
Is Labour Productivity of Irrigated Crops Better than Rainfed Crops?: A Meta-Data Analysis

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ABSTRACT

An intricate question arises in the context of labour productivity is whether any perceptible variation exists in it among different crops cultivated under irrigated and rainfed conditions. We tried to answer this puzzle in this paper using the cost of cultivation survey data covering period from 1975-76 to 2016-17. It is known that labour productivity changes across crops and therefore, a total of six crops (three irrigated and three rainfed crops) cultivated in 12 different states are considered for the analysis. The labour productivity is estimated under four dimensions which are (1) ratio of value of output (Rs/ha) to total labour man-hours, (2) ratio of value of output to total human labour cost (Rs/ha) incurred for cultivating the crops, (3) ratio of yield (kg/ha) to total labour man-hours, and (4) ratio of yield to total human labour cost (Rs/ha) incurred for cultivating the crops. To study the changes in labour productivity, growth rate and averages are computed by dividing the study period into three, viz., Period-I (1975-76 to 1990-91), Period-II (2000-01 to 2016-17) and for the entire period (1975-76 to 2016-17). It was found that the labour productivity estimated under all four dimensions is higher among the irrigated crops in different states as compared to the rainfed crops in both period-I and period-II. The labour productivity both in terms of value of output and yield (in kg) computed using labour man-hours as denominator has increased for all the six irrigated and rainfed crops. However, when the estimate is made using total labour cost as denominator, the labour productivity either declines or does not increase appreciably for both irrigated and rainfed crops.

Keywords: Farm labour productivity, Human labour; Irrigated crops, Rainfed crops, Value of crop output

JEL: J2, J3, E24, Q16

I

INTRODUCTION

The Indian agricultural sector has undergone several changes after the introduction of green revolution during the mid-sixties. The high-yielding varieties (HYVs) led technology has not only prompted the use of yield increasing inputs such as chemical fertilisers and pesticides but also the use of farm machineries such as tractors, harvesters, threshers, winnowers, etc. For instance, the use of tractors (which is an important constituent in farm machineries) has increased from just three per 1000 hectares of net sown area (NSA) in 1962-65 to 167 per 1000 hectares of NSA in 2005-08 at the all India level (Bhalla and Singh, 2012). Despite rapid increase in farm mechanisation in Indian agriculture, the role of human labour is still very important

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in carrying out different operations because of two reasons: (a) machineries are not available in the market to perform all the required operations for cultivation of all the crops, and (b) farm holdings are highly fragmented and small in size in India where machineries cannot be used extensively. In fact, an increased scarcity of farm labour of late has been reported in different parts of the country (Gulati *et al.*, 2013; Chand and Srivastava, 2014).

Since farm labour accounts for the largest share in the total labour force of the country and the incidence of poverty is higher among the farm labour households in rural areas, a large number of studies have been carried at different time points relating farm labour with different parameters. Rudra and Sen (1980) analysed the relationship between farm size and labour use in the context of debate on farm size and productivity relations in the 1980s, while Chattopadhyay (1984) studied the transformation of labour use in Indian agriculture using farm management survey data of different time points from 1950s and 1960s. Utilising NSSO data on employment and unemployment relating to the periods 1993-94 and 2009-10, Chand and Srivastava (2014) have provided a detailed account of the changes in the rural labour market and their implications for agriculture.

Farm labour productivity plays a critical role in deciding the wage rate of labour and therefore, many scholars have studied this issue over the years. With the help of data from the farms of Indian Agricultural Research Institute for the years 1951-52 to 1954-55, Kahlon and Bharadwaj (1959) have shown that the labour productivity is mostly determined by the volume of production and product prices. Concerned with the contrasting beliefs on the use and productivity of agricultural labour, Mellor (1963), after reviewing various studies and providing an empirically appropriate conceptual framework for analysing farm labour use with productivity, underlined that “in most densely populated low income countries there is a positive marginal product from additional increments of labour applied to agricultural production”(p. 532).

While studying the inter-state variations in agricultural labour productivity and sources of labour productivity growth using data from four time points, namely, triennium averages ending 1964-65, 1972-73, 1977-78 and 1982-83, Dev (1988) concludes that the growth in productivity of crop was the major source for the rise in labour productivity and the contribution of land-man ratio to the variation in labour productivity was higher than that of land-productivity. After making a detailed analysis using the results generated from numerous regression models with the help of data from 281 districts for the period 1962-65 and 1970-73, Bhalla and Alagh (1983) surmises that “..... labour productivity in modern agriculture depends on the intensity of use of both mechanical and biological inputs. Since high growth districts are the predominant users of available tractors and tubewells (and other inputs) in the country, capital intensity per worker is the main determinant of labour productivity in these districts” (p.834). Recently, while studying the agricultural labour productivity and its determinants using data collected from different sources

for the period 1991-92 to 2016-17, Shanmugan and Baria (2019) have shown an increasing trend in labour productivity in agriculture with marginal variations between various estimates across various dimensions of time-series measurements.

