Development strategy in Bihar through revitalizing the agricultural sector : a preliminary analysis

著者	Fujita Koichi
権利	Copyrights 日本貿易振興機構（ジェトロ）アジア経済研究所 / Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO) http://www.ide.go.jp
journal or publication title	IDE Discussion Paper
volume	332
year	2012-03-01
URL	http://hdl.handle.net/2344/1129

INSTITUTE OF DEVELOPING ECONOMIES

IDE Discussion Papers are preliminary materials circulated
to stimulate discussions and critical comments

IDE DISCUSSION PAPER No. 332

Development Strategy in Bihar through Revitalizing the Agricultural Sector: A Preliminary Analysis

Koichi Fujita*

March 2012

Abstract

Based mainly on secondary data and partly on primary information obtained through field surveys in selected rural areas in Bihar in 2011, this paper firstly argues the critical importance of agricultural growth for overall economic development, and then reviews the sluggish growth of agriculture in Bihar in the past and examines the major reasons for this. The long-term negligence of agricultural research (especially development and diffusion endeavors for improved rice varieties suitable to the local conditions of Bihar) by the state government and some sort of 'backwardness' in tube-well irrigation technology can be pointed out as important constraints. There is, in particular, the 'paradox' in Bihar agriculture of why rice and wheat yields have remained so low in spite of the relatively well-developed irrigation by tube-wells. Finally, by showing the process of a rapid increase in autumn and winter rice yields

* Professor, Center for Southeast Asian Studies, Kyoto University (kfujita@cseas.kyoto-u.ac.jp)

during the 1990s in West Bengal, it is suggested that Bihar farmers and policy-makers should learn from the experience of West Bengal in order to get some hints for the development of the rice sector in Bihar.

Keywords: Bihar, agricultural backwardness, rice improved varieties, tube-wells, experience of West Bengal
JEL classification: O1, Q1

INSTITUTE OF DEVELOPING ECONOMIES (IDE), JETRO
3-2-2, WAKABA, MIHAMA-KU, CHIBA-SHI
CHIBA 261-8545, JAPAN

Development Strategy in Bihar through Revitalizing the Agricultural Sector: A Preliminary Analysis

Koichi Fujita
Center for Southeast Asian Studies, Kyoto University
kfujita@cseas.kyoto-u.ac.jp

Abstract

Based mainly on secondary data and partly on primary information obtained through field surveys in selected rural areas in Bihar in 2011, this paper firstly argues the critical importance of agricultural growth for overall economic development, and then reviews the sluggish growth of agriculture in Bihar in the past and examines the major reasons for this. The long-term negligence of agricultural research (especially development and diffusion endeavors for improved rice varieties suitable to the local conditions of Bihar) by the state government and some sort of 'backwardness' in tube-well irrigation technology can be pointed out as important constraints. There is, in particular, the 'paradox' in Bihar agriculture of why rice and wheat yields have remained so low in spite of the relatively well-developed irrigation by tube-wells. Finally, by showing the process of a rapid increase in autumn and winter rice yields during the 1990s in West Bengal, it is suggested that Bihar farmers and policy-makers should learn from the experience of West Bengal in order to get some hints for the development of the rice sector in Bihar.

Key words: Bihar, agricultural backwardness, rice improved varieties, tube-wells, experience of West Bengal

INTRODUCTION

The per capita net state domestic product (NDSP) in Bihar in 2008-09 (at current prices) was Rs.13663, by far the poorest in India, and the disparity between Bihar and the other states was still very large[1]. The recent accelerated economic growth in Bihar, however, has been paid much attention; the average growth rate of per capita gross state domestic product (GSDP) (at constant prices of 2004-05) during the last six years from 2004-05 to 2010-11 was registered at 9.24 per cent, compared to 5.12 per cent between 1999-00 and 2008-09 (at constant prices of 1999-00) (Table 1).

---

[1] Compared to the per capita NSDP in Bihar in 2008-09 (100), the position of the major states in the same year were as follows: Uttar Pradesh (137), Jharkhand (157), Madhya Pradesh (158), Assam (176), Rajasthan (198), Orissa (216), Chattisgarh (252), West Bengal (266), Andhra Pradesh (299), Karnataka (304), Himachal Pradesh (326), Tamil Nadu (330), Gujarat (360), Kerala (361), Punjab (387), Maharashtra (402), Haryana (504), and Delhi (647) (GOI 2011, A13). It should be noted here, however, that Bihar receives a substantial amount of remittance from migrants, which is not included in the income here estimated. On regional disparity in India, further see Ghani (2010), Hirashima et al eds. (2011), and others.

Table 1 Growth rate of Bihar economy and sector-wise contributions

	Annual growth from 1999-00 to 2008-09	Annual growth from 2004-05 to 2008-09	Share in GSDP in 1999-00	Contribution to growth (1999-00 to 2008-09)
Agriculture	3.02	2.67	30.3	13.0
Forestry	4.12	-2.06	1.8	1.1
Fishery	5.28	2.34	1.4	1.0
Mining	-7.11	3.97	0.2	-0.2
Manufacturing	3.26	4.76	7.2	3.3
Construction	26.01	25.55	3.8	14.0
Elec./Water/Gas	2.37	6.83	1.4	0.5
Transport/Storage/Communication	5.18	9.97	7.4	5.4
Trade/Hotel/Restaurant	13.50	19.63	15.0	28.7
Banking/Insurance	7.31	16.51	3.6	3.7
Real Estate/Legal & Business Services	5.1	9.62	4.2	3.0
Public administration	3.88	6.84	7.6	4.2
Other services	3.69	6.02	16.1	8.4
Total GSDP	7.06	10.93	100.0	86.1
Per capita	5.12	9.24		

Source: Calculated by the author, based on data obtained from the Government of Bihar, *Economic Survey 2010-11* , February 2011.

The table also shows the contribution of various sectors to overall economic growth during 1999-00 to 2008-09. The result indicates that the largest contributor was trade/hotels/restaurants (28.7%), followed by construction (14.0%) and agriculture (13.0%)[2]. Although the growth rate of agriculture was not so high (3.02%), its contribution became quite substantial because of its large share in the GSDP (30.3%). In other words, due to the importance of the agricultural sector in terms of income sources (more so in terms of employment) in Bihar, even if agriculture grew rather moderately, this would still have a large impact.

The role of agriculture in the overall economic development of an economy like Bihar, however, is not limited to the aspect mentioned above. Agricultural growth stimulates the growth of a wide range of non-agricultural sectors through linkages between agriculture and non-agriculture. The linkages here include both forward and backward linkages, but the more important linkage is through the so-called ‘final demand effect’ of agricultural growth. Agricultural growth brings about a rise in the income of farmers and, to a lesser extent, agricultural laborers. Since there is a huge number of farmers and agricultural laborers, and since their propensity to consume is considered to be very high, the increased income of farmers and agricultural laborers stimulates demand for products and services in all sectors in the economy, including non-agricultural sectors. Therefore, agricultural growth is vital, especially for backward economies such as Bihar.

This paper focuses on the agricultural sector, especially the rice and wheat sectors, in Bihar. The major objectives are, one, to review the rather sluggish growth process of Bihar agriculture in the past and analyze the major factors behind this, and, two, to discuss the potential of agricultural development in Bihar. Before the main arguments, however, we review the process of agricultural development in India as a whole in the next chapter as this has some important implications for the

[2] The total contribution of all the sectors in Table 1 should theoretically be 100%, compared to the actual 86.1%. This is because the estimation was based on the share of sectors in 1999-00.

chapters that follow.

1. AGRICULTURAL DEVELOPMENT IN INDIA

Just after its independence in 1947, the Indian economy was still basically agrarian, with agricultural GDP accounting for more than 55 per cent, but its share drastically declined to less than 17 per cent very recently (GOI 2011: A5).

Figure 1 illustrates the growth rates of the Indian economy (three-year moving averages) after Independence. As is well known, the overall GDP growth rate in India has started to move upward since the 1980s and it further accelerated after the 1990s, when the policy of full-scale economic liberalization was adopted. However, I emphasize here the critical role of the high agricultural growth achieved in India in the preceding 1980s as one of the most important pre-requisites for the accelerated economic growth since the 1990s. The process of the economic transformation in India can be summarized as follows[3].

