security where more than 50 percent of rural population is below poverty line and population growth is more than 2 percent.

From survey of farmers' field, it emerged that though the state departments are spending huge amount of money, the penetration of soil testing facilities in these states are rare thing to talk about among the farmers. Due to this, they are unaware about the situation of nutrient mining and deficiency of other micro-nutrients, which if not taken care of soon, will cause irreparable loss to soil fertility. Furthermore, on the basis of costs and return estimation for major crops grown by the farmers I the study area, farmers' economic capacity has been measured, which is the annual saving from the farming after meeting the operational expenses.

The results were un-nerving for at least Bihar and Orissa farmers. First of all, it was found that farmers in these two states are selling their main produce to local traders even below the minimum support price (MSP)/ procurement price announced by the government in lack of proper agency to purchase from them. Secondly, in the light of dwindling profitability from farms, even small farmers are hiring labour for all kinds of farming activities, which are making their economic situation even worse. Thirdly, the net profit from agriculture in Bihar and Orissa is as low as Rs. 15000 to Rs. 21000 per annum, which is much lower than the standard set for the poverty line. Fortunately, the draught in large part of the country during study period fuelled the price of pulses and oilseeds, thus farmers in M.P. were able to sell their produce at much higher price than the MSP, making their annual income up to Rs. 72000. Thus, farmers in M.P. have better economic capacity than those of in Bihar and Orissa.

During field survey, it was observed that majority of farmers feel that they were using the inputs sub-optimally or not in tune of the recent developments in agricultural research. Therefore, though, they have willingness to use these inputs according to recommendations, but due to the certain socio-economic, technological as well institutional constraints, they were unable to do so. For example, the reliability and affordability of the quality seeds are the major factors/ constraints due to which small and marginal farmers (who are in majority) are not going for quick replacement of seeds. Usually, the farmers use same seeds of foodgrains or oilseeds for 2-3 years. In absence of soil tests facilities in the vicinity, farmers are applying the fertilizers according to their established knowledge. Even if soil testing facilities are available, they are not aware of the long-term benefits of the soil test based fertilizer application. Similarly, in absence of cheaper energy source, the diesel-based groundwater irrigation being costly affair, even rabi crops like wheat are given hardly 2-3 irrigations in Bihar state. On the other hand, underdevelopment of surface irrigation is also leading to depletion of groundwater. Infrastructural bottlenecks (unsurfaced rural roads, poor or no electricity supply, etc.) and institutional insensitivity (lengthy procedure or rules practically debarring marginal farmers from accessing institutional credit) to the farmers need serious overhauling for keeping the food growers in the region afloat. However, from the findings of the study, it appears that among the 3 states under study, Madhya Pradesh would come out from the poverty cycle first, although with very high income inequality among farmer-households followed by Bihar and lastly, Orissa state.

The quality of economic infrastructure, energy infrastructure and technological divisions between rich and poor states threaten to intensify the disadvantages of the poor states and the advantages of the developed states. In the current situation, the government policy to help agriculture in terms of all kind of subsidies- minimum support price/procurement price, fertilizer subsidy, electricity subsidy, interest rate subvention, etc. are helping mainly those farmers of developed states who are main user of these schemes. The farmers in poor states like Bihar, M.P. and Orissa in general don't participate in government procurement at MSP, use less fertilizer, very least user of electricity, poor access to institutional credit, therefore not getting required benefit of the government schemes. The farmers in the selected states by and large are also disadvantaged in terms of access to irrigation, to credit and extension services. These interlocking inequalities have an important bearing on the distribution of benefits from economic growth.

Policy implications:

The results of this study have important policy implications. In order to make agriculture in this region remunerative, there is a need of multi-pronged approach.

- **Priority to increase public spending on agricultural research & extension.** These types of investment not only have a large impact on poverty, but they also produce the greatest growth in agricultural productivity. Increased investment with clear focus will help in devising regional specific technologies to increase the productivity. Currently, in poor states, farmers mainly depend on private sector's generated technologies, for which they need to pay premium price and remain by and large unaffordable. Therefore, public spending for generating transferable technologies is the need of the hour for these states.
- **Increased technical assistance to the farmers for technology related capacity building.** There is a need for wider demonstration of new crop production technologies at farmers' fields to show the results of new technological advancement in terms of package of practices, varieties, irrigation methods or new machineries to reduce the cost of production by either increasing crop productivity or reducing input costs. It is necessary to mention that many farmers in Bihar and Orissa states are still sowing wheat and/or most of the pulses & oilseeds by broadcasting method, resulting into poor crop yield even with high seed rate.