Although a large number of studies have analysed the farm labour productivity in India and neighbouring countries (Selim, 2012), not many focused on the comparison of labour productivity between irrigated and rainfed crops/regions. Besides helping to increase the farm wage rate and reducing rural poverty (Narayanamoorthy and Deshpande, 2003; Narayanamoorthy, 2007), irrigation coverage plays a paramount role in deciding the productivity of crops as well as its value of output (see, Dhawan, 1988; Narayanamoorthy *et al.*, 2015). Productivity of crops is a key factor that decides the labour productivity. Not only the productivity of crops, but the cost of cultivation, cost incurred on wage labour, wage rate and value of crop output are also the important determinants of labour productivity. These parameters distinctly varied between the crops that are cultivated under irrigated and rainfed conditions. Therefore, we have attempted here to analyse farm labour productivity from different crops cultivated under irrigated and rainfed condition using spatial and temporal data. The following specific issues and questions are attempted:

- 1) Is labour productivity between irrigated and rainfed crops cultivated in different states differ significantly?
- 2) How far labour productivity among different crops differs when estimated in terms of value of crop output in monetary terms and absolute productivity (kg/ha)?
- 3) What are the trends in labour productivity among different irrigated and rainfed crops estimated under different dimensions?
- 4) Does labour productivity for the same crop differs when cultivated under irrigated or rainfed condition in different states?

II

METHODS AND DATA

The entire analysis in this study is carried out using Cost of Cultivation Survey (COCS) data published by the Commission for Agricultural Costs and Prices (CACP) of the Ministry of Agriculture and Farmers' Welfare, Government of India. CACP has been publishing CCS data on selected crops with all operations including labour use since 1970-71. Here, we have taken data from 1975-76 to 2016-17, for which latest data is available for ready use. Since the major objective of the study is to analyse the temporal and spatial pattern of labour productivity in different crops cultivated under irrigated and rainfed conditions, the study has considered three irrigated crops, namely, paddy, wheat and sugarcane and three rainfed crops, namely, tur (red gram), groundnut and cotton. Productivity of crops, labour use and other parameters are varied from state to state due to various reasons. Therefore, in order to find out whether any variation exists in farm labour productivity within the same crop cultivated in different states, two states for each crop are selected for the analysis. That is, data from a total of six crops and 12 states are used in this study.

The details of selected crops, states and the data period are presented in Table 1.

TABLE 1. CROPS, STATES AND DATA USED FOR THE STUDY

(values in Rs. are at 2004-05 prices)

