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Economics of paddy (*Oryza sativa*) production: A comparative study of Bihar and Punjab

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ABSTRACT

Rice (*Oryza sativa* L.) is a staple food for about 65% of the population in India. It plays a vital role in strengthening food and livelihood security. Despite having stagnant area during the last decade, the rice production has registered an increase of 18%. But there is a common concern about declining profitability in paddy production. This article explores the trends in the cost of cultivation and profitability in rice production in two rice growing Indian states of Bihar and Punjab, which have almost contrasting scenario in productivity and use of inputs. Bihar is a traditional paddy growing state, whereas paddy emerged as principal crop in Punjab after the green revolution. Analysis of data for the last 30 years revealed that the per hectare cost of paddy cultivation increased at faster rate in Bihar but it was still double in Punjab, mainly due to more use of fertilizers, agro-chemicals and machine power. Use of human labour in paddy cultivation declined due to mechanization in Punjab but wages paid to human labour increased by more than 22 times during the period under study. Farmers realized very little income over total cost of cultivation in Punjab whereas farmers of Bihar encountered even losses in paddy cultivation during the last decade, mainly due to low productivity caused by inadequate use of manures and fertilizers, low adoption level of modern technologies, less mechanization and insufficient irrigation. However, Bihar's performance in paddy cultivation in context of gross income to the total cost has improved during recent past which needs further improvement for increasing profitability in paddy cultivation. There is an urgent need to create an enabling environment to ensure adequate income from paddy cultivation to farmers for improving their livelihoods.

Key words: Bihar, Cost of cultivation, Economics, Income, Paddy, Punjab

During the past century, agriculture has seen many changes. It has fed millions of people which seemed impossible earlier. India produces 107 million tonnes of rice (*Oryza sativa* L.) in an area of 44 Million ha which constitutes about 35% of area and 40% of production of the foodgrain in the country. It is a staple food of about 65% of the country's population, which itself indicates its importance in the food security of the country. Paddy production generates employment of about 3.5 billion mandays and contributes about 10% to Agricultural GDP in the country. However, paddy is considered 'water guzzler' and the unfavourable monsoon adversely affects its area, production and productivity in the country (Bouman 2009). Despite a lower growth in area under paddy during post-green revolution period (1971-90) as compared to pre-green revolution era (1950-70), the paddy production registered almost identical

growth during both the periods. Paddy production increased by two fold from 20.58 million tonnes to 42.22 million tonnes during pre-green revolution period, mainly due to increase in area whereas the production got doubled during 23 years of post-green revolution period (1971-94), which was attributed by increase in productivity. It was made possible through investment in agricultural research and development, creating an enabling environment for extension, large scale technology adoption by farmers, introduction of high yielding varieties (HYV), increased irrigation facility, subsidy on fertilizers, electricity and diesel, and improvement in extension services in the country (Guptha *et al.* 2014). However, the achievements in agricultural production would not be possible without decisive role of farmers (Swaminathan, 2008). Annual growth in paddy production was only 1.45% in the country during 1991-2013. The steam of paddy production growth seems to have exhausted during last two decades. The recent yield stagnation in paddy is not due to technology fatigue, but could be due to the sluggish input intensification.

Despite slow growth in paddy productivity, the production reached to 106.54 million tonnes in 2013-14. Increase in input prices including human labour did not deter farmers from increasing investment on inputs which resulted

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in reducing profitability in paddy production, particularly in regions of low paddy productivity (Singh, 2004). There is a common concern about declining profitability in Indian agriculture and paddy production is not an exception. Indian economy experienced overall growth but there is a need to understand the causes of distress in farming and production of principal crops. Keeping in view these observations, an attempt has been made in this paper to explore trends in cost of cultivation and profitability among paddy farmers in Bihar and Punjab which have almost contrasting scenario in productivity and use of inputs.

MATERIALS AND METHODS

Cost of paddy cultivation estimates generated by the Commission on Agricultural Costs and Prices (CACP) for Bihar and Punjab were used for analysis for making reliable conclusions. Cost C_3 is used as total cost of cultivation which includes all actual expenses in cash and kind incurred in production by owner (Cost A_1) as well as interest on value of owned capital assets (excluding land), rental value of owned land and rent paid for leased-in land, imputed value of family labour (statutory minimum or actual wage whichever is higher) and 10% of the above mentioned total cost (Cost C_2) on account of managerial function performed by farmer. Cost of cultivation data of last three decades were used for the study however, cost of cultivation data of triennium ending 1983, 1993, 2003 and 2013 were used for detailed analysis.