- **Expansion of surface irrigation to augment groundwater irrigation and reduce cost of irrigation.** Irrigation was one of the most limiting factors for raising productivity. In states like Bihar and Orissa, with abundant water resources, not much has been done since couple of decades towards expanding surface irrigation. This will also help in recharging groundwater in those areas which are away from river catchments.
- **Assure supply of low cost energy source (electricity) for agricultural operations.** In absence of electricity, most of the agricultural operations are done using diesel-operated energy source in these 3 states, which increase the cost of crop production as well as post-harvest operations, thus affecting the farmers' profitability.
- **Improved accountability to financial institutions.** Many times landless people or marginal farmers grow food on leased-in lands with better efficiency using more family labour and less capital, which is good for rural poverty reduction. But, they are debarred from the benefits of low interest agricultural credit. Therefore, accountability to the lead bank has to be fixed to bring this section of the people in their ambit.
- **Improve marketing infrastructure.** Weak marketing infrastructure is another barrier to participation in urban markets, where food prices are multiple times higher than the rural market. Usually these infrastructures are typically weak in areas with high concentration of poverty. Distance to markets and poor-quality roads are a central concern for the rural poor across these states. High transport costs result in lower farm-gate prices, which in turn reduce household income.
- **Emphasis on education and health.** The education crisis afflicts poor overwhelmingly. States with high level of illiteracy and restricted opportunities for education, if they attempt to integrate into, can expect a diminishing share of economic growth. Similarly, with lacking access to clean water & sanitation, adequate nutrition, and medical care, poor people are more susceptible to infectious diseases. Single episode of sickness can plunge small and marginal farmers into deep poverty, reducing productivity and the availability of labour. Thus, there is a need of sustained strategy to close the education and health gap between poor and rich states.

Thus, the farmers' economic capacity in economically fragile region of the country like states of Bihar, Madhya Pradesh and Orissa not only depend on agriculture related variables but largely depends on the public investment in road, research & extension, energy, irrigation, credit, education and health. Therefore, to increase the income and economic capacity of the poor farmers, there is an urgent need to improve the synergy among these socio-economic-technological and institutional variables.

References:

Ahluwalia, M. S. (2000), "Economic performance of states in post-reforms period", Economic *and Political Weekly*, May 6, pp. 1637-1648.

Balakrishnan, P. and Parameswaran, M. (2007a), "Understanding economic growth in India: A prerequisite", *Economic and Political Weekly*, July 14. pp. 2915-2922.

Balakrishnan, P. and Parameswaran, M. (2007b), "Understanding economic growth in India: Further observations", *Economic & Political Weekly*, November 3 pp. 117-119.

Bandyopadhyay, A. and A.K. Giri (2001), "Pattern of employment in India and in major states", *Indian Journal of Agricultural Economics*, Vol. 56, No. 3: 526-537.

Bhalla, G.S. and Gurmail Singh (2009), "Economic liberalisation and Indian agriculture: A statewise analysis", *Economic & Political Weekly*, Vol. XLIV, No. 52: 34-44.

Bhanumurthy, N.R. and Prakash Singh (2009). *Understanding Economic Growth in Indian States*, IEG Discussion Paper Series No.137/2009, Institute of Economic Growth, Delhi.

Bosworth, Barry P., Collins, Susan, M. and Virmani, A. (2007), "Sources of Growth in the Indian Economy", NBER Working Paper no. 12901.

Chadha, G.K. (2001), "Impact of economic reforms on rural employment: No smooth sailing anticipated", *Indian Journal of Agricultural Economics*, Vol. 56, No. 3: 491-525.

Chand Ramesh and L.M. Pandey (2008). *Fertilizer Growth, Imbalances and Subsidies: Trends and Implications,* Discussion Paper NPP 02/2008, National Centre for Agricultural Economics and Policy Research, New Delhi.

Chand Ramesh, S. Garg and L.M. Pandey (2009). *Regional Variations in Agricultural Productivity: A District Level Study,* Discussion Paper NPP 01/2009, National Centre for Agricultural Economics and Policy Research, New Delhi.

Fan, S., P.B.R. Hazell and S. Thorat (1999). *Linkages between Government Spending, Growth, and Poverty in Rural India.* Research Report No. 110. International Food Policy Research Institute, Washington, D.C.

Chand Ramesh, S.S. Raju and L.M. Pandey (2007). Growth crisis in agriculture: Severity and options at national and state levels. *Economic & Political Weekly,* June 30, 2007: 2528-2533.

Menon, P., A. Deolalikar and A. Bhaskar (2008). *The Indian State Hunger Index: Comparisons of Hunger Across States.* Discussion Paper, IFPRI (Monologue).