Crops (1)	State (2)	Parameters (3)	1970-71 to 2016-17		No. of years data available/used (6)		
			Average (4)	SD (5)			
Irrigated crops	Paddy	Andhra Pradesh	HL (Man hrs)	979.94	214.22	41	
			HLC (Rs./ha)	10058.23	3894.90	41	
			VOP (Rs./ha)	25147.98	8342.11	41	
			Yield (kg/ha)	4289.44	1182.15	41	
	Wheat	Punjab	HL (Man hrs)	553.50	183.87	38	
			HLC (Rs./ha)	7621.03	1138.17	38	
			VOP (Rs./ha)	33722.95	8101.62	38	
			Yield (kg/ha)	5708.26	830.53	38	
	Sugarcane	Maharashtra	HL (Man hrs)	319.86	130.92	45	
			HLC (Rs./ha)	5871.96	612.63	45	
			VOP (Rs./ha)	23920.28	6400.61	45	
			Yield (kg/ha)	3691.98	831.54	45	
	Rainfed crops	Tur	Madhya Pradesh	HL (Man hrs)	360.82	84.66	42
				HLC (Rs./ha)	6820.96	1779.83	42
				VOP (Rs./ha)	23059.28	6606.64	42
				Yield (kg/ha)	3530.98	855.96	42
Groundnut		Andhra Pradesh	HL (Man hrs)	2233.59	471.45	38	
			HLC (Rs./ha)	21123.18	8177.27	38	
			VOP (Rs./ha)	70778.59	22811.74	38	
			Yield (kg/ha)	84154.16	10292.26	38	
Cotton		Uttar Pradesh	HL (Man hrs)	1204.57	101.62	42	
			HLC (Rs./ha)	9612.56	2728.07	42	
	VOP (Rs./ha)		44865.22	14506.10	42		
	Yield (kg/ha)		45945.14	6116.46	42		
	Tur	Uttar Pradesh	HL (Man hrs)	442.88	98.47	33	
			HLC (Rs./ha)	4205.28	1283.73	33	
			VOP (Rs./ha)	12594.53	4025.74	33	
			Yield (kg/ha)	685.58	188.10	33	
	Groundnut	Gujarat	HL (Man hrs)	585.29	82.24	30	
			HLC (Rs./ha)	5553.63	1252.51	30	
			VOP (Rs./ha)	17506.72	2377.53	30	
			Yield (kg/ha)	962.83	188.90	30	
Cotton	Karnataka	HL (Man hrs)	668.50	112.20	33		
		HLC (Rs./ha)	6938.11	3346.12	33		
		VOP (Rs./ha)	17443.80	8786.46	33		
		Yield (kg/ha)	1042.94	376.56	33		
Cotton	Maharashtra	HL (Man hrs)	490.80	81.20	39		
		HLC (Rs./ha)	6488.40	2707.43	39		
		VOP (Rs./ha)	17737.84	7219.33	39		
		Yield (kg/ha)	1033.82	440.72	39		
Cotton	Maharashtra	HL (Man hrs)	699.91	126.37	30		
		HLC (Rs./ha)	6089.49	2974.81	30		
		VOP (Rs./ha)	18294.57	8961.49	30		
		Yield (kg/ha)	856.17	406.40	30		
Cotton	Maharashtra	HL (Man hrs)	819.35	132.87	30		
		HLC (Rs./ha)	8879.29	4887.99	30		
		VOP (Rs./ha)	19641.90	9561.79	30		
		Yield (kg/ha)	928.53	486.75	30		

Source: Computed using data from CACP (various years).

Notes: SD - standard deviation; HL - human labour; HLC - human labour cost; VOP - value of output.

Data on human labour use in terms of man hours (LMH), total human labour cost (HLC) in monetary terms (Rs./ha), yield of crops (kg/ha) and value of crop output (VOP) in monetary terms (Rs./ha) are the variables primarily used for computing the labour productivity under different dimensions. Since the study uses time-series data, all the cost and income related data are converted into constant value using Consumer Price Index of Agricultural Labour (CPIAL) with the base year 2004-05 to study the real change in labour productivity over time.

Generally, labour productivity is measured in terms of ratio of total agricultural output to total labour input following the broader framework of growth accounting method postulated by Solow (1957), which is also employed recently by Shanmugan and Baria (2019). However, we cannot always capture the real picture of farm labour productivity in terms of value of output alone because the numerator namely VOP (Rs./ha) used in this method is highly influenced by the market price of the crop which highly fluctuates in India (see, Narayanamoorthy, 2013; CACP, 2018). Due to the excess supply of agricultural commodities in certain seasons and distortions in prices created by middlemen, farmers do not get the expected price for their produces in the market (Narayanamoorthy and Suresh, 2013, NITI Aayog, 2015; 2016). This often dampens the total value of output realised from the cultivation of crops. Given this, when one estimates the farm labour productivity using the value of output as numerator and total labour input as denominator, the farm labour productivity may turn out to be very low. Can we then say that the labour productivity is lower in India using the results estimated from this kind of method? Actually, the entire computations have larger weights in the fluctuations of prices. These problems can be avoided when the farm labour productivity is measured in terms of actual productivity of crops (kg/ha). Keeping this in view, in this study, we estimate the farm labour productivity under the following four dimensions:

$$FLP_{vh} = \frac{VOP}{LMH} \quad \dots(1)$$

$$FLP_{vc} = \frac{VOP}{HLC} \quad \dots(2)$$

$$FLP_{vh} = \frac{Yield}{LMH} \quad \dots(3)$$

$$FLP_{vc} = \frac{Yield}{HLC} \quad \dots(4)$$

where, FLP = farm labour productivity, VOP = value of crop output in Rs./ha at 2004-05 prices; LMH = labour man hours per ha; HLC = human labour cost in Rs./ha at 2004-05 prices; Yield = productivity of crops in kg/ha; v = short form of value of

output; h = short form of labour man-hours; c = short form of human labour cost; y = short form of yield of crop.

In equation (1), the farm labour productivity (FLP_{vh}) is measured relating value of crop output (v) with labour man hours (h), which is estimated by dividing per hectare value of crop output (VOP) in Rs./ha with human labour man-hours (LMH).

In equation (2), the farm labour productivity (FLP_{vc}) is measured relating value of crop output with human labour cost (c), which is estimated by dividing per hectare value of crop output with the cost incurred on human labour for cultivating each of the selected crops.