1) Independence to the mid-1960s

The agriculture, especially the crop sector, of British colonial India was either stagnant or it registered slight negative growth after World War I (Blyn, 1966; Kurosaki, 1999). This tendency, however, was reversed after Independence. Foodgrain production registered a high growth rate at 4.13 per cent during 1951-52 to 1960-61 (Kurosaki, 1999), mainly because of high agricultural

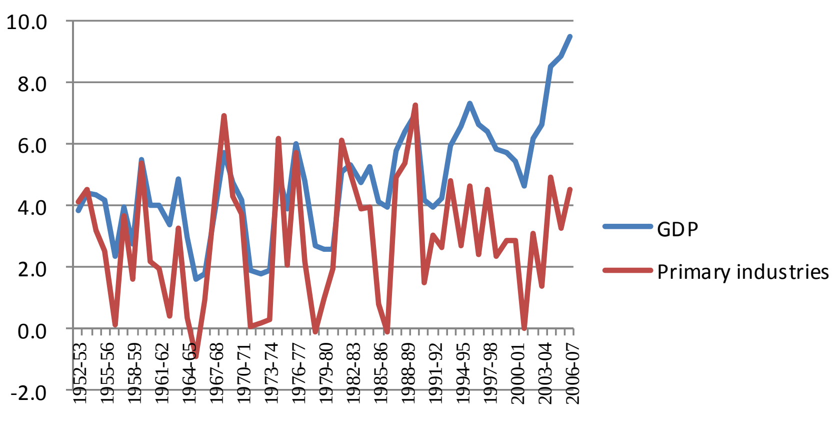

Figure 1 Growth rates of Indian economy after independence (Three-year moving averages)

prices worldwide. Both the expansion of the sown area and the increase in crop yields contributed to this growth. However, as is shown in Figure 1, agricultural growth decelerated towards the mid-1960s. The main priority in agricultural policy was given to major irrigation projects and

[3] The following constitutes a revised version of Fujita (2010b).

institutional reforms such as land reform and organizing farmers' cooperative societies. As a 'socialist' nation, India strongly promoted heavy industrialization, especially after the second Five Year Plan (1956-57 to 1960-61). This left the agricultural sector relatively neglected. Two consecutive years of severe droughts struck India in the mid-1960s and these shattered its agricultural economy. Agriculture recorded large negative growth and India faced a serious food problem. India was obliged to import 10 million tons of food (mainly wheat) for two years. The slump in agriculture hit the whole economy and even the political regime.

2) The mid-1960s to the end of the 1970s

The serious economic and political crisis which India faced in the mid-1960s triggered a complete restructuring of the agricultural policy of the government, which started to emphasize technological innovation, especially by introducing new agricultural technologies from abroad.

It was a fortunate coincidence for India that the mid-1960s was the time when new seed-fertilizer technologies started to be spread to the tropical developing world. In particular, it was fortunate for India that wheat HYVs were developed at CIMMYT in Mexico (Mexican semi-dwarf wheat varieties). These were quite suitable for the climate in north-west India in areas such as Punjab, Haryana and western Uttar Pradesh. This was followed by the introduction of rice HYVs from IRRI. The most important factor that promoted the dissemination of new seed-fertilizer technologies was the diffusion of private tube-wells.

Thus new seed-fertilizer technologies, especially for wheat, started to spread very rapidly in north-west India. This was followed by rice HYVs in parts of peninsular India in Andhra Pradesh and Tamil Nadu[4]. Within a decade or so, India had moved closer to food self-sufficiency, apart from some drought years. We call this the first wave of the Green Revolution in India. However, the Indian economy as a whole had to experience a bitter 'lost decade' during this period mainly because of the stagnant import-substituting industrial sectors that suffered from a shortage of foreign exchange (Ohno, 1999). This was because India had to continue to import a large amount of food for several years and it also had to import chemical fertilizers and agricultural machinery for the development of agriculture. India had to pay a huge cost because of the neglect of agriculture in the preceding period. This proved to be a typical case of the 'Ricardian trap' in development economics (Hayami, 1997).

The first wave of the Green Revolution in India was also limited from the viewpoint of the overall economic development of the country. As the diffusion of the Green Revolution was confined to the wheat crop and to the north-west and small deltaic regions of peninsular India, it could not raise rural incomes and alleviate rural poverty in a wider area. Except for some spots, rural India continued to be poor.

3) During the 1980s

The decade of the 1980s witnessed very favorable agricultural growth, which included almost all the regions and almost all the important crops (Table 2). We call this the second wave of the Green Revolution in India. The rapid increase in rice production, which is an important staple

[4] Rice HYVs were disseminated widely in north-west India as well, but a decade later, after the diffusion of wheat HYVs in the same region.

food in east and south India, was especially essential for the economic development of hitherto poverty-stricken rural areas. The most important factor behind the rapid agricultural growth was the widespread diffusion of private tube-wells (especially small-scale shallow tube-wells). Shallow tube-wells, much cheaper than deep tube-wells, were invested in by individual farmers in India whereas deep tube-wells were usually funded by the public sector (Fujita et al, 2003). The diffusion of tube-wells in rain-fed areas (or areas where canals provided unreliable irrigation) enabled farmers to grow HYV wheat instead of minor crops such as pulses in the *rabi* season, and the rice yield was increased substantially by switching varieties from traditional to modern types (HYVs) in the *kharif* season. Thus a highly productive double cropping of HYV rice and HYV wheat was established in a wide area of rural India, especially in the Indo-Gangetic Basin. Furthermore, in some places with plenty of rainfall, such as West Bengal[5], the double cropping of HYV rice was widely disseminated.

Table 2 Growth Rate of Indian Agriculture

	1950-60	1960-70	1970-80	1980-90	1990-96
Rice	4.53	2.12	1.73	4.08	1.60
Wheat	5.79	7.73	4.15	4.29	3.64
Coarse grains	3.76	1.67	0.55	0.71	-0.99
Maize	7.84	3.90	0.64	3.20	1.30
Cereals total	4.45	3.10	2.07	3.38	1.81
Pulses	3.80	-0.47	-1.18	2.45	-0.07
Foodgrains	4.35	2.63	1.76	3.31	1.66
Oilseeds	3.05	2.41	1.34	6.01	4.16
Sugarcane	5.62	2.54	2.27	4.38	3.72
Cotton	4.54	2.03	2.69	3.23	4.51
Jute/Mesta	5.60	0.32	2.13	1.28	2.18

Note: We first calculated the annual growth rate, and then three-year moving averages in each year. Figures in the table are the averages for each decade. Also note that 1980-90 means 1980/81-1989/90 for instance.

Source: Government of India, *Agricultural Statistics at a Glance 1997.*

There is a well-known debate among Indian economists regarding the reasons why new agricultural technologies were not accepted for such a long time in east India, in contrast to the north-west and some other parts. Some Marxist economists attributed it to the 'semi-feudal mode of production' in agriculture (Bhaduri, 1973). This argument, however, was largely refuted from a theoretical viewpoint (Newberry, 1974) and also on empirical grounds (Bardhan and Rudra, 1978). The most critical factor which determined the diffusion of new seed-fertilizer technologies was apparently private tube-wells, therefore the key question is why in east India the introduction of private tube-wells was delayed until the 1980s. One answer may be a shortage of capital for purchasing private tube-wells, because east India is generally dominated by small-scale poor farmers with fragmented land parcels. After the 1980s, the real price of tube-wells declined substantially so that even relatively poor farmers in east India could purchase tube-wells. Another factor may be the delay in rural electrification in east India, because irrigation costs are much higher for diesel-driven

[5] The double cropping of HYV rice (*aman* in the *kharif* season and *boro* in the *rabi* season) occurred widely in the neighboring country of Bangladesh as well.

tube-wells than electric ones[6]. Extreme land fragmentation in east India together with the lack of a successful land consolidation program was also often given as an explanation for the delay in tube-well diffusion (Bardhan, 1984). However, the experience in east India after the 1980s challenged this hypothesis because tube-wells *did* rapidly spread even with land fragmentation, as a water sales market (a groundwater market) emerged on an extensive basis and developed[7].

In many regions in India agricultural growth during the 1980s was accompanied by a substantial increase in labor productivity[8] (Bhalla and Singh, 1997), which caused, besides an increase in off-farm job opportunities in rural areas, a rise in agricultural wages (Lanjouw, 2004; Yanagisawa, 2008). Agricultural wages in India grew by 47 per cent for male workers and 37 per cent for female workers in real terms from 1977-78 to 1987-88 (Table 3).

Table 3 Rural Real Wages in India (Rs/day)

	Agriculture		Non-farm	
	Male	Female	Male	Female
1977/78	3.81	2.69	5.26	2.83
1987/88	5.59	3.69	7.82	4.53
1993/94	6.26	4.38	8.74	5.37

Source: Bhalla and Singh (1977).

It should also be noted that the National Sample Survey (NSS) data show that poverty in India declined sharply after the mid-1970s; the head count ratio declined from more than 55 per cent in 1973-74 to 35 per cent in 1989-90 (World Bank, 2000). South Asia and sub-Saharan Africa used to have the same per capita calorie intake at around 2100 calorie/day, but after the 1980s, whereas sub-Saharan Africa stagnated, South Asia began to experience a continuous rise to 2300 calorie/day by the end of the 1980s (FAO, 1995).