Rai, A., S.D. Sharma, P.M. Sahoo and P.K. Malhotra (2008), "Development of livelihood index for different agro-climatic zones of India", *Agricultural Economics Research Review*, vol. 21, no. 2: 173-182.

Rao, M.G., Shand, R.T. and Kalirajan, K.P. (1999), "Convergence of incomes across Indian states: A divergent view", *Economic and Political Weekly*, vol. 34, no. 13, pp. 769-78. March 27-April 2.

Rodrik, D. and Subramanian, A. (2005), "From 'Hindu Growth' to Productivity Surge: The Mystery of Indian Growth Transition", *IMF Staff Papers*, vol. 52, pp. 193-228.

Madhusudan Ghosh (2010), "Structural breaks and performance in Indian agriculture", *Indian Journal of Agricultural Economics*, Vol. 65, No. 1: 59-79.

Appendix I. Actual and forecasted production and yield of major crops in Bihar

Period	Rice		Maize		Wheat		Gram		Arhar		Foodgrains	
	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)
TE 1975	3072.97	881	641.70	895	1781.63	1119	114.67	586	63.67	888	4259.07	883
TE 1985	3627.00	1013	772.33	1359	2883.00	1604	135.67	885	78.33	1348	3513.07	1211
TE 1995	4431.00	1421	887.87	1814	4138.07	2062	110.83	964	47.67	1035	7198.63	1358
TE 2005	3805.17	1130	1433.43	2291	3397.10	1667	62.40	961	45.10	1254	9170.40	1368
TE 2010*	4574.49	1534	1649.76	2686	3920.38	1923	47.50	1027	40.08	1203	10626.14	1624
TE 2015*	4786.30	1629	1797.08	2949	4232.47	2043	39.07	1085	37.03	1254	11437.71	1727

**Projected production and yield using ARIMA model*

continued…

Period	Sugarcane		Rapseed-Mustard		Linseed		Potato		Jute	
	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 bales)	Yield (Kg/ha)
TE 1975	4960.30	36808	37.33	557	38.13	456	898.20	9408	675.40	1047
TE 1985	3749.67	32218	41.93	624	35.86	465	1064.27	10070	1179.37	1341
TE 1995	5019.50	42059	77.22	808	20.24	440	1256.88	9740	940.13	1349
TE 2005	4245.17	41217	76.91	866	24.87	817	1414.17	9416	1167.40	1502
TE 2010*	5680.61	45784	91.25	1042	23.67	935	1244.10	9022	1196.47	1571
TE 2015*	5609.62	47309	99.25	1115	21.82	1003	1312.01	9339	1262.49	1653

**Projected production and yield using ARIMA model*

Appendix II. Actual and forecasted production and yield of major crops in Madhya Pradesh

Period	Rice		Jowar		Bajra		Maize		Wheat		Barley	
	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)
TE 1975	1040.27	740	1355.77	701	136.13	677	461.10	844	2527.53	828	185.20	960
TE 1985	1139.43	738	1731.97	879	113.13	676	871.47	1206	4006.27	1138	133.57	953
TE 1995	1298.60	831	939.37	827	121.40	854	972.93	1270	6805.47	1694	108.57	1324
TE 2005	1459.65	908	757.13	1126	257.63	1424	1455.73	1633	6791.30	1713	109.03	1333
TE 2010*	1501.86	883	541.68	1095	254.19	1417	1115.51	1712	7367.62	1860	95.30	1386
TE 2015*	1589.76	917	425.02	1156	270.92	1535	1217.79	1833	8063.76	2011	82.90	1451

**Projected production and yield using ARIMA model*

continued…

Period	Gram		Arhar		Foodgrains		Soybean		Groundnut	
	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)
TE 1975	1072.07	612	327.70	716	6800.00	593	42.00	470	267.20	639
TE 1985	1362.27	667	377.80	844	9770.67	840	676.60	746	172.33	627
TE 1995	2063.40	848	294.30	852	12118.50	1132	3345.63	920	208.87	931
TE 2005	2528.03	928	255.27	788	14392.03	1171	4318.60	1007	242.77	1139
TE 2010*	2543.15	1002	225.45	715	14638.80	1251	5167.15	1078	211.09	1157
TE 2015*	2763.09	1059	214.00	729	15756.28	1344	5881.99	1166	206.85	1242