In equation (3), the farm labour productivity (FLP_{yh}) is measured relating yield (kg/ha) of crop with labour man-hours (h), which is estimated by dividing per hectare yield of crop with human labour man hours (LMH) used for the crop.

In equation (4), the farm labour productivity (FLP_{yc}) is measured relating yield of crop (y) with human labour cost (c), which is estimated by dividing per hectare of yield of crop with the cost incurred on human for cultivating crop (Yield/HLC).

After having estimated the labour productivity through these four approaches, we estimated growth rates for the same using log-linear function ($\log Y = \alpha + bt$) to find out the growth in labour productivity during different periods for all the six irrigated and rainfed crops cultivated in 12 states.

III

RESULTS AND DISCUSSION

It is a well accepted fact that precise measurement of farm labour productivity is very difficult and challenging as the productivity of crops is determined by a host of factors where labour is one of the factors. Along with yield increasing inputs such as fertilisers and pesticides, human labour, bullock labour and machine labour are also used for cultivating crops. The use of labour (all types) changes considerably from crop to crop and also every year due to various endogenous and exogenous factors. Therefore, even with rigorous econometric analysis, it would be very difficult to find out the exact contribution of human labour to production of crop as well as the human labour productivity. The difficulties in estimating the productivity of labour and machinery particularly tractor are amply explained by Binswanger (1978). Understanding the difficulties in measurement, in this study, we estimate the labour productivity only by taking into account the human labour use both in terms labour man-hours and total labour cost incurred for cultivating the selected six crops.

(A) Labour Productivity (in Rs.) per Man-Hour (VOP/LMH)

The first dimension of labour productivity that we have estimated for this study is the ratio of labour productivity to labour man-hour. The amount of labour hours spent for carrying out various agricultural operations will have direct impact on the

productivity of crops as it explains the intensity of labour use. If higher labour is used in any farm means, either the agricultural operations are carried out systematically or the yield of crop is higher; increased crop output also warrants higher labour for harvesting operation. Therefore, the labour productivity is measured in terms of labour man-hours. Table 2 presents the labour productivity in Rs. per man-hour of labour for both irrigated and rainfed crops for all the selected states. As the labour use pattern has been changing over the years, labour productivity is computed by dividing the period of analysis into three, namely, period-I (1975-76 to 1990-91), period-II (2000-01 to 2016-17) and for the entire period (1975-76 to 2016-17) to see whether any perceptible changes are taking place in it. It is clear that the labour productivity computed in terms of labour man-hours has increased with fluctuations over the years in both irrigated and rainfed crops (see, Figure 1). In the case of paddy cultivated in Andhra Pradesh, the labour productivity increased from Rs. 15.19/man-hour in period-I to Rs. 39.02/man hour in period-II, with the growth rate of 4.20 per cent per annum. Similarly, in the case of cotton cultivated in Maharashtra, it increased from Rs. 14.07/man hour to 26.83/man hour with the growth rate of 3.79 per cent per annum. Similar trend is also observed in all the crops and the states selected for the analysis.

TABLE 2. LABOUR PRODUCTIVITY – IN MONETARY TERMS PER LABOUR HOUR
(values in Rs. are at 2004-05 prices)

	Crops (1)	State (2)	Period – I (1975-76 to 1990-91)			Period – II (2000-01 to 2016-17)			All Period (1975-76 to 2016-17)		
			Average (Rs.) (3)	CV (4)	Growth Rate (5)	Average (Rs.) (6)	CV (7)	Growth Rate (8)	Average (Rs.) (9)	CV (10)	Growth Rate (11)
Irrigated crops	Paddy	Andhra Pradesh	15.19	14.46	1.09 ^{ns}	39.02	35.69	4.99 ^a	28.56	55.60	4.20 ^a
		Punjab	34.47	22.46	5.67 ^a	87.03	31.33	4.07 ^a	70.43	47.80	4.58 ^a
	Wheat	Punjab	42.81	21.12	2.18 ^a	146.19	42.68	6.20 ^a	100.24	69.53	5.05 ^a
		Haryana	38.70	22.62	3.46 ^a	88.59	29.38	3.76 ^a	68.40	47.17	3.65 ^a
	Sugarcane	Maharashtra	23.88	15.66	0.32 ^{ns}	38.84	38.21	3.98 ^a	33.33	41.94	2.60 ^a
		Uttar Pradesh	29.16	21.53	2.68 ^b	42.24	27.69	2.96 ^a	37.26	31.66	2.06 ^a
Rainfed crops	Tur	Madhya Pradesh	18.75	24.39	7.94 ^c	33.12	32.73	3.23 ^a	29.63	38.74	3.33 ^a
		Uttar Pradesh	25.22	16.46	1.23 ^{ns}	32.06	16.55	0.41 ^{ns}	30.47	19.02	0.86 ^b
	Groundnut	Andhra Pradesh	17.35	39.37	9.44 ^a	29.56	39.32	3.82 ^a	26.23	44.99	3.56 ^a
		Gujarat	29.59	22.33	2.49 ^c	38.92	26.03	2.33 ^a	35.18	29.27	1.79 ^a
	Cotton	Karnataka	23.42	34.24	4.95 ^{ns}	26.39	41.05	4.87 ^a	25.50	39.33	2.18 ^a
		Maharashtra	14.07	29.46	0.64 ^{ns}	26.83	24.62	3.00 ^a	23.00	36.42	3.79 ^a