4) After the 1990s

The broad-based agricultural growth in India during the 1980s contributed to the rise of rural India as a big market for a wide variety of non-agricultural products and services. Through I-O analysis, Sastry et al. (2003) estimated the coefficient of increased demand for manufactured goods which was induced by one unit increase of agricultural production and obtained a result that it sharply increased from only 0.087 in 1968-69 to 0.297 in 1993-94. The demand for manufacturing goods had become much more sensitive to agriculture’s growth by the mid-1990s, although agriculture’s share of GDP continued to decline rapidly in India. Yanagisawa, by analyzing a series of ‘market surveys’ carried out by the Indian Council of Applied Economic Research (ICAER) from

[6] However, even in a situation without rural electrification, tube-wells rapidly spread in rural Bangladesh during the 1980s (Fujita, 2010a).
[7] See, for example, Kahnert and Levine (1993), Pant (1992), Fujita, Kundu and Jaim (2003). See also Fujita (2010) regarding Bangladesh.
[8] The increase in labor productivity during the 1980s was, it is supposed, attained by the increase in land productivity with the land-labor ratio remaining almost at the same level, rather than by the introduction of labor-saving technologies such as farm mechanization.

the mid-1980s to the mid-1990s, concluded that (1) more than half the consumer durables were owned by rural households, and that the rural market for consumer durables expanded faster than the urban market after the 1980s, (2) the aforementioned consumer durables were at first cheap, for instance, bicycles, radios and watches, but they gradually became more expensive items like TVs, electric fans, and motorbikes, (3) in the background there was an increase in income in rural areas, especially among low income groups and there was a greater improvement in income distribution in the rural areas than in the urban areas during the 1980s, (4) the group who increased their purchases of consumer durables the most were people who belonged to low income groups in the rural areas, who ‘did not graduate from universities’, and (5) it seems that they purchased more consumer durables than could be accounted for just by the increase in their incomes (Yanagisawa, 2008).

In sum, the broad-based agricultural growth achieved in India during the 1980s was one of the most important pre-requisites for the accelerated economic growth after the 1990s, which was mainly led by the non-agricultural sectors. The critical period that was needed for full-scale non-agricultural sector development, i.e. the creation of a market in the vast rural areas, was completed by the end of the 1980s. Thus the Indian economy plunged into a new developmental phase after the 1990s.

Since the per capita consumption of foodgrains (rice and wheat) has reached near-saturation level (Fujita, 2006), agriculture is no longer expected to grow quickly even if high-valued product sectors, such as livestock, vegetables, fruits and flowers, are expected to grow rapidly. The disparity between agriculture and non-agriculture (or between rural and urban) is becoming a serious problem for the economy.

The agricultural growth rate declined to 2.5 per cent after 1990 (Figure 1). The ‘crisis’ of the agricultural/rural economy became a serious social problem, especially in the midst of the rapid growth in the urban centers. Though the government has set the agricultural growth target at 4 per cent in the Five Year Plan, etc., it may be quite difficult to realize this (World Bank, 2005) since the major problem is now on the demand side, not on the supply side. The growth rate further decelerated to below 2 per cent after the mid-1990s (Chand et al., 2007).

The declining per capita consumption of cereals (especially rice), along with the ‘failure’ of the government’s food management, has made India a major exporter of rice to the world market, particularly to Bangladesh and sub-Saharan Africa since the mid-1990s. The export of rice was strongly associated with an excessive buffer stock that had accumulated in the public sector (Food Corporation of India). India faced the severest problem from excessive stocks of foodgrains three times: the mid-1990s, at the beginning of the 2000s, and very recently.

Another problem is related to subsidies for agricultural inputs such as chemical fertilizers, irrigation (canals) and electricity (for electric pump sets such as tube-wells), which have rapidly increased since the 1980s. Agricultural subsidies became a big fiscal burden for both central and state governments. The subsidies benefit mainly advanced agricultural areas and wealthy farmers, in particular. Necessary public investment for agricultural growth and/or rural development is thereby neglected, which seems to perpetuate the disparity between advanced and backward rural regions.

2. THE PROBLEMS IN BIHAR AGRICULTURE

1) The development process in the rice and wheat sectors in Bihar

Foodgrains (cereals plus pulses) account for nearly 85 per cent of the gross cropped area in Bihar (new state) in recent years. Particularly, rice and wheat account for 70 per cent of the total. The critical importance of the two crops, rice and wheat, is obvious[9].

It can largely be said that the agricultural sector in Bihar, as in other eastern states of India, more or less stagnated (at least in terms of per capita output) until the end of the 1970s. The stagnation in rice production was especially apparent. However, if we examine the statistical data more closely, Bihar *did* experience the first wave of the Green Revolution in wheat production after the mid-1960s, as in north-west India (Figure 2). In the first half of the 1960s the area under wheat was only 12-13 per cent of the area under rice. Wheat was a minor crop in Bihar. However, the wheat area increased rapidly thereafter until the mid-1970s, when it reached nearly 2 million hectares and more than 35 per cent of the area under rice. The impact of such a growth in wheat production for the entire agricultural sector in Bihar, however, was limited because of its low yield.

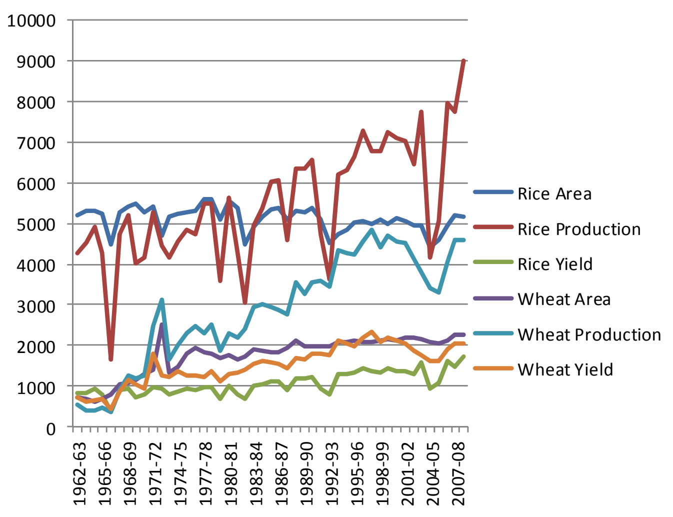

Figure 2 Rice and Wheat Production Trends in Bihar (old state)

The real 'revolution' came after the 1980s. Agriculture in Bihar started to be influenced by the second wave of the Green Revolution, as in other eastern states in India. First, rice production started to increase due to a gradual rise in its yield. The area under rice, by contrast, continued to decrease gradually until very recently. Second, and more pertinently, wheat production increased very rapidly. It reached around 70 per cent of rice production by the mid-1990s. The rapid increase

---

9 However, in terms of value-added, vegetables and fruits accounted for 49.7 per cent of the total crop sector, followed by 19.7 per cent for rice and 12.0 per cent for wheat in 2001-02, although vegetables and fruits accounted for less than 10 per cent of the gross cropped area (Bansil, 2011: 85-86).

in its yield was mainly attributable to this. The yield of the wheat crop remained only 1.3 ton/ha in the mid-1970s, then started to increase relatively quickly and reached more than 2 ton/ha by the mid-1990s. It recorded a peak of 2.34 ton/ha in 1997-98.

The agricultural sector in Bihar proceeded to the third developmental stage after the mid-/late-1990s. Wheat production started to stagnate whereas rice production began to increase rather rapidly, so that rice production reached nearly double that of wheat production in very recent years.

Lastly, Figures 3 and 4 show the production trends for rice and wheat production in the new state of Bihar, after the separation of Jharkhand. By comparing them with Figure 2, several facts can be pointed out. First, almost all the wheat production is concentrated in the territory of Bihar (new state). Second, about 70 per cent of the area under rice is in Bihar. Third, the rice yield in Jharkhand is substantially higher than in Bihar. The average yield during the three years from 2006-07 to 2008-09 was 1.98 ton/ha in Jharkhand compared to 1.44 ton/ha in Bihar. Fourth, the increase in the rice yield after 2000-01 is observed only in Jharkhand, not in the new state of Bihar.