In order to analyse the trend in cost of cultivation, the main contributing factors namely; family human labour, hired human labour, bullock labour, seeds, machine labour, fertilizers and manures were considered for detailed analysis. These major contributing factors were compared to the cost of cultivation with respect to (i) actual values, (ii) changes over the decade and (iii) percentage to cost of cultivation. Profitability was estimated by using different profit measure tools. Gross income from paddy cultivation is sum of values of main and by product which was estimated by the Commission on Agricultural Costs and Prices (CACP). Net income is gross income minus total expenses in paddy cultivation (Cost C_3). Family labour income is net income plus imputed value of family labour wages. Farm business income is gross income minus all actual expenses in cash and kind incurred in production by owner (Cost A_1). Profitability was also examined as percentage of profit or loss made over the cost by the formulae $\{(\text{Value of produce}/\text{Cost of cultivation}) - 1\} \times 100$. For comparing the increase in cost of cultivation and value of produce, the percentage change of both were calculated across the years. Relative change in increase in value of produce in comparison to cost of cultivation was calculated using the formulae: (percentage change in value of produce over previous decade) – (percentage change in cost of cultivation over previous decade).

RESULTS AND DISCUSSION

Punjab and Bihar are the major paddy growing states of

India, and these two states together constitute about 13.6% of paddy area and contribute 15.8% to paddy production in the country. There has been contrasting scenario of paddy production in these two states of India. Area under paddy increased from 0.42 million ha at triennium ending (TE) 1973 to 2.8 million ha at TE 2013 in Punjab but there has been declining trend in paddy area in Bihar during the same period (Table 1).

Paddy, being not an important crop in Punjab during pre-green revolution era, was cultivated in only 7.1% gross cropped area (GCA) at TE 1973 increased continuously and covered 36.0% of GCA at TE 2013. In contrast, it was grown in 47.7% of GCA at TE 1973 in Bihar and declined to 42.3% of GCA at TE 2013. The declining paddy area may be due to unreliable and costly irrigation facility, uneconomic holdings and low profitability in paddy production in Bihar (GoI 2008, Kishore 2004). Per ha paddy (husked paddy) productivity has been much higher in Punjab than Bihar. However, difference in paddy productivity of two states got much wider in post green revolution period and reached to 22.86 q/ha at TE 1993. Thereafter, the difference has almost remained constant till TE 2013.

Cost of cultivation

Cost of cultivation of paddy is the total variable cost and fixed expenditure including interest on working capital and depreciation and interest on fixed capital. In present

Table 1 Area, production and productivity of paddy in Bihar and Punjab during 1973 to 2013

	TE 1973	TE 1983	TE 1993	TE 2003	TE 2013
<i>Area (000'ha)</i>					
Bihar	3448	3405	3359	3576	3260
Punjab	420	1357	2106	2544	2838
Difference	3028	2048	1253	1032	422
<i>Production (000'tonnes)</i>					
Bihar	3298	2981	3706	5278	5478
Punjab	1021	4146	7133	9117	11061
Difference	2277	-1165	-3427	-3839	-5583
<i>Productivity (kg/ha)</i>					
Bihar	955	873	1100	1476	1682
Punjab	2112	3055	3386	3583	3897
Difference	-1157	-2182	-2286	-2107	-2215
<i>Gross cropped area (000'ha)</i>					
Bihar	7230	7645	7645	7912	7712
Punjab	5891	6940	7564	7874	7887
<i>Share of paddy area in GCA (%)</i>					
Bihar	47.7	44.5	43.9	45.2	42.3
Punjab	7.1	19.5	27.8	32.3	36.0

Sources: Computed from various issues of Indian Agriculture at a Glance

paper, estimates of cost of cultivation of paddy for Bihar and Punjab generated by CACP have been used for detailed analysis. Per ha cost of cultivation showed increasing trend in Bihar and Punjab during TE 1983 to TE 2013 (Table 2).

Cost of cultivation of paddy was higher in Punjab than Bihar during the period under study due to higher variable and fixed expenditures incurred in paddy cultivation in Punjab. But annual increase in cost of cultivation was comparatively higher in Bihar (38%) than Punjab (33%), mainly due to low base of expenditure in Bihar. Moreover, the farmers of Bihar also started adopting modern technologies in paddy production. Fixed and variable costs increased in Punjab and Bihar during 1983-2013 but proportion of variable cost in total cost of cultivation increased from 55.5% to 74.0% at TE 1983 and 2013, respectively in Bihar whereas the proportion of variable cost to total cost showed a decreasing trend in Punjab. The much lower expenditure in cultivation of paddy in Bihar up to TE 2003 was mainly due to low use of fertilizers, machine power and modern seeds. On the other hand higher fixed cost in paddy cultivation in Punjab was