Source: Computed using data from CACP (various years).

Notes: CV - Coefficient of variation; growth rate is computed using log-liner function; growth rate is in percent per annum; a, b, c are significant at 1, 5 and 10 per cent level respectively and ns – not significant.

Whether any distinct difference exists in labour productivity between the irrigated crops and the rainfed crops is the main focus of this paper. The results show that the

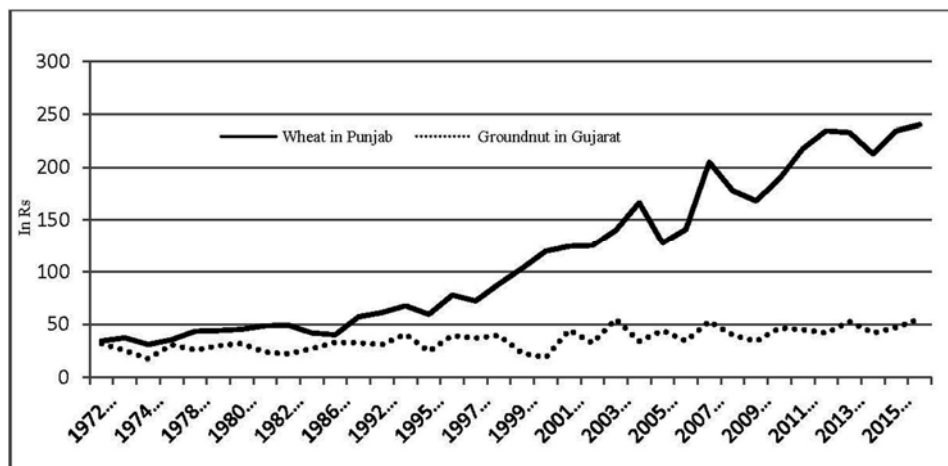


Figure 1. Labour Productivity (VOP/LMH) in Wheat and Groundnut.

labour productivity per man-hour in most crops is higher for irrigated crops than those crops cultivated under rainfed condition in period-I. The range of labour productivity varies from Rs. 15.19 to Rs. 42.81 for different irrigated crops during period-I, but the same vary from Rs. 14.07 to Rs. 29.59 for rainfed crops during the same period. However, in the case of irrigated paddy cultivated in Andhra Pradesh, the labour productivity comes to only Rs. 15.19 during period-I, which is lower than the labour productivity of many rainfed crops. The position of labour productivity changes completely during period-II, where it ranges from Rs. 38.84 to 146.19 for irrigated crops and from Rs. 26.39 to Rs. 38.92 for different rainfed crops. These changes noted from period-I to period-II could be due to three reasons. First, the increased productivity in different crops during period-II may have increased the labour productivity. Second, the increased use of machine labour that increased considerably since 1990-91 as per the CCS data may have also contributed to increased productivity of labour. Third, the substantial increase in minimum support prices for irrigated crops like paddy, wheat and sugarcane particularly during the last 15 years or so may have also contributed to increase in labour productivity in period-II. On the whole, the analysis shows that the labour productivity measured by dividing the value of output (Rs.) with labour man-hours is higher among the irrigated crops than the rainfed crops.

(B) *Labour Productivity in per Unit of Labour Cost (in Rs.) (VOP/HLC)*

Many authors have used measurement of labour productivity by dividing the value of output with the total labour cost incurred for cultivating the crop. Although this method of measurement has serious limitations due to the fact that the numerator number VOP used in this type of measurement is highly influenced by exogenous

factor, namely, market price, we have also employed this method to estimate the labour productivity specifically to find out the variations in it as compared to other three dimensions of labour productivity. Some studies using CCS data have shown that the cost incurred on account of labour input has increased substantially than the other major inputs especially after the introduction of MGNREGS (Gulati *et al.*, 2013; Narayanamoorthy *et al.*, 2014). Has the recent increase in labour cost affected the productivity of labour?