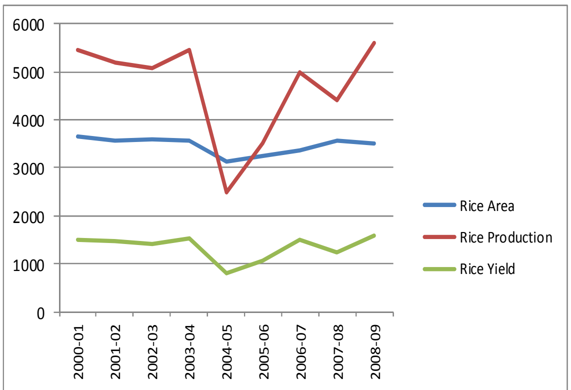

Figure 3 Rice Production in Bihar (new state)

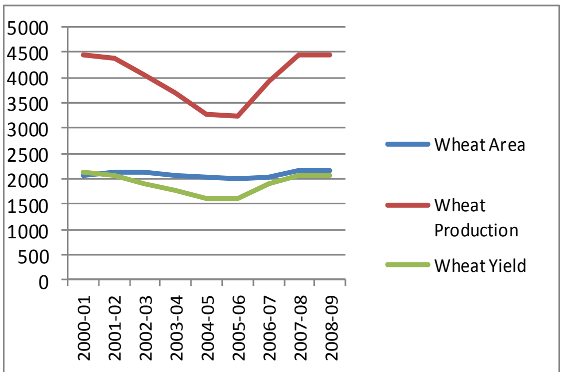

Figure 4 Wheat Production in Bihar (new state)

2) On irrigation in Bihar

Water control, including irrigation, drainage and flood control, plays a decisive role in the dissemination of seed-fertilizer technology. Table 4 illustrates the development of irrigation in Bihar (new state) with different sources of water, although some disparities are observed between the two sources of data, especially for canals and tube-wells. However, the general trend was that both canals and tube-well irrigation started to be developed in Bihar (probably) from the 1970s until the end of the 1990s. The most notable fact here is that in Bihar, one, most of the canal irrigation was completed by the end of the 1970s and, two, rapid growth in tube-well irrigation was observed after the 1980s until the end of 1990s, but, three, at the same time, the 1970s also saw a substantial increase in the number of tube-wells. The last point is in sharp contrast with the experience of other eastern states in India, such as West Bengal. The diffusion of the first wave of the Green Revolution in Bihar in the form of the development in wheat production seems to be related to this earlier development of irrigation.

Table 4 Irrigation development in Bihar (new state) (lakh hectare)

	Total irrigated area		Gross cropped area in ES	Irrigated ratio (%)	Source									
					Canal		Tank		Tube-well		Other wells		Other sources	
	Bansil	ES			Bansil	ES	Bansil	ES	Bansil	ES	Bansil	ES	Bansil	ES
1948-51	17.82				3.62		2.56		0		2.61		9.03	
1962-65	17.76				5.74		1.69		1.04		1.83		7.46	
1978-81	33.45				12.87		0.89		10.09		1.77		7.83	
1988-91	40.01				14.26		0.95		16.69		0.91		7.20	
1998-99	45.68				13.28		1.63		26.64		0.21		3.92	
2000-01	45.62	40.24			12.30	16.66	1.80	0.33	28.71	23.10	0.16	0.15	2.65	0
2001-02	45.40	40.36			12.37	16.79	1.40	0.33	29.65	23.09	0.16	0.15	1.82	0
2002-03	45.71	41.50			12.59	16.27	1.49	0.33	29.65	24.75	0.18	0.15	1.80	0
2003-04	45.66	44.54			11.43	17.56	1.50	0.33	31.03	26.50	0.13	0.15	1.57	0
2004-05	42.58	42.66			10.63	15.46	1.18	0.43	28.87	26.64	0.67	0.12	1.23	0.01
2005-06	43.25	44.08	73.96	59.6%	10.61	17.14	1.83	0.33	28.95	26.43	0.12	0.15	1.74	0.03
2006-07		44.74	77.19	58.0%		17.14		0.33		27.10		0.15		0.02
2007-08		44.61	77.65	57.5%		17.10		0.33		27.01		0.15		0.02
2008-09		44.67				16.95		0.33		27.22		0.15		0.02
2009-10		39.97				12.20		0.33		27.27		0.15		0.02

Source: Bansil: Banshil, P.C., *Bihar Agriculture: A Perspective*, 2011, p.96.
ES: Government of Bihar, *Economic Survey 2010-11*, February 2011, p.55.

Table 5 summarizes the district-wise state of information on irrigation and agriculture in the year 2003-04. The whole state was classified into four agro-ecological zones: Zone 1 (north-west), Zone 2 (north-east), Zone 3A (south-east), and Zone 3B (south-west). In terms of irrigation, the most developed zone is Zone 3B (both by canals and tube-wells), followed by Zone 3A (both by canals and tube-wells). By contrast, irrigation is relatively underdeveloped in Zones 1 and 2, where most of the water for irrigation is provided by tube-wells.

Rice is classified into three seasons: (1) autumn rice, (2) winter rice, and (3) summer rice. Autumn rice and summer rice are the pre-monsoon season rice and dry season rice, respectively, whereas winter rice is the monsoon season rice. The winter rice varieties were photosensitive, which was an original adaptation to the monsoon climate. In contrast, the autumn and summer rice varieties are non-photosensitive, being introduced later in the area. The share in total rice cropped area in 2003-04 was 15.5 % (autumn), 81.3% (winter), and 3.3% (summer), but the share of total rice production was 12.6% (autumn), 84.2% (winter), and 3.2% (summer), reflecting the differences in average yield. Zones 3A and 3B are characterized by a concentration of winter rice (where the highest yield in winter rice is attained) but autumn rice is observed more in Zones 1 and 2, whereas summer rice is relatively more observed in Zone 2. Wheat production, on the other hand, is more evenly distributed in the four agro-ecological zones, but the highest yield is achieved in Zone 3B and some selected districts in Zones 1 and 3A.

Now, in order to analyze the effect of irrigation in Bihar, we prepared two sorts of figures: the relation between irrigation and land use intensification (Figures 5 and 6), and the relation between irrigation and crop yields (Figures 7 to 10). These figures were processed from the district-level data in 2003-04.