**Projected production and yield using ARIMA model*

continued…

Period	Rapeseed/ Mustard		Sesamum		Linseed		Nigerseed		Cotton		Potato	
	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 bales)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)
TE 1975	94.23	520	43.77	168	165.07	300	45.30	199	219.07	59	187.17	11542
TE 1985	162.93	624	41.53	192	100.88	268	30.00	210	148.33	91	277.47	11657
TE 1995	535.27	860	46.87	265	94.00	341	29.93	226	390.30	135	360.57	11241
TE 2005	668.33	1015	54.27	379	60.17	414	24.63	231	670.03	194	700.90	14998
TE 2010*	729.89	1057	50.23	356	46.56	412	20.57	227	904.06	226	732.50	15091
TE 2015*	827.81	1146	51.74	385	29.55	429	17.78	237	1012.43	250	814.17	15684

**Projected production and yield using ARIMA model*

Appendix III. Actual and forecasted production and yield of major crops in Orissa

Period	Rice		Jowar		Maize		Wheat		Ragi		Gram	
	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)
TE 1975	4034.00	871	15.43	661	87.10	858	92.03	1623	145.33	730	14.47	501
TE 1985	4839.67	1111	33.27	914	180.37	1040	117.83	1868	234.47	806	26.40	575
TE 1995	6398.57	1418	14.50	669	47.90	947	34.67	1707	48.60	614	21.23	606
TE 2005	6686.23	1491	5.87	574	95.57	1550	5.67	1361	43.27	608	19.20	575
TE 2010*	6913.53	1544	8.40	936	102.92	1646	Neg.	1305	25.62	583	20.46	551
TE 2015*	7341.80	1642	7.39	967	103.76	1459	Neg.	1263	8.21	556	21.34	577

**Projected production and yield using ARIMA model*

continued…

Period	Arhar		Other Pulses		Foodgrains		Groundnut		Rapeseed/ Mustard		Sesamum	
	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)
TE 1975	28.70	513	433.53	458	4938.67	791	138.33	1362	39.07	463	49.07	467
TE 1985	90.37	705	726.90	553	6506.30	959	419.87	1359	61.40	492	126.23	499
TE 1995	126.83	762	262.97	446	6996.87	1232	101.50	1092	5.07	175	19.13	245
TE 2005	94.37	708	171.70	306	7134.50	1325	101.83	1204	3.13	191	10.60	225
TE 2010*	117.64	848	164.29	298	7215.99	1403	224.28	1443	Neg.	170	9.91	105
TE 2015*	130.36	895	128.65	276	7567.18	1489	236.36	1435	Neg.	128	4.78	52

**Projected production and yield using ARIMA model*

continued…

Period	Nigerseed		Sugarcane		Chillies		Sweet Potato		Mesta		Onion	
	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)	Prodn ('000 bales)	Yield (Kg/ha)	Prodn ('000 t)	Yield (Kg/ha)
TE 1975	42.33	419	2709.93	62228	27.13	613	223.93	6774	183.87	911	148.00	5455
TE 1985	79.00	437	3090.07	63806	67.00	787	417.87	7310	219.83	913	307.20	7917
TE 1995	95.27	470	1191.27	58575	77.00	781	389.27	7566	185.67	1015	338.57	7590
TE 2005	34.60	279	930.33	60147	61.97	838	394.07	8373	103.67	827	404.97	8876
TE 2010*	38.54	265	1196.71	59957	67.97	866	404.26	8632	89.61	939	304.16	8524
TE 2015*	38.36	243	1034.48	59687	73.74	899	429.93	8912	77.47	947	324.28	8771