Table 3 presents the labour productivity measured by dividing the value of output (Rs./ha) with the total labour cost incurred for cultivating the selected crops. As expected, the labour productivity in different irrigated and rainfed crops has either declined or not increased much in most of the crops in period-II as compared to period-I. Interestingly, there seems to be no significant difference in the labour productivity between the irrigated and rainfed crops in period-I. The labour productivity ranges from Rs. 2.87 to Rs.4.93 for irrigated crops in period-I, while the same ranges from Rs.3.05 to Rs. 4.58 for rainfed crops. In some irrigated crops, the average labour productivity is lower than the rainfed crops in period-I. Though the labour productivity of both irrigated and rainfed crops have declined in period-II as compared to period-I, it is found to be relatively better among the irrigated crops (see, Figure 2). In period-II, the range of labour productivity varies from Rs. 2.42 to Rs. 4.67 among different irrigated crops, whereas the same ranges from Rs. 2.17 to Rs. 3.18 among the rainfed crops. The decline in labour productivity between the two periods could have happened because of the following two reasons. First, the cost of labour incurred for different crops might have increased at a faster rate that may have

TABLE 3. LABOUR PRODUCTIVITY – VALUE OF PRODUCTION PER UNIT OF WAGE COST
(values in Rs. are at 2004-05 prices)

	Crops (1)	State (2)	Period – I (1975-76 to 1990-91)			Period – II (2000-01 to 2016-17)			All Period (1975-76 to 2016-17)		
			Average (Rs.) (3)	CV (4)	Growth Rate (5)	Average (Rs.) (6)	CV (7)	Growth Rate (8)	Average (Rs.) (9)	CV (10)	Growth Rate (11)
Irrigated crops	Paddy	Andhra Pradesh	2.87	20.69	-2.27 ^b	2.42	8.93	1.83 ^{ns}	2.62	18.28	-0.76 ^a
	Wheat	Punjab	3.80	15.95	3.04 ^b	4.67	10.54	0.51 ^c	4.40	15.13	0.99 ^a
		Punjab	3.32	10.77	0.58 ^{ns}	4.60	10.65	0.96 ^a	4.03	19.21	1.29 ^a
		Haryana	3.16	21.39	2.26 ^b	3.59	13.78	-0.99 ^a	3.42	17.76	0.43 ^c
	Sugarcane	Maharashtra	4.93	26.95	-5.24 ^a	2.94	25.13	-0.10 ^c	3.67	37.49	-2.16 ^a
		Uttar Pradesh	4.87	17.42	0.94 ^{ns}	4.61	18.12	0.92 ^c	4.71	17.83	0.81 ^{ns}
Rainfed crops	Tur	Madhya Pradesh	3.30	19.09	4.09 ^{ns}	2.96	19.58	-0.11 ^{ns}	3.04	19.70	-0.35 ^a
	Groundnut	Uttar Pradesh	3.61	18.55	-2.19 ^{ns}	3.18	23.76	-2.81 ^{ns}	3.28	22.81	-1.79 ^a
		Andhra Pradesh	3.05	24.76	4.00 ^{ns}	2.59	54.10	-1.24 ^{ns}	2.72	46.53	-1.67 ^b
	Cotton	Gujarat	3.09	24.96	2.27 ^c	2.66	22.08	-0.34 ^{ns}	2.80	23.11	0.45 ^{ns}
		Karnataka	4.58	28.03	0.47 ^{ns}	2.68	27.38	0.16 ^{ns}	3.25	39.03	-2.19 ^a
		Maharashtra	3.21	33.16	5.93 ^{ns}	2.17	1.29	0.97 ^{ns}	2.48	34.92	-2.03 ^a

Source and Notes: Same as in Table 2.