Table 5 District-wise irrigation and agriculture in Bihar

2003-04	Share of new sown area (%)	Cropping intensity (%)	Irrigated area (%)	Irrigated area by canal (%)	Irrigated area by tube-wells (%)	Autumn rice			Winter rice			Summer rice			Rice, total			Wheat			Proportion under cultivation in summer (%)
						Area (ha)	Production (ton)	Yield (kg/ha)	Area (ha)	Production (ton)	Yield (kg/ha)	Area (ha)	Production (ton)	Yield (kg/ha)	Area (ha)	Production (ton)	Yield (kg/ha)	Area (ha)	Production (ton)	Yield (kg/ha)	
Saran	78.1	121	50.5	1.0	49.5	8,705	7,434	854	69,859	133,513	1,911	360	539	1,497	78,924	141,486	1,793	94,593	208,739	2,207	49.2
Siwan	72.6	147	44.9	2.6	39.1	42,996	52,557	1,222	62,040	69,830	1,126	0	0	0	105,036	122,387	1,165	84,459	181,132	2,145	51.9
Gopalganj	73.9	155	46.3	21.8	23.2	61,274	91,873	1,499	29,840	42,543	1,426	11	16	1,455	91,125	134,432	1,475	85,212	199,739	2,344	56.6
Muzaffarpur	65.7	164	38.4	0.0	38.4	36,908	42,681	1,156	116,374	121,729	1,046	834	848	1,017	154,116	165,258	1,072	90,699	129,362	1,426	44.2
E. Champaran	66.9	112	48.1	0.2	47.8	62,815	91,437	1,456	107,849	150,395	1,394	317	347	1,095	170,981	242,179	1,416	91,390	143,031	1,565	31.8
W. Champaran	57.8	131	48.2	35.1	11.7	60,482	101,979	1,686	89,790	117,144	1,305	7,660	7,992	1,043	157,932	227,115	1,438	79,151	141,538	1,788	31.0
Sitamarhi	54.6	156	38.0	0.8	33.8	22,085	30,780	1,394	80,400	99,185	1,234	903	914	1,012	103,388	130,879	1,266	52,930	84,738	1,601	44.5
Sheohar	60.9	165	29.0	0.0	29.0	5,670	4,218	744	19,587	7,795	398	53	58	1,094	25,310	12,071	477	10,838	18,893	1,743	41.1
Vaishali	62.9	150	40.7	0.0	34.5	13,377	13,099	979	48,738	31,081	638	73	74	1,014	62,188	44,254	712	39,075	34,720	889	30.9
Darbhanga	68.0	122	48.6	0.0	45.6	26,026	16,740	643	70,987	80,021	1,127	3,705	5,241	1,415	100,718	102,002	1,013	73,492	97,345	1,325	44.7
Madhubani	63.7	141	43.7	0.0	13.0	37,220	34,390	924	135,156	136,088	1,007	4,106	5,840	1,422	176,482	176,318	999	82,822	65,802	794	38.6
Samastipur	70.4	137	44.6	0.0	44.6	31,888	34,327	1,076	50,432	31,522	625	1,483	2,147	1,448	83,803	67,996	811	52,122	59,571	1,143	29.0
Begusarai	62.4	149	52.3	0.0	51.3	4,742	6,530	1,377	21,832	29,364	1,345	328	436	1,329	26,902	36,330	1,350	55,379	107,492	1,941	47.5
Zone 1	65.8	138	45.1	6.1	34.4	414,188	528,045	1,275	902,884	1,050,210	1,163	19,833	24,452	1,233	1,336,905	1,602,707	1,199	892,162	1,472,102	1,650	40.4
Saharsa	66.6	177	49.0	2.8	43.6	19,051	22,362	1,174	66,477	81,344	1,224	2,615	3,809	1,457	88,143	107,515	1,220	43,708	79,240	1,813	42.3
Supaul	65.1	173	52.9	25.1	27.4	29,910	37,886	1,267	89,672	120,294	1,341	5,396	6,411	1,188	124,978	164,591	1,317	56,874	76,749	1,349	40.1
Madhepura	73.2	156	64.8	16.0	45.2	19,287	28,937	1,500	58,335	85,354	1,463	1,503	2,726	1,814	79,125	117,017	1,479	38,948	40,681	1,044	30.8
Purnea	70.5	139	55.5	3.8	51.7	18,467	20,512	1,111	81,449	139,874	1,717	20,481	28,023	1,368	120,397	188,409	1,565	58,778	71,463	1,216	35.8
Kishanganj	69.3	149	25.8	0.0	25.8	5,554	4,586	826	86,029	128,719	1,496	11,110	13,473	1,213	102,693	146,778	1,429	27,750	22,669	817	29.6
Araria	66.6	156	39.3	0.0	39.3	25,038	28,924	1,155	83,394	118,046	1,416	13,862	21,226	1,531	122,294	168,196	1,375	53,697	52,118	971	37.3
Katihar	57.4	167	46.4	0.0	46.4	11,522	6,698	581	76,062	82,863	1,089	39,255	65,936	1,680	126,839	155,497	1,226	46,803	56,043	1,197	51.5
Khagaria	56.7	158	62.3	0.0	57.3	6,549	4,869	743	15,032	14,635	974	1,987	2,664	1,341	23,568	22,168	941	40,787	61,432	1,506	50.5
Zone 2	65.7	158	49.0	6.3	41.7	135,378	154,774	1,143	556,450	771,129	1,386	96,209	144,268	1,500	788,037	1,070,171	1,358	367,345	460,395	1,253	39.2
Jamui	26.6	109	41.7	1.2	34.3	0	0	0	52,784	60,080	1,138	0	0	0	52,784	60,080	1,138	16,972	22,120	1,303	20.9
Sheikpura	71.2	142	85.2	38.2	0.8	0	0	0	30,314	42,299	1,395	0	0	0	30,314	42,299	1,395	22,287	39,392	1,767	50.4
Munger	34.4	144	60.7	19.3	35.6	0	0	0	25,974	38,980	1,501	1	1	1,000	25,975	38,981	1,501	22,780	41,423	1,818	47.4
Lakhisarai	52.9	115	65.0	2.8	52.6	0	0	0	29,386	38,431	1,308	0	0	0	29,386	38,431	1,308	23,938	51,182	2,138	35.2
Bhagalpur	57.3	122	44.1	2.4	32.5	1,094	1,345	1,229	43,555	55,133	1,266	406	567	1,397	45,055	57,045	1,266	43,502	76,853	1,767	30.1
Banka	50.3	105	71.7	55.8	14.8	0	0	0	100,564	150,537	1,497	0	0	0	100,564	150,537	1,497	27,157	42,013	1,547	17.7
Zone 3A	45.2	118	59.2	21.2	28.0	1,094	1,345	1,229	282,577	385,460	1,364	407	568	1,396	284,078	387,373	1,364	156,636	272,983	1,743	29.0
Patna	65.0	123	70.7	20.1	47.7	0	0	0	100,766	230,257	2,285	212	309	0	100,978	230,566	2,283	61,820	158,649	2,566	30.1
Nalanda	77.7	126	84.6	4.1	71.9	2	2	1,000	99,064	96,889	978	0	0	0	99,066	96,891	978	83,849	124,225	1,482	46.4
Bhojpur	78.1	123	82.7	17.9	59.7	1,001	1,255	1,254	105,425	223,506	2,120	7	9	1,286	106,433	224,770	2,112	76,500	185,606	2,426	41.3
Buxar	82.8	105	78.6	30.6	45.8	5	6	1,200	67,873	154,414	2,275	0	0	0	67,878	154,420	2,275	45,684	126,276	2,764	33.0
Rohtas	65.1	143	91.1	72.3	9.9	323	404	1,251	195,387	516,983	2,646	16	24	1,500	195,726	517,411	2,644	128,102	322,248	2,516	50.4
Kaimnur	45.0	133	81.3	48.1	26.6	150	181	1,207	109,797	341,697	3,112	0	0	0	109,947	341,878	3,109	63,927	144,491	2,260	41.5
Gaya	40.6	138	84.8	83.8	0.0	1,720	2,124	1,235	159,125	244,150	1,534	144	194	1,347	160,989	246,468	1,531	63,367	127,641	2,014	31.7
Jehanabad	67.7	126	84.0	0.7	72.3	10	13	1,300	76,407	134,983	1,767	10	13	1,300	76,427	135,009	1,767	33,990	88,027	2,590	53.4
Arwal	66.7	139	82.6	49.3	31.0																
Nawada	44.5	135	84.9	9.4	73.0	33	40	1,212	78,394	127,325	1,624	47	65	1,383	78,474	127,430	1,624	49,812	95,080	1,909	45.1
Aurangabad	60.0	142	79.6	50.7	23.4	0	0	0	173,050	312,702	1,807	0	0	0	173,050	312,702	1,807	53,655	111,218	2,073	27.1
Zone 3B	59.4	131	82.6	40.8	36.5	3,244	4,025	1,241	1,165,288	2,382,906	2,045	436	614	1,408	1,168,968	2,387,545	2,042	660,706	1,483,461	2,245	38.1
Bihar total	61.1	138	57.9	17.4	36.2	553,904	688,189	1,242	2,907,199	4,589,705	1,579	116,885	169,902	1,454	3,577,988	5,447,796	1,523	2,076,849	3,688,941	1,776	38.4

Source: Government of Bihar, Economic Survey.

Figures 5 and 6 indicate no relation between irrigation and intensified land use. Instead, we can even observe a weak negative relation between irrigation and cropping intensity (Figure 5). If we examine Table 3 more closely, it seems that the cultivation of autumn rice is contributing to the overall higher cropping intensity. Note also that autumn rice cultivation does not basically require irrigation[10]. This may be the major reason why we could not find any positive relation between irrigation and intensified land use.

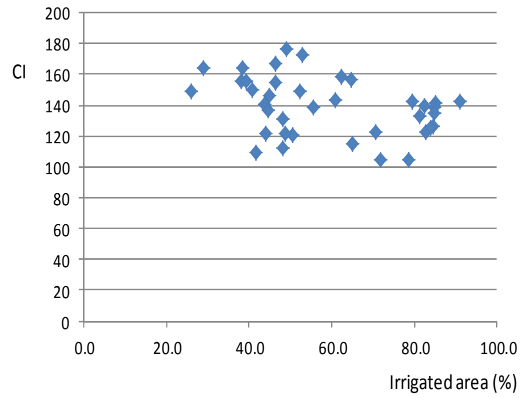

Figure 5 Relation between Irrigation and Cropping Intensity

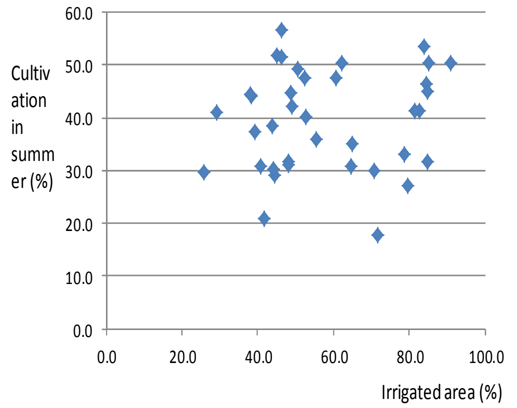

Figure 6 Relation between Irrigation and Cultivation in Summer Season

Figures 7 and 8 show the relation between irrigation and rice/wheat yield. We can now observe relatively clear positive relations between the two variables, regardless of rice and wheat. Irrigation *does* matter in increasing the yields of rice and wheat in Bihar. However, if we look at

[10] Autumn rice is called in Bengal (including Bangladesh) *aus* rice. *Aus* rice is basically 'coarse' rice and is not preferred by people because of its poor taste, especially compared to *aman* rice (winter rice). In Bangladesh, during the 1950s and 60s the expansion of the area under *aus* rice occurred on a large scale in the form of double cropping with *aman* rice under rain-fed conditions. This was basically due to the increased population pressure, but some technological changes, such as the introduction of early-maturing *aus* varieties and weak photosensitive *aman* varieties, facilitated the process (Fujita, 1986).

Figures 9 and 10, which shows the relation between tube-well irrigation and crop yields, it is found that the positive relations have almost vanished.