**Projected production and yield using ARIMA model*

Appendix IV. District-wise land productivity of Bihar state

	Ramesh Chand et al (2009)		Gurmail Singh (2007)	
State	Districts	Productivity (Rs/ha)	Districts	Productivity (Rs/ha)
Bihar	Araria	17399	Araria	17970
Bihar	Arwal	23959		
Bihar	Aurangabad	25023	Aurangabad	21160
Bihar	Banka	22787	Banka	11766
Bihar	Begusarai	41743	Begusarai	17903
Bihar	Bhabhua	28537	Bhabhua	24121
Bihar	Bhagalpur	30944	Bhagalpur	13992
Bihar	Bhojpur	23144	Bhojpur	20350
Bihar	Buxar	23632	Buxar	18142
Bihar	Chamaparan(West)	25038	Chamaparan(West)	20574
Bihar	Champaran(east)	23708	Champaran(east)	14980
Bihar	Darbhanga	33639	Darbhanga	10459
Bihar	Gaya	20364	Gaya	16792
Bihar	Gopalganj	26178	Gopalganj	21117
Bihar	Jahanabad	22617	Jahanabad	17679
Bihar	Jamui	17640	Jamui	10508
Bihar	Katihar	35215	Katihar	23583
Bihar	Khagaria	39959	Khagaria	18286
Bihar	Kishanganj	24416	Kishanganj	15926
Bihar	Lakhisarai	16776	Lakhisarai	12623
Bihar	Madhubani	18270	Madhubani	13393
Bihar	Madhupura	42908	Madhupura	20756
Bihar	Monghyr	36570	Monghyr	14925
Bihar	Muzaffarpur	41428	Muzaffarpur	16903
Bihar	Nalanda	33303	Nalanda	14917
Bihar	Nawadha	27160	Nawadha	17009
Bihar	Patna	32367	Patna	21407
Bihar	Purnea	24008	Purnea	16543
Bihar	Rohtas	32321	Rohtas	24437
Bihar	Saharasra	40025	Saharasra	19879
Bihar	Samastipur	30554	Samastipur	17312
Bihar	Saran	26790	Saran	14402
Bihar	Sheikhpura	25112	Sheikhpura	15017
Bihar	Sitamari	33042	Sitamari	18589
Bihar	Sivhar	55682	Sivhar	17738
Bihar	Siwan	21261	Siwan	18373
Bihar	Supaul	22631	Supaul	19711
Bihar	Vaishali	53003	Vaishali	20359

Appendix V. District-wise land productivity of Madhya Pradesh state

	Ramesh Chand et al (2009)		Gurmail Singh (2007)	
State	**Districts**	**Productivity**	**Districts**	**Productivity**
M.P.	Anupur	6491	Anupur	6429
M.P.	Ashoknagar	11381	Ashoknagar	11419
M.P.	Balaghat	14817	Balaghat	12386
M.P.	Barwani	12001	Barwani	8645
M.P.	Betul	13898	Betul	11813
M.P.	Bhind	16021	Bhind	14892
M.P.	Bhopal	21219	Bhopal	16651
M.P.	Burhanpur	40855	Burhanpur	8876
M.P.	Chhatarpur	15058	Chhatarpur	12087
M.P.	Chhindwara	21210	Chhindwara	13640
M.P.	Damoh	13707	Damoh	10358
M.P.	Datia	17263	Datia	16643
M.P.	Dewas	25753	Dewas	20187
M.P.	Dhar	20151	Dhar	13536
M.P.	Dindori	7701	Dindori	7429
M.P.	Guna	13659	Guna	10750
M.P.	Gwalior	23092	Gwalior	17161
M.P.	Harda	24288	Harda	24029
M.P.	Hoshangabad	25269	Hoshangabad	23797
M.P.	Indore	33077	Indore	21216
M.P.	Jabalpur	20541	Jabalpur	13135
M.P.	Jhabua	9769	Jhabua	7905
M.P.	Katni	12393	Katni	8665
M.P.	Khandwa	13804	Khandwa	15626
M.P.	Khargone	14751	Khargone	9319
M.P.	Mandla	8801	Mandla	10612
M.P.	Mandsaur	21412	Mandsaur	13109
M.P.	Morena	22755	Morena	17739
M.P.	Narsinghpur	24634	Narsinghpur	21903
M.P.	Neemach	27190	Neemach	17855
M.P.	Panna	8556	Panna	8394
M.P.	Raisen	14230	Raisen	13976
M.P.	Rajgarh	18644	Rajgarh	11514
M.P.	Ratlam	25030	Ratlam	14675
M.P.	Rewa	11718	Rewa	11159
M.P.	Sagar	15399	Sagar	10803
M.P.	Satna	12701	Satna	10578
M.P.	Sehore	23051	Sehore	20329
M.P.	Seoni	13062	Seoni	11061
M.P.	Shahdol	8046	Shahdol	6817
M.P.	Shajapur	20239	Shajapur	13037
M.P.	Sheopur kalan	23165	Sheopur kalan	17540
M.P.	Shivpuri	18397	Shivpuri	15015
M.P.	Sidhi	9336	Sidhi	8375
M.P.	Tikamgarh	20891	Tikamgarh	17329
M.P.	Ujjain	22654	Ujjain	13519
M.P.	Umaria	7084	Umaria	6549
M.P.	Vidisha	15478	Vidisha	13265