only due to complete mechanization of paddy cultivation, irrigation through deep tube wells and higher rental value of land. Cost of paddy production was identical at ₹ 102/q in 1981-82 (GoI 1996) in both the states under study but the increase in cost of production was faster in Bihar than Punjab, mainly due to low productivity in Bihar. Cost of paddy production increased to ₹ 1081/q in Bihar at TE 2013, which was higher than the corresponding cost of cultivation in Punjab. Human labour and fertilizer are the most important inputs in paddy cultivation and expenditure on these two inputs constituted 58.2% of total operational cost in Bihar and 41.7% in Punjab at TE 1983 which increased to 71.9% and 56.22% at TE 2013, respectively.

Expenditure on human labour was about half in Bihar than Punjab at TE 1983, mainly due to lower wage rate in Bihar (₹ 5.84/day) than Punjab (₹ 11.16/day). However, the expenses on human labour was comparatively less in Bihar than Punjab up to TE 1993 but the situation turned to be just reverse from mid-nineties when Punjab farmers started accruing less expenditure on human labour in paddy cultivation due to rapid mechanization (GoI, 2007). It is

Table 2 Expenses (₹/ha) on operational and fixed costs in paddy cultivation in Bihar and Punjab

Particular	TE 1983		TE 1993		TE 2003		TE 2013	
	Bihar	Punjab	Bihar	Punjab	Bihar	Punjab	Bihar	Punjab
Human labour	625 (48.73)	1151 (31.65)	1880 (57.46)	2005 (33.03)	4802 (58.54)	4394 (31.49)	12272 (62.45)	11975 (44.24)
Bullock labour	343 (26.78)	135 (3.71)	693 (21.18)	82 (1.36)	716 (8.73)	55 (0.40)	936 (4.76)	67 (0.25)
Machine labour	4 (0.31)	368 (10.13)	104 (3.19)	1001 (16.49)	796 (9.71)	2835 (20.31)	2236 (11.38)	4680 (17.29)
Seed	95 (7.42)	130 (3.56)	202 (6.17)	183 (3.01)	759 (9.26)	541 (3.88)	1275 (6.49)	1367 (5.05)
Fertilizer	121 (9.43)	841 (23.12)	268 (8.18)	1194 (19.67)	843 (10.28)	2094 (15.00)	1860 (9.46)	3243 (11.98)
Manure	30 (2.32)	81 (2.23)	40 (1.22)	73 (1.20)	12 (0.15)	109 (0.78)	1 (0.01)	278 (1.03)
Irrigation	33 (2.59)	717 (19.72)	17 (0.52)	1046 (17.23)	80 (0.97)	2383 (17.08)	637 (3.24)	2040 (7.54)
Agricultural chemical	0.0 (0.00)	114 (3.14)	0.0 (0.00)	322 (5.31)	0.0 (0.00)	1163 (8.33)	3 (0.02)	2704 (9.99)
Miscellaneous	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	14 (0.10)	0.0 (0.00)	26 (0.10)
Interest on working capital	31 (2.42)	99 (2.73)	68 (2.08)	164 (2.70)	194 (2.36)	367 (2.63)	431 (2.19)	689 (2.54)
Total operational cost	1282 (100)	3638 (100)	3273 (100)	6070 (100)	8202 (100)	13956 (100)	19652 (100)	27067 (100)
Fixed cost	1027	2002	2269	4971	4167	11122	6829	29545
Total cost	2310	5640	5542	11042	12369	25077	26480	56612

Source: Computed from various Reports of the Commission for Agricultural Costs and Prices.

worth pointing out that the wage of human labour increased in both states by almost similar rate that is; 21 fold in Bihar and 22 fold in Punjab during the period 1983-2013.

Punjab and Bihar did not differ much in per ha use of human labour in paddy cultivation at TE 1983. Use of human labour in cultivation of paddy declined from 856 hours at TE 1983 to 787 hr at TE 2013 in Bihar but the corresponding decline was faster in Punjab (from 825 hr to 386 hr) during the period. Despite decline in use of human labour in paddy cultivation in both the states, Punjab could be able to reduce the use of human labour by more than 50% during 1983–2013 whereas the corresponding decline was only 8% in Bihar during the period (Table 3).