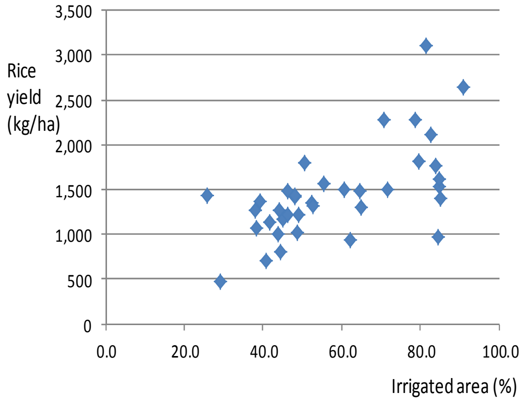

Figure 7 Relation between Irrigation and Rice Yield

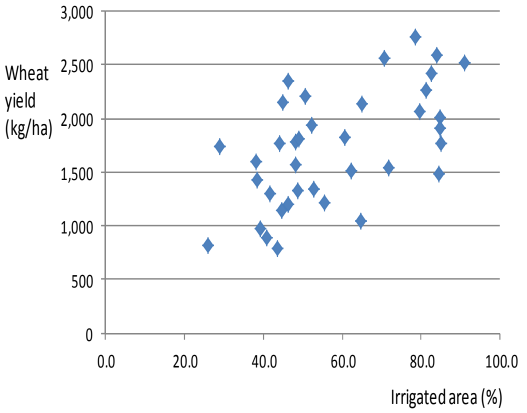

Figure 8 Relation between Irrigation and Wheat Yield

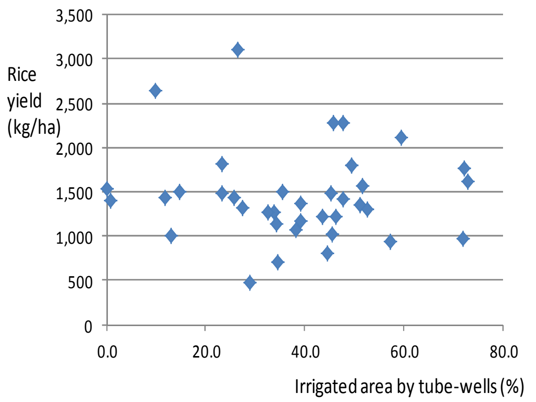

Figure 9 Relation between Tube-well Irrigation and Rice Yield

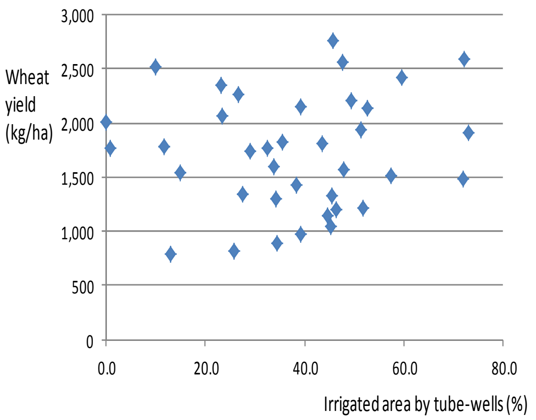

Figure 10 Relation between Tube-well Irrigation and Wheat Yield

Another notable fact is that the average yield of rice (1.52 ton/ha) and wheat (1.78 ton/ha) in Bihar (Table 3) remained at a very low level, especially compared to the national average in India (2.08 ton/ha for rice and 2.71 ton/ha for wheat in the same year of 2003-04).

Now the key questions regarding the backwardness of Bihar agriculture become clearer. Why did the yield of rice and wheat remain so low in spite of the relatively better endowment of irrigation, both in terms of (1) the proportion of irrigated area, and (2) the high dependency on tube-wells with a (usually) more assured supply of water (generally much more reliable than other systems, including government canals).

3) Reasons for low yields in rice and wheat in Bihar: Technological aspects

Why did the yield of rice and wheat remain so low in Bihar? Field observations and surveys in selected rural areas in Bihar in 2011 provided us with some hints. It seems that the major issues are twofold. One is the limited availability of improved varieties (especially rice) for farmers and the other is some kind of technological 'backwardness' regarding tube-well irrigation in Bihar.

Let us start our discussion with the first issue. It goes without saying that agricultural technologies in general are inherently highly location-specific in that they depend upon particular local agro-ecological conditions. Therefore, it is usually critical for the government to develop agricultural technologies that are suitable to each local situation, and this is especially true when developing improved seed varieties. The role of international research institutes, such as CIMMYT and IRRI, is to develop 'basic' technologies, whereas the national research institutes in each country are expected to develop more location-specific technologies through more adaptive research. In the case of Bihar, the state government had not been making the necessary effort in this regard, especially for rice varieties, until the mid-2000s when the present prime minister Nitish Kumar finally took power.

According to our field survey in a village in Madhepura District in September 2011, rice farmers still largely used traditional local rice varieties, but, at the same time, several hybrid rice varieties developed by private companies had started to be used in the village. On the other hand, high yielding varieties (HYVs) for rice, such as Sorna, MTU1001 (released by the state government in 1997) and Rajendra Mansuri (released in 2004)[11], were not disseminated in the village at all because these HYVs required plentiful water and were therefore, given the high price of irrigation water (Rs.70/hour), unprofitable for farmers. Hybrid rice varieties, on the other hand, needed less water than HYVs, and this was the major reason for their diffusion. According to information obtained from a seed dealer in Madhepura town, they first introduced a few hybrid rice varieties for sale in the year 2000. However, the diffusion of the hybrid rice varieties only accelerated after Nitish Kumar took power in November 2005, because only then was a subsidy program for the price of recommended varieties[12] introduced and, also, young university graduates who had studied breeding or agronomy started to be employed in each District Agricultural Office in order to disseminate new technologies centering around newly released improved varieties through 'contact' farmers. In total, 10-20 contact farmers were selected from every *gram panchayat*.

Interviews with several farmers in the village (in the aforementioned Madhepura District), revealed, however, that the advantage of hybrid rice over local varieties was not prominent enough for farmers to adopt them enthusiastically. Although the yield of hybrid rice varieties was 2-3 *maund* (1 *maund*≒40 kg) per *katta* (1 *katta*=1/20 *bigha*), 2-3 times higher than the local varieties which produce only 1 *maund* per *katta*, the disadvantages of the hybrid varieties were not small: one, the price of seed, which had to be purchased every year, was much higher; two, there were higher costs involved in the more intensive use of inputs needed, such as chemical fertilizers and insecticides; and, three, the market price of rice was lower (30-40 per cent lower than the local varieties), mainly

---

[11] Masuri varieties (Pajam) were developed by the Japanese breeders in the 1950s and early 60s in Malaysia, before the 'Green Revolution'. They need less chemical fertilizers and other inputs, but their yield is also lower than HYVs. Therefore, they are not included in HYVs in a strict sense. However, they are still now widely accepted because of the good taste.

[12] According toiinterviews by the author in September 2011 at Madhepura District Agricultural Office, a subsidy of Rs.200 for every kilogram of hybrid seed (the market price was slightly more than Rs.250/kg) was provided. Note that 6 kg of hybrid seed is needed for an acre of paddy field. Other interviews with farmers in the village in Madhepura showed that, in the case of rice HYVs, a subsidized price of Rs.7/kg of seed is applied, compared to its market price of Rs.21/kg.

because of the poor taste[13].

Besides, it seemed that farmers in the village were so discouraged from the three years of consecutive natural disasters after 2008 (there was a large-scale flood in 2008, followed by drought in each of the next two years) that they had largely lost interest in adopting new technologies. During the droughts, they needed to purchase irrigation water, which cost as much as Rs.70 per hour. Moreover, although they spent a lot of money for irrigation, the rice yield declined substantially because of the problems with pests that often occur in drought years.

In sum, it seems that a major problem is the lack of ‘apparently’ superior improved varieties of cereals (especially rice) in Bihar, which can be attributed to the neglect of the state government in developing such varieties over a long period of time.

Our field observations in a few villages in Kishanganj District in September 2011 provided us with some additional insights. The major differences with the village we visited in Madhepura District were that, firstly, HYVs (such as Sorna and Rajendra Masuri) were much more widely diffused in the winter rice, and, secondly, the cultivation of summer rice with HYVs was also widely observed. It should also be noted here that new agricultural technologies such as HYVs and the cultivation of summer rice came from West Bengal. According to a very knowledgeable and entrepreneurial farmer we happened to encounter, Rajendra Masuri, an HYV for winter rice, was introduced by a trader from West Bengal in the mid-1990s. He also told us that the technology for summer rice cultivation with HYV Sonalika was brought in in the mid-2000s by a migrant from the village who had moved to West Bengal.

It should now be remembered that Rajendra Masuri was, according to the Madhepura District Agricultural Office, ‘released’ in Bihar in 2004. However, it was already disseminated in some rural Bihar villages near West Bengal through some ‘private’ routes such as that mentioned above. The proximity to West Bengal, along with the climate with plentiful rainfall in the district, may be the reason for such a diffusion of advanced agricultural technologies from West Bengal.