Appendix VI. District-wise land productivity of Orissa state

State	Ramesh Chand et al (2009)		Gurmail Singh (2007)	
	Districts	Productivity (Rs/ha)	Districts	Productivity (Rs/ha)
Orissa	Angul	41929	Angul	18703
Orissa	Balasore	28711	Balasore	17473
Orissa	Bargarh	20960	Bargarh	18987
Orissa	Bhadrak	33815	Bhadrak	17486
Orissa	Bolangir	21428	Bolangir	12373
Orissa	Boudh	41681	Boudh	13901
Orissa	Cuttak	41344	Cuttak	20963
Orissa	Deogarh	26474	Deogarh	15271
Orissa	Dhenkanal	42838	Dhenkanal	20954
Orissa	Gajapati	35115	Gajapati	23067
Orissa	Ganjam	35128	Ganjam	21626
Orissa	Jagatsingpur	51722	Jagatsingpur	21830
Orissa	Jajpur	32404	Jajpur	18814
Orissa	Jharsuguda	25763	Jharsuguda	15899
Orissa	Kalahandi	23493	Kalahandi	13385
Orissa	Kendrapara	39031	Kendrapara	17642
Orissa	Keonjhar	42945	Keonjhar	14817
Orissa	Khurda	44206	Khurda	15451
Orissa	Koraput	25820	Koraput	14855
Orissa	Malkangiri	33121	Malkangiri	12284
Orissa	Mayurbhanj	23774	Mayurbhanj	13090
Orissa	Nawapara	21892	Nawapara	11465
Orissa	Nawarangpur	22396	Nawarangpur	12749
Orissa	Nayagarh	31994	Nayagareh	17677
Orissa	Phulbani	53537	Phulbani	25903
Orissa	Puri	52270	Puri	18832
Orissa	Rayagada	31709	Rayagada	17311
Orissa	Sambalpur	27985	Sambalpur	18829
Orissa	Sonepur	33005	Sonepur	19049
Orissa	Sundargarh	22143	Sundargarh	10150

Appendix VII. Crops varieties grown on sample farms in Bihar

Crops	Bhojpur district	Purnea district
Paddy	Basmati, BB-524 (110 days), BT-52, Kalica(2), Tikwa, Mansuri, Moti, Ratna, Sita, Sonam, Gadar, 1001, China, Dwarf mansuri	Local, Karma, GS1, Panjhali, Sighara, BB11, Pankaj, 1001, Saran, Panseri **Boro-** Shyam, Jaya, GS-1
Wheat	234, 373, HD2285, 147, Ganga-2, Lok1, UP-62, WH-154, 1553, Golden, Sher-e-panjab, UP-262, Sonalika, 145, 343, 1553	UP-262, 343, 373
Maize	Composite-I, Local	Kaveri, 3092, Panicle, Pioneer, 6240, Hybrid
Potato	Local, C1, Lal gulab	
Gram, Lentil, Moong	Local	Local
Mustard	Local, Bold, Varuna	Local, Pusa bold, Myhco

Appendix VIII. Crops varieties grown on sample farms in Madhya Pradesh

Crops	Rewa district	Ujjain district
Paddy	Deshi, PHB-71, Hybrid, Kranti, Poornma, IR-36, IR-64, Samrat, 6444, Sonam, Ratna, Rupali, Sinduri,	
Soybean	JS-335, JS-305, 7105, 9305, Loknath-505,	JS-335, JS-305, 7105, 9305, NRC-71, 95-06, 340, 385
Wheat	Lok-1, Sonalika, WH-147, Sujata,	Lok-1, GW-273, Sujata, Sharbati
Arhar	Deshi	
Gram		Deshi, Dollar, Moshmi, J-5, Vishal

Appendix IX. Crops varieties grown on sample farms in Orissa

Crops	Baragarh district	Nayagarh district
Paddy (Kharif)	Swarna, Pooja, annapurna, lalat, 1001	Local, Pooja, musori, swarna, mayurkantha, keshari, 1021, 1019, 1009, kalagiri, kuji
Paddy (Rabi)	Swarna, 1001, 1010, 1038	
Moong (Rabi)		Local, PDM-54, TRM-1, T-9, nayagarh local,

Appendix X. Distribution of farmers according to different cropping system in M.P.

Cropping system	Ujjain			Rewa		
	Small	Medium	Large	Small	Medium	Large
Soybean- Wheat	17	15	6	11	3	-
Soybean- Gram	11	1	0	1	-	-
Soybean- Wheat- Gram	11	9	13	2	1	-
Soybean-Wheat-Gram-Vegetables	2	3	4	-	-	-
Soybean-Wheat-Gram-Maize/Tur	1	-	3	-	-	-
Soybean- Wheat- Gram-Berseem	-	-	4	-	-	-
Soybean- Wheat- Potato	1	1	0			
Paddy- Wheat	-	-	-	17	9	-
Paddy- Wheat-Gram/Urd/Tur/Lentil	-	-	-	8	11	3
Paddy/Soybean-Wheat-Gram/Lentil/Urd	-	-	-	6	6	3
Paddy-Wheat-Gram/Urd/Tur/Lentil- Sesamum	-	-	-	2	3	7
Paddy- Wheat- Gram/Urd/Tur-Vegetables	-	-	-	4	1	1
Paddy/Soybean-Wheat	-	-	-	1	-	-