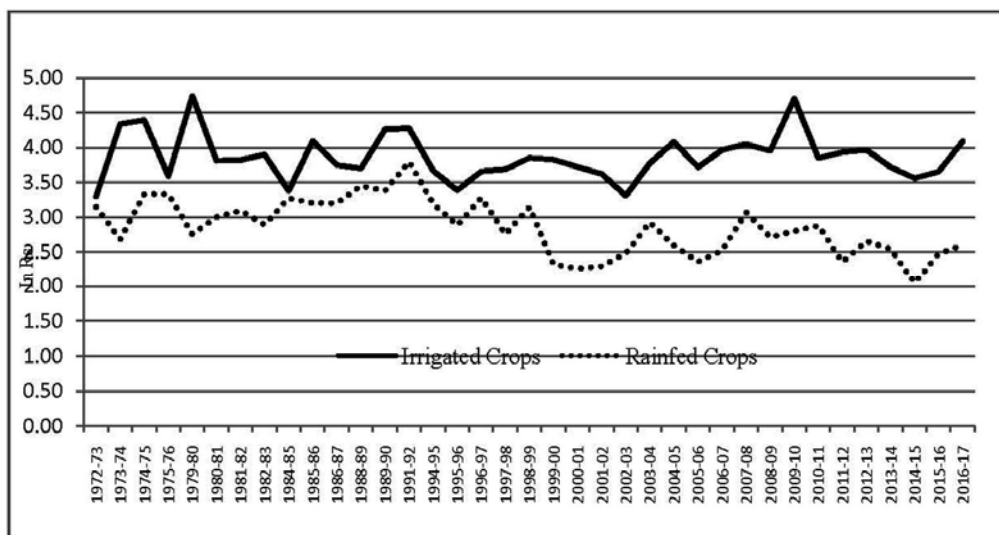


Figure 2. Average Labour Productivity (VOP/HLC) of Irrigated and Rainfed Crops.

ultimately dampened the labour productivity. Second, the prices received by the farmers for crops may not have increased in consonance with the cost of cultivation that may have also indirectly affected the value of output realised. On the whole, the results suggest that the labour productivity computed in relation to the labour cost seems to be relatively higher in most number of irrigated crops and states than those crops and states where rainfed crops are cultivated.

(C) Labour Productivity in Volume of Yield per Labour Hour (Yield/LMH)

The third dimension of labour productivity that we have computed is the ratio of yield (in kg) to total labour man-hours utilised for cultivating the selected crops. This would tell us how much yield is generated from every hour of labour used for cultivating the selected crop. Since the values of numerator and denominator used in this method of estimation are not influenced by the exogenous factors, namely, price of the crop, this value of labour productivity is expected to reflect the near reality. It is to be noted here that the increased use of labour hours does not necessarily lead to reduction in labour productivity, but rather it can increase the productivity of labour through yield augmentation. For instance, when weeding and intercultural operations are carried out for a crop more than once by employing more labour that helps increasing the productivity of crops through which the labour productivity can also be increased.

The average labour productivity in kg of yield to one hour of labour for irrigated and rainfed crops cultivated in different states is presented in Table 4. Unlike the

labour productivity which is estimated by dividing the labour cost, the labour productivity in kg of yield for every hour of labour use has impressively increased in period-II as compared to period-I in both irrigated and rainfed crops. During period-I, the labour productivity ranges from 2.77 kg to 35.09 kg for irrigated crops, while it ranges only from 0.61 kg to 1.96 kg in rainfed crops. Similarly, during period-II, it ranges from 6.42 kg to 44.98 kg for irrigated crops and from 1.25 kg to 2.22 kg for rainfed crops.

TABLE 4. LABOUR PRODUCTIVITY – VOLUME OF YIELD PER LABOUR HOUR

	Crops	State	Period – I (1975-76 to 1990-91)			Period – II (2000-01 to 2016-17)			All period (1975-76 to 2016-17)		
			Average (kg)	CV	Growth Rate	Average (Kg)	CV	Growth Rate	Average (kg)	CV	Growth Rate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Irrigated crops	Paddy	Andhra Pradesh	2.77	12.08	1.52 ^a	6.42	33.55	4.62 ^a	4.82	50.65	3.81 ^a
		Punjab	6.58	22.21	5.04 ^a	14.01	24.88	3.15 ^a	11.66	39.37	3.73 ^a
	Wheat	Punjab	6.98	27.07	3.89 ^a	21.85	41.97	5.61 ^a	15.24	66.68	4.90 ^a
		Haryana	6.34	31.39	5.78 ^a	13.59	17.97	2.03 ^a	10.65	39.83	3.55 ^a
	Sugarcane	Maharashtra	30.01	14.96	2.77 ^a	44.98	18.42	1.95 ^a	39.47	25.75	2.09 ^a
		Uttar Pradesh	35.09	10.93	1.68 ^a	40.14	9.99	1.10 ^a	38.22	12.09	0.81 ^a
Rainfed crops	Tur	Madhya Pradesh	1.19	16.13	-0.26 ^{ns}	1.71	27.91	2.50 ^a	1.59	30.34	2.21 ^a
		Uttar Pradesh	1.61	17.53	-4.80 ^{ns}	1.67	17.15	-1.66 ^a	1.65	17.01	-0.89 ^c
	Groundnut	Andhra Pradesh	1.05	22.44	5.14 ^c	1.77	25.34	2.78 ^a	1.58	32.72	3.03 ^a
		Gujarat	1.96	28.49	3.82 ^{ns}	2.22	29.22	2.18 ^a	2.06	32.62	1.63 ^a
	Cotton	Karnataka	1.03	28.66	3.58 ^{ns}	1.25	39.30	5.91 ^a	1.19	37.87	2.75 ^a
		Maharashtra	0.61	24.44	4.03 ^{ns}	1.29	28.87	4.69 ^a	1.08	41.16	4.75 ^a

Source and Notes: Same as in Table 2.