Now, let us examine the issue on the ‘backwardness’ of tube-well irrigation technologies in Bihar. The tube-well technology currently in place in rural Bihar seems to have some disadvantages. First of all, almost all the tube-wells run on diesel oil, not electricity. This seems to be the most fundamental reason why the water rate in rural Bihar is so expensive (Rs.70-100/hour in the villages in Madhepura and Kishanganj we visited in September 2011, compared to Rs.50/hour in Madurai District, Tamil Nadu, for instance). Second, the depth of the tube-wells is generally very shallow in Bihar. In the village in Madhepura District, the average depth of the tube-wells was 45-55 feet[14]. In another village we visited in Kishanganj District, the average depth was only 25 feet, but the area irrigated by the tube-wells covered only 50 per cent of the farmland because the remaining 50 per

[13] The rice harvesting system in the village gives harvesting laborers a certain share (usually one-ninth) of the harvested bundles of paddy. Therefore, laborers also get hybrid rice if they have worked in the field where hybrid rice varieties were planted. Some farmers told us that even poor laborers were reluctant to receive such paddy as their wages because of the poor taste.

[14] In our several study villages in Madurai District, Tamil Nadu, the depth of bore-wells reached 300 feet in 2010 compared to 100-150 feet in around 2000 (Fujita, 2011: 9). For reference, shallow tube-wells in Bangladesh usually lift groundwater from a depth of 90-150 feet.

cent could only be irrigated by digging deeper tube-wells to 60-70 feet, which, according to the informant, was not profitable. In other words, the high cost of lifting the groundwater, along with the low crop yield, hampers farmers from exploiting a deeper groundwater aquifer. Third, tube-wells in Bihar are not fixed in a small hut at a specific location. Rather, there are only a number of holes (inserted by plastic pipes) dug at the edge of the paddy field where a diesel engine on a small wooden cart is temporarily installed for lifting the groundwater. The water is then distributed by a long plastic hose. Hence, there is little capital investment required for tube-wells in Bihar. We must say, though, that even if they saved money on investment in tube-well irrigation through such ways, the price of water is still high.

However, it should also be noted here that in a village we visited in Kishanganj District, farmers purchased plenty of water from tube-wells, although the water rate was high (Rs.80/hour). A farmer we interviewed used irrigation water for winter rice 2-3 times in a season with 2-3 hours/time/*bigha*[15], but for summer rice, he used water 25 times in a season with 3 hours/time/*bigha*, which seems to be possible only because he obtained a relatively high yield after introducing an improved variety of rice.

To conclude tentatively, we can hypothesize that there has been very little information on, and access to, improved seed varieties in rural Bihar, until very recently (except for some spots such as Kishanganj). Because of this, many farmers have long hesitated to use plentiful groundwater, since the water rate was expensive and the yield was low, so it was unprofitable. The limited demand for groundwater irrigation, in turn, hampered large-scale investment in tube-well irrigation, which kept the high water rate quite high[16]. In other words, although tube-wells are widely disseminated in Bihar, the technology has been rather 'primitive' (mainly due to the diesel-operated engines), which seems to have resulted in an expensive water rate. The high water rate, in turn, along with the low crop yield arising from the non-availability of improved seeds, discouraged farmers from using more water for intensive cultivation.

At the same time, however, we can often observe relatively advanced agricultural practices in Zone 3B. Our hypothesis is that this was realized because of the plentiful supply of water from the government canals at much cheaper rates in that area.

4) On the agrarian structure

The Agricultural Census 1995-96 provides the latest data for capturing the characteristics of the agrarian structure in Bihar. According to the Census, which categorized farm households based on operated land, the total number of farm households was 11,382,000 with a total operated land of 6,810,000 hectares. Therefore the average size of operated land per farm household was 0.60 hectares. Nearly 85 per cent of farm households operated less than 1 hectare, whereas large-scale farm households with more than 4 hectares accounted for only 1.5 per cent, though they operated 14.8 per cent of the total land. The average size of operated land was largest in Zone 3 (0.70 ha), followed by Zone 2 (0.67 ha) and Zone 1 (0.49 ha) (Bansil, 2011: 73).

---

[15] One *bigha* is equivalent to 0.5 acres in the locality.
[16] This remark is still hypothetical, so a more careful and detailed analysis is required in the future.

The 59th Round of National Sample Survey data (published in 2004) revealed that around 12 per cent of the operated land in Bihar was under tenancy, but some micro-level studies indicate that as high as 25 to 35 per cent of the total cultivated area in the state is under tenancy. Sharecropping is the most dominant form of tenancy, but lease contracts on a fixed rent basis are becoming popular, especially in irrigated areas (Bansil, 2011: 75-76).

In India, much debate has been conducted in the past regarding the implications for productivity of the unequal distribution of land in India. I would like to summarize the essence of the argument by taking the case of Bangladesh (which has an agrarian structure that is similar to that of Bihar) (Fujita, 2009).

--There is a well-known argument regarding size-productivity relations. In Bangladesh, a quite strong inverse relationship between farm size and land productivity has been observed. Land productivity is mainly determined by three factors: cropping intensity, yield per unit of sown area for individual crops, and crop mix. An inverse relation was observed in all three components. First, small farmers achieved higher cropping intensity, either through using more irrigation or by simply applying more labor. Second, small farmers generally achieved a higher yield per unit of land for individual crops through the adoption of more high yielding varieties, applying more fertilizers (both manures and chemical fertilizers) and water. Third, small farmers grew more labor-intensive (with therefore a higher productivity per unit of land) crops by applying more labor.

--The inverse relation aforementioned is mainly derived from two factors. One is the 'subsistence pressure' faced by small farmers. Given the imperfect labor market, they try to use their family labor beyond the point where the marginal productivity of labor equals the prevailing market wage rate. The other is the high cost for large farmers of recruiting and monitoring hired labor. Large farmers therefore fail to hire enough labor up to the point where the marginal productivity of labor equals the prevailing market wage rate. This latter aspect (the high cost for large farmers of recruiting and monitoring hired labor) tends to be rather neglected, but it is usually more important than the former (the subsistence pressure faced by small farmers) in explaining the actually observed inverse relation.

--Basically, tenancy should be regarded as an effective measure for reducing/eliminating the problem of inefficiency arising from the inverse relation mentioned above. Through tenancy large farmers can save the cost of recruiting/monitoring hired labor, and landless or small farmers can find employment on rented-in land, in addition to their own land. In this sense, the real problem of the traditional agrarian economy such as in South Asia *is* the underdeveloped tenancy market, *not* the widespread tenancy relations. Compared to pre-war Japan where around half the total farmland was under tenancy, for instance, in contemporary South Asia in countries such as India and Bangladesh the problem is the underdevelopment of the tenancy market.

--Besides the aforementioned problems, there may be problems of inefficient production systems in the tenancy relationship itself. However, compared to the stylized fact of an inverse relation between farm size and productivity, the productivity gap between owned and self-operated land versus rented-in land is still highly controversial. In Bangladesh, it was revealed that the productivity of rented-in land was slightly higher (than owned land) in the case of small tenants, whereas it was lower in the case of large tenants. This happened because small tenants are facing fierce competition in getting tenancy land, but large tenants usually do not face such competition due to social reasons so that they can apply more resources and labor to their own land rather than rented-in land.

Although the same type of detailed analysis is needed in Bihar, the conclusions obtained above from the analysis in Bangladesh seem to be largely applicable to the case of Bihar as well.

5) On the labor shortage problem in agriculture

Due to the large-scale emigration from Bihar during the last few decades, the agricultural wage rate has been surging rapidly in Bihar in recent years. The effects of this are increasingly being felt by large farmers who often complain about the problem of a labor shortage for their agricultural operations. In fact, a large farmer from the village we visited in September 2011 in Kishanganj District told us that the rice harvesting (including threshing) wage, which was 10-15 per cent of the harvest 5 years ago, increased to 20 per cent recently. During the last five years the difficulty in getting hired labor has become acute.

Under such circumstances, the alleged inverse relation between farm size and productivity has to be more sharply observed. Large farmers, faced with the problem of an acute labor shortage, especially in the peak agricultural seasons, are going to rent-out more land in the tenancy market. In the case of the study village in Kishanganj to give land to the tenancy market, due mainly to the difficulty in getting hired labor, started 10-15 years ago and it has become much more common now. Such an increase in the supply of land in the tenancy market is expected to result in improvements in tenancy conditions through the strengthened bargaining power of the weaker sections of rural society.

Seed-fertilizer technology for raising crop yields is basically labor-intensive. Bihar agriculture is facing a big challenge in this sense. The crop yield should be raised substantially, but there has emerged the serious problem of a labor shortage.

3. CONCLUDING REMARKS

Remembering that nearly nine-tenths of the Bihar’s population lives in rural areas, earning their livelihood mainly from agriculture, one cannot visualize an accelerated and inclusive growth process where agriculture is not accorded center stage (Ghose, 2011: 291). Besides, the review of the development process of the Indian economy as a whole revealed that the broad-based agricultural growth in India during the 1980s was an important pre-requisite for the accelerated economic growth, mainly by non-agricultural sectors, since the 1990s, because rural India provided a big market for non-agricultural sectors for their products and services. Agricultural growth is essential for the development of the entire economy, especially when rural poverty is still a serious problem.