- Categories of farmers not cultivating respective cropping system

Appendix XI. Distribution of farmers according to different cropping system in Bargarh district of Orissa

Crop combinations grown during different seasons					No. of farmers
paddy(K)	Paddy®				41
paddy(K)					16
paddy(K)	paddy®	G.nut®			8
paddy(K)	Paddy®	brinjal®	tomato®		5
paddy(K)	brinjal®				3
paddy(K)	G.nut	moong			3
paddy(K)	paddy®	G.nut	moong		3
paddy(K)	Brinjal	Moong®			1
paddy(K)	brinjal	G.nut	chilli	moong	1
paddy(K)	Chilli®	G.nut®	brinjal®		1
paddy(K)	G.nut(K)				1
paddy(K)	G.nut(K)	brinjal®			1
paddy(K)	G.nut®	mustard			1
paddy(K)	moong(R)	G.nut®	biri		1
paddy(K)	paddy(K)	G.nut®	pumpkin		1
paddy(K)	Paddy(R)	brinjal	moong		1
paddy(K)	Paddy®	G.nut	moong®	brinjal(K)	1
paddy(K)	Paddy®	moong	G.nut®	brinjal	1
paddy(K)	Paddy®	tomato	G.nut®	moong®	1
paddy(K)	Paddy®	G.nut(K)	G.nut®	brinjal®	1
paddy(K)	Paddy®	G.nut	pumpkin®	G.nut®	1
paddy(K)	paddy®	G.nut	mustard	moong	1
paddy(K)	Paddy®	G.nut	moong	biri	1
paddy(K)	Paddy®	G.nut	brinjal	tomato	1
paddy(K)	Paddy®	G.nut	brinjal	tomato	1
paddy(K)	Paddy®	G.nut	pumpkin	tomato	1
paddy(K)	pumpkin®	moong®			1
paddy(K)	pumpkin®	G.nut®	moong®	brinjal(K)	1

Appendix XII. Distribution of farmers according to different cropping system in Nayagarh district of Orissa

Crop combinations grown during different seasons					No. of farmers
Paddy(K)	moong				20
Paddy(K)	moong	s.cane			14
Paddy(K)	moong	s.cane	brinjal		10
Paddy(K)	brinjal/arum	s.cane			8
Paddy(K)	moong	biri	s.cane		8
Paddy(K)	moong	biri			7
Paddy(K)					4
Paddy(K)	brinjal	s.cane	S.flower		3
Paddy(K)	moong	s.cane	arum		3
Paddy(K)	moong	brinjal			3
Paddy(K)	moong	cauliflower	biri	g.nut	2
Paddy(K)	moong	brinjal	s.cane	S.flower	2
Paddy(K)	chana				2
Paddy(K)	moong	g.nut			2
Paddy(K)	moong	Cauliflower	g.nut		2
Paddy(K)	moong	g.nut	biri		2
Paddy(K)	biri	g.nut			1
Paddy(K)	brinjal	s.cane	biri		1
Paddy(K)	moong	arum			1
Paddy(K)	moong	cauliflower	s.cane	g.nut	1
Paddy(K)	moong	cauliflower			1
Paddy(K)	moong	s.cane	brinjal	biri	1
Paddy(K)	s.cane				1
Paddy(K)	s.flower	s.cane	biri		1