Fertilizer is another most critical input in paddy production. Fertilizer (NPK) use in crop production was much imbalanced in Punjab (60.8:12.7:1), whereas farmers of Bihar used more balanced fertilizer (5.5:2.1:1.0) in crop production (ASG 2015). Farmers of Punjab used relatively higher quantity of fertilizer (NPK) than Bihar farmers in paddy cultivation. Per ha use of fertilizer increased in both the states but per ha use of fertilizer for paddy cultivation in Bihar was only 45% of Punjab at TE 2013 whereas it was only 13% at TE 1983. Annual increase in fertilizer use has been observed much higher in Bihar (10.1%) than Punjab (0.97%) during period under study but per ha expenditure on fertilizer for paddy cultivation was much higher in Punjab than Bihar during period under study. The lower rate of increase in fertilizer expenditure in Punjab was probably due to higher base of fertilizer use. However, the difference in per ha fertilizer use in paddy cultivation in Punjab and Bihar got narrowed down with the passage of time.

The mechanization of a traditional agricultural system may produce substantial indirect effects on other sectors of the economy, particularly where agriculture contributes significantly to Gross National Product (GNP) and farm mechanization becomes relatively widespread. The indirect effects, exemplified in the concepts of 'forward' and 'backward' linkages, stem from production and consumption interactions of the agricultural sectors with the non-agricultural sectors. Traditional field operations on farms have improved during the three decades in Punjab and about one and half decades in Bihar. The traditional system of crop production was in vogue in both the states up to early eighties. Per ha expenditure on machine labour

in paddy cultivation was comparatively high in Punjab (₹ 368.44) than Bihar (₹ 3.99), constituting 10.31% and 0.31% of respective total operational cost at TE 1983. Per ha expenditure on machine labour increased several fold in these states and reached to ₹ 2834.89 in Punjab and Rs 796.37 in Bihar at TE 2003 which further increased to Rs 4679.97 and ₹ 2236.42, respectively at TE 2013. Increase in machine labour cost during TE 1993 to TE 2003 was only due to increased use of tractor and combined harvester in Punjab and tractorization in Bihar whereas the increase during TE 2003 to TE 2013 was mainly due to increase in diesel price which increased from ₹ 20/l in 2003 to ₹ 60/litre in 2013.

Irrigation is also an important input in paddy production which helps increasing efficiency of other factors. But about 40% paddy is still cultivated in rain fed situation in India. Despite variation in rainfall in different regions of the country, productivity of paddy is generally higher in state with higher irrigation facility. Madhya Pradesh has one of the lowest paddy area under irrigation (22%) with lowest rice yield (1.5 t/ha), whereas in Punjab almost entire paddy area under irrigation (99.5%) has the highest rice productivity (4.0 t/ha). Also in Punjab, area under irrigated paddy increased from 80% at TE 1993 to 99.5% at TE 2013, whereas in Bihar it increased from 40% to 61% during the same period. Irrigation cost increased from ₹ 33/ha in Bihar and ₹ 717/ha in Punjab at TE 1983 to ₹ 637 /ha and ₹ 2040/ha, respectively at TE 2013.

The use of agricultural chemicals was much lower in Bihar during period under study but their use increased many folds in Punjab during last decade, mainly due to increase in use of herbicides in paddy cultivation. There was sharp decline in use of farmyard manure (FYM) in both the states and proportion of expenditure on this item was about 1% in Punjab and less than 1% in Bihar. Farmers of Bihar almost stopped using FYM in paddy cultivation due to decline in number of livestock and its alternative use as fuel. Use of bullock labour in paddy cultivation declined in Bihar from 242 h at TE 1983 to 30 h at TE 2013 whereas the use of bullock labour was much lower in Punjab at TE 1983 (33 hrs/ ha) and almost no use of bullock labour observed in Punjab at TE 2013 (1.10 hr/ha). Seed is a critical input in paddy production but cost of seed showed declining trend in both the states under study during TE 1983–2013.

Table 3 Per ha use of major inputs in paddy cultivation in Bihar and Punjab

Particular	TE 1983		TE 1993		TE 2003		TE 2013	
	Bihar	Punjab	Bihar	Punjab	Bihar	Punjab	Bihar	Punjab
Seed (kg/ha)	50	35	55	35	64	35	49	35
Fertilizer (kg/NPK/ha)	22	165	49	197	75	192	90	212
Manure (q/ha)	7	56	5	34	1	25	0	24
Human labour (Man hr/ha)	856	826	893	565	861	469	787	386
Bullock labour (Pair hr/ha)	242	33	178	6	60	1	30	1

Source: Computed from various Reports of the Commission for Agricultural Costs and Prices.