The lack of purchasing power among the rural population in Bihar is easily seen when we travel the state. When we go by car along the main roads, we encounter small growth centers at intervals along the road. However, unlike other states in India (for example, Tamil Nadu or West Bengal), we can see only a small number of shops where only a limited variety of goods is available. In other states, we pass by many buses, trucks and vehicles, but not in Bihar. Not many rural people go even to the capital city of Patna.

Therefore, the strategic importance of agricultural development is apparent in Bihar. The key question is how to develop the agricultural sector. Some people might say that priority should be given to growing sectors within agriculture: vegetables and fruits, and animal husbandry, especially dairy farms. However, the market for such growing sectors within the state is apparently limited. In this sense, more priority should be given to the staple foods: rice, wheat, and we should add maize for animal feed.

Fortunately or unfortunately, the yield levels of these staple foods in Bihar are generally very low. There is a lot of potential that remains to be exploited. Figure 11 shows the movement of rice and wheat yields in West Bengal, where rice is classified into three types: autumn rice (*aus*), winter rice (*aman*), and summer rice (*boro*). According to the figure, the highest yield in the 2000s was attained in *boro* (3 ton/ha), followed by *aman* (2.5 ton/ha) and *aus* (2 ton/ha). By contrast, the yield for each category of rice in Bihar is 1.4 ton/ha for autumn rice (*aus*) and winter rice (*aman*), and 1.6 ton/ha for summer rice (*boro*). We notice an important fact from Figure 11 that until the late 1980s the yield of rice, except *boro*, in West Bengal was almost the same level as in today's Bihar. In other words, West Bengal farmers accomplished a dramatic increase in the monsoon rice yield in just 10 years until the beginning of the 2000s. According to the author's interview in the Rice Research Station in West Bengal in February 2012, 60-70 per cent of the seed varieties in *aman* rice in West Bengal are Sorna, a HYV now recommended in Bihar[17]. The Sorna originally came from Andhra Pradesh and was released in West Bengal in 1979.

There is enough room for Bihar farmers and policy-makers to learn from the experience of West Bengal during the 1990s and reach the level attained in West Bengal.

[17] Regarding the current status of rice in West Bengal, see Adhikar et al. 2010.

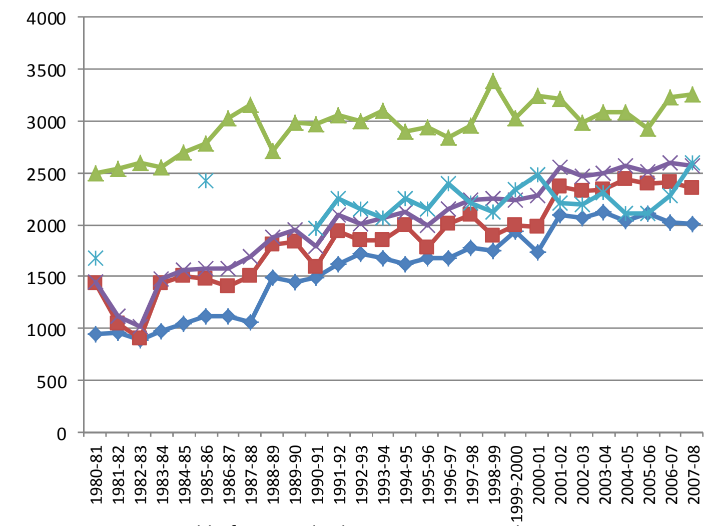

Figure 11 Yield of Rice and Wheat in West Bengal

References

Adhikari, B. et al., 2010, *Status Paper on Rice in West Bengal*, Rice Research Station, Govt. of West Bengal.

Bhalla, G.S. and G. Singh, 1997, "Recent Developments in Indian Agriculture: A State Level Analysis", *Economic and Political Weekly*, 42(27-28), July 14.

Bansil, P.C., 2011, *Bihar Agriculture: A Perspective*, Concept Publishing Company PVT. LTD.

Bardhan, P.K., 1984, *Land, Labor and Rural Poverty: Essays in Development Economics*, Oxford: Oxford University Press.

Bardhan, P.K. and A. Rudra, 1978, "Interlinkage of Land, Labour and Credit Relations: An Analysis of Village Survey Data in East India", *Economic and Political Weekly*, Annual Number, February, 367-384.

Bhaduri, A., 1973, "A Study of Agricultural Backwardness under Semi-Feudalism", *Economic Journal*, March, 120-137.

Blyn, G., 1966, *Agricultural Trends in India, 1891-1947: Output, Availability and Productivity*, Philadelphia: University of Pennsylvania Press.

Chand, R., S.S. Raju and L.M. Pandey, 2007, "Growth Crisis in Agriculture Severity and Options at National and State Levels", *Economic and Political Weekly*, 42(26): 2528-33.

Food and Agriculture Organization (FAO), 1995, *World Agriculture: Towards 2010*, Rome: FAO.

Fujita, K., 1986, "Banguradeshu niokeru Nogyo Hatten: Nogyo Kozo to Gijutsu Henka no Kanren o Chushin ni" (in Japanese) (Agricultural Growth in Bangladesh with Special Reference to Institutional factors), *Ajia Keizai*, 27(12), 2-23.

Fujita, K. 2006, "Indo no Syokuryo Mondai to Syokuryo Seisaku: Sono Kozo to Tenbo" (in Japanese) (Food Problems and Food Policy in India: The Structures and Perspectives), *Kokusai Kaihatsu Kenkyuu* (Journal of International Development Studies), 15(2), 51-64.

Fujita, K., 2009, "Worlds Apart: Peasants in Japan and Agricultural laborers in Bangladesh", International Journal of South Asian studies, Vol.2, 87-104.

Fujita, K., 2010a, *Re-thinking Economic Development: Green Revolution, Agrarian Structure and Transformation in Bangladesh*, Kyoto: Kyoto University Press and Trans Pacific Press, forthcoming.

Fujita, K., 2010b, "The Green Revolution and Its Significance for Economic Development: The Indian Experience and Its Implications for Sub-Saharan Africa", JICA Research Institute Working Paper No.17.

Fujita, K., 2011, "Introduction: Socio-Economic Dynamics in a Tank-Irrigated Rural Area in Contemporary Tamil Nadu, India", *Southeast Asian Studies*, 49(1), 3-21.

Fujita, K., A. Kundu and W.M.H. Jaim, 2003, "Groundwater Market and Agricultural Development in West Bengal: Perspectives from A Village Study", *Japanese Journal of Rural Economics*, 5, 51-65.

Ghani, E. ed., *The Poor Half Billion in South Asia: What is Holding Back Lagging Regions?*, Oxford University Press.

Ghose, P.P., 2011, "Interstate Dispality in India and Development Strategies for backward States", In Hirashima et al eds, (2011), 270-295.

Government of Bihar (GOB), 2011, *Economic Survey 2010-11*.

Government of India (GOI), 1997, *Agricultural Statistics at a Glance 1997*.

GOI, 2011, *Economic Survey 2010-11*.

Hayami, Y., 1997, *Development Economics: From the Poverty to the Wealth of Nations*, Oxford: Oxford University Press.

Hirashima, S., H. Oda, and Y. Tsujita eds., *Inclusiveness in India: A Strategy for Growth and Equity*, Palgrave Macmillan.

Kahnert, F. and G. Levine, 1993, *Groundwater Irrigation and the Rural Poor: Options for Development in the Gangetic Basin*, Washington D.C.: World Bank.

Kurosaki, T., 1999, "Agriculture in India and Pakistan, 1900-95: Productivity and Crop Mix", *Economic and Political Weekly*, 34 (52), December 25, A160-A168.

Newberry, D.M.G., 1974, "Crop-Sharing Tenancy in Agriculture: A Comment", *American Economic Journal*, 64.

Ohno, A., 1999, "Indo: Kyozou wa Tachiagarunoka?" (India: The Big Elephant Will Stand Up?), In Hara, Y. ed., *Ajia Keizai Ron* (Asian Economies), Tokyo: NTT Publishers, 381-415.

Pant, N., 1992, *New Trend in Indian Irrigation: Commercialisation of Ground Water,* New Delhi: Ashish Publishing House.

Sastry, D.V.S.; B. Singh; K. Battacharya and N.K. Unnikrishnan, 2003, "Sectoral Linkages and Growth Prospects: Reflections on the Indian Economy", *Economic and Political Weekly*, 38(24), June 14.

World Bank, 2000, *India: Reducing Poverty, Accelerating Development*, Oxford: Oxford University Press.

World Bank, 2005, *India: Re-Energizing the Agricultural Sector to Sustain Growth and Reduce Poverty*, Oxford: Oxford University Press.

Yanagisawa, H., 2008, "Gendai Indo no Keizai Seicho to Noson Shakai no Henyo" (in Japanese) (Economic Growth and Transformation of Rural Society in Contemporary India), *Chiba Daigaku Keizai Kenkyu* (Chiba University Economic Journal), 23(3), 283-314.