Appendix XIII. Frequency and severity of floods in Bihar states, 1980-2006

Year	District	Blocks	Village	Human (in Lakh)	Animal (in Lakh)	Total Area (in Lakh ha)	Cropped area (in Lakh ha)	Crop Damaged (in Rs. Lakh)
2006	14	63	959	10.89	0.1	1.81	0.87	706.63
2005	12	81	1,464	21.04	5.35	4.6	1.35	1,164.50
2004	20	211	9,346	212.99	86.86	27	13.99	52,205.64
2003	24	172	5,077	76.02	11.96	15.08	6.1	6,266.13
2002	25	6	8,318	160.18	52.51	19.69	9.4	51,149.61
2001	22	194	6,405	90.91	11.7	11.95	6.5	26,721.79
2000	33	213	12,351	90.18	8.09	8.05	4.43	8,303.70
1999	24	150	5,057	65.66	13.58	8.45	3.04	24,203.88
1998	28	260	8,347	134.7	30.93	25.12	12.84	36,696.68
1997	26	169	7,043	69.65	10.11	14.71	6.55	5,737.66
1996	29	195	6,417	67.33	6.6	11.89	7.34	7,169.29
1995	26	177	8,233	66.29	8.15	9.26	4.24	19,514.32
1994	21	112	2,755	40.12	15.03	6.32	3.5	5,616.33
1993	18	124	3,422	53.52	6.68	15.64	11.35	13,950.17
1992	8	19	414	5.56	0.75	0.76	0.25	58.09
1991	24	137	4,096	48.23	5.13	9.8	4.05	2,361.03
1990	24	162	4,178	39.57	2.7	8.73	3.21	1,818.88
1989	16	74	1,821	18.79	0.35	4.71	1.65	704.88
1988	23	181	5,687	62.34	0.21	10.52	3.95	4,986.32
1987	30	382	24,518	286.62	33.25	47.5	25.7	67,881.00
1986	23	189	6,509	75.8	N.A.	19.18	7.97	10,513.51
1985	20	162	5,315	53.09	N.A.	7.94	4.38	3,129.52
1984	23	239	11,154	135	N.A.	30.5	15.87	18,543.85
1983	22	138	4,060	42.41	N.A.	18.13	5.78	2,629.25
1982	15	110	3,708	46.81	45.14	9.32	3.23	9,700.00
1981	21	201	7,367	69.47	74.83	12.61	7.71	7,213.19
1980	21	193	7,010	74.45	N.A.	17.86	9.43	7,608.43

Appendix XIV. Rainfall and Natural Calamities in Orissa state

Year	Normal Rainfall	Actual Rainfall	Deviation from Normal Rainfall		Natural Calamities
			in mm	in %	
1965	1502.5	997.1	-505.4	-33.6	Severe Drought
1966	1502.5	1134.9	-367.6	-24.5	Drought
1967	1502.5	1326.7	-175.8	-11.7	Cyclone, Flood
1968	1502.5	1296.1	-206.4	-13.7	Cyclone, Flood
1969	1502.5	1802.1	299.6	19.9	Flood
1970	1502.5	1660.2	157.7	10.5	Flood
1971	1502.5	1791.5	289	19.2	Severe Cyclone, Flood
1972	1502.5	1177.1	-325.4	-21.7	Flood, Drought
1973	1502.5	1360.1	-142.4	-9.5	Flood
1974	1502.5	951.2	-551.3	-36.7	Severe Drought, Flood
1975	1502.5	1325.6	-176.9	-11.8	Flood
1976	1502.5	1012.5	-490	-32.6	Severe Drought, Flood
1977	1502.5	1326.9	-175.6	-11.7	Flood
1978	1502.5	1261.3	-241.2	-16.1	Hailstorm, Whirlwind, Tornado
1979	1502.5	950.7	-551.8	-36.7	Severe Drought
1980	1502.5	1321.7	-180.8	-12	Flood, Drought
1981	1502.5	1187.4	-315.1	-21	Whirlwind, Tornado, Flood, Drought
1982	1502.5	1179.9	-322.6	-21.5	Severe Flood & Drought, Cyclone
1983	1502.5	1374.1	-128.4	-8.5	
1984	1502.5	1302.8	-199.7	-13.3	Drought
1985	1502.5	1606.8	104.3	6.9	Flood
1986	1502.5	1566.1	63.6	4.2	
1987	1502.5	1040.8	-461.7	-30.7	Severe Drought
1988	1502.5	1270.5	-232	-15.4	
1989	1502.5	1283.9	-218.6	-14.5	
1990	1502.5	1865.8	363.3	24.2	Flood
1991	1502.5	1465.7	-36.8	-2.4	
1992	1502.5	1344.1	-158.4	-10.5	Flood & Drought
1993	1502.5	1421.6	-80.9	-5.4	
1994	1502.5	1700.2	197.7	13.2	Flood
1995	1502.5	1739.3	236.8	15.8	Flood
1996	1502.5	1042.4	-460.1	-30.6	Drought
1997	1502.5	1493	-9.5	-0.6	
1998	1502.5	1277.5	-225	-15	
1999	1502.5				Super Cyclone, Flood
2000	1502.5				
2001	1502.5				Severe Flood

Source: 1. *Agricultural Statistics of Orissa- At a Glance,* 1996, Directorate of Agriculture and Food Production, Orissa, Bhubaneswar

2. *Compendium of Environmental Statistics.* 1999, Central Statistical Organisation, New Delhi.