Table 4 Per ha gross income and total cost in paddy cultivation in Bihar and Punjab

Particular	TE 1983		TE 1993		TE 2003		TE 2013	
	Bihar	Punjab	Bihar	Punjab	Bihar	Punjab	Bihar	Punjab
Gross income (₹/ha)	2604	6879	5820	13581	11393	32606	25508	76331
Total cost (₹/ha)	2310	5640	5502	11042	12369	25077	26480	56612
Net income (₹/ha)	296	1239	318	2539	-975	7529	-973	19719
Family labour income (₹/ha)	566	1600	1303	3207	829	9372	4464	24059
Farm business income (₹/ha)	1549	3519	3460	8044	4697	20333	10952	53319
Percent profit (%)	12.7	22.0	5.8	23.0	-7.9	30.0	-3.7	34.8

Source: Computed from various Reports of the Commission for Agricultural Costs and Prices.

Trend in profitability

In India, declining income of farmers is a common concern due to increase in input prices in comparison to harvest prices of agricultural commodities. An attempt has been made in this section of paper to examine the profitability in paddy production in Punjab and Bihar during last 30 years. Profit measures namely Gross Income, Net Income, Family Labour Income and Farm Business income have been used for analysis. Gross income continuously increased in both the states and got doubled every 10 years due to increase in per ha productivity and prices of paddy. Net Income in paddy cultivation also increased in Punjab during period under study but farmers of Bihar earned marginal net income at TE 1983 and TE 1993 but incurred per ha losses of ₹ 975 at TE 2003 and ₹ 973 at TE 2013, however, per ha total cost of cultivation increased by 140% during TE 1993–2003 and gross income increased by 123% due to low increase in productivity, resulting negative net income from paddy cultivation in Bihar. The similar trend was observed during TE 2003–2013 in case of Bihar.

Family labour income in paddy cultivation was positive in Bihar during period under study due to use of more family labour in paddy cultivation. In Bihar, family labour constituted about 44% of human labour used in paddy cultivation whereas the corresponding share of family labour ranged from 31 to 36% operational costs of paddy cultivation in Punjab. The wages of human labour increased with almost same rate in Punjab and Bihar during period under study however human labour wages were almost double in Punjab than wages paid to human labours in Bihar during the period. Farm business income of paddy cultivation was positive in both the states but difference became wider in succeeding years during study period due to declining proportion of fixed cost in total cost of cultivation in Bihar and just reverse trend in use of fixed assets in Punjab.

A comparative analysis of relative increase in cost of cultivation and value of produce in two states was carried out. The difference was positive in Punjab at all the four triennium years which showed increasing trend from 22.0% at TE 1983 to 34.8% at TE 2013 (Table 4). But the difference was positive in Bihar at only first two out of 4 triennium years. Poor response to costly chemical fertilizers due to deficient

irrigation, low level of adoption of modern technology and partial adoption of appropriate package of practices due to increase in human labour wages, which might be responsible for slow growth in paddy productivity in Bihar during the period under study.

However, the trend in percentage of profitability indicates that the margin is reducing in Bihar over the years but just reverse trend was observed in case of Punjab. The comparative change in gross income and total cost was computed for First Period (TE 1983–1993) Second Period (TE 1993 – 2003) and Third Period (TE 2003 –2013). In Bihar, the comparative increase in cost of cultivation was 14.7% more than increase in gross income in the first period, which increased to 29.0% in the Second period but the difference turned positive in the third period. In case of Punjab also, the difference in increase in gross income and cost of cultivation was only 1.6% but it increased to 13% in the second period but declined to 8.4% in the third period, indicating comparatively more increase in cost of cultivation than gross income in paddy cultivation during TE 2003–2013, indicating deceleration of profitability in paddy cultivation in Punjab also during last 10 years.

Conclusion and implications

The present study has analysed the dynamics of cost of cultivation and profitability in paddy cultivation in Bihar and Punjab having contrasting scenario. Bihar is a traditional paddy growing state, whereas in Punjab, paddy was introduced as principal crop after green revolution. Per ha cost of paddy cultivation increased faster in Bihar than Punjab during last 3 decades, however, the per ha cost of cultivation was double in Punjab than Bihar mainly due to intensive use of fertilizers, irrigation, pesticides and farm machinery. Use of human labour declined in Punjab but labour wages increased by more than 22 times during the same period. Analysis of profitability revealed that the farmers received very little income over total cost of cultivation in Punjab where as farmers of Bihar encountered losses in paddy cultivation during last decade mainly due to low productivity owing to less mechanization, low use of fertilizers and organic manure, low adoption level of modern technologies and inadequate irrigation. However, Bihar's performance in paddy cultivation in context of gross

income to total cost improved during recent past which need further improvement for increasing profitability. Efforts need to be taken to create an enabling environment to ensure a commensurate income to paddy farmers for improvement in their livelihood.

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