While comparing the labour productivity of irrigated crops with rainfed crops, the results clearly show that the labour productivity is substantially higher among the irrigated crops than the counterpart rainfed crops. In fact, the labour productivity of irrigated crops such as paddy and wheat has increased more than two times in period-II over the level of period-I, which is not observed in any of three rainfed crops considered for the analysis. As per the data of Ministry of Agriculture and Farmers Welfare (Government of India, 2019), the average productivity of paddy and wheat in different states in India has increased appreciably over the years due to the introduction of yield augmenting varieties which might have helped to increase the labour productivity of these crops. This means that the technological development (seed varieties) plays an important role in increasing the productivity of labour especially when it is estimated in terms of yield. The inference that comes out from this analysis is that the labour productivity has increased much higher among the irrigated crops than that of the rainfed crops in all the selected states.

(D) Labour Productivity in Volume of Yield per Unit of Labour Cost

How the labour productivity in kg of yield changes to labour cost incurred for cultivating the crops is the fourth dimension of labour productivity that we have estimated in this study. This is estimated by dividing the yield (kg/ha) of crop with that of the labour cost incurred for cultivating the crop. The objective of this estimate is to see whether the labour cost incurred for the crops has any role in augmenting the labour productivity. Here, two possibilities are possible. If the yield of crop increases at a rate more than the rate at which the per hectare labour cost increases, then the labour productivity in kg of yield would increase for every rupee spent on labour. Conversely, when the labour cost increases more than the rate at which the rate of yield is increasing, then the labour productivity is expected to decline. As mentioned earlier, the labour cost has increased at a faster rate since the beginning of 2000s and accentuated further after the introduction of MGNREGS, the evidence of which can be seen from the price policy reports published by the Commission for Agricultural Costs and Prices (see, Gulati, *et al.*, 2013). With this background, we have analysed the results of labour productivity.

Table 5 presents the values of labour productivity in kg per rupee of labour cost for both irrigated and rainfed crops cultivated in different states. Similar to the labour productivity estimated earlier using value of output with the total labour cost (VOP/HLC), the labour productivity in kg has either not increased much or declined between period-I and period-II for both irrigated and rainfed crops. During period-I, the labour productivity ranges from 0.52 kg to 6.09 kg for irrigated crops, whereas the same ranges only from 0.14 kg to 0.23 kg for rainfed crops. But, during period-II,

TABLE 5. LABOUR PRODUCTIVITY - VOLUME OF YIELD PER UNIT OF WAGE COST

	Crops (1)	State (2)	Period – I (1975-76 to 1990-91)			Period – II (2000-01 to 2016-17)			All Period (1975-76 to 2016-17)		
			Average (kg) (3)	CV (4)	Growth Rate (5)	Average (kg) (6)	CV (7)	Growth Rate (8)	Average (kg) (9)	CV (10)	Growth Rate (11)
Irrigated crop	Paddy	Andhra Pradesh	0.52	17.61	-1.83 ^c	0.40	9.27	-0.34 ^{ns}	0.46	19.89	-1.15 ^a
		Punjab	0.73	14.23	2.38 ^b	0.77	10.22	-0.40 ^{ns}	0.75	11.62	0.14 ^{ns}
	Wheat	Punjab	0.54	17.90	2.36 ^a	0.70	10.15	0.39 ^{ns}	0.63	18.17	1.15 ^a
		Haryana	0.52	29.24	4.58 ^a	0.54	16.18	-1.48 ^a	0.53	21.90	0.27 ^{ns}
	Sugarcane	Maharashtra	6.09	19.04	-2.79 ^c	3.55	19.62	-2.13 ^a	4.49	33.93	-2.67 ^a
		Uttar Pradesh	5.99	19.78	0.61 ^{ns}	4.49	13.36	-0.94 ^a	5.06	22.30	-1.16 ^a
	Tur	Madhya Pradesh	0.21	23.78	4.11 ^{ns}	0.16	20.95	-0.84 ^{ns}	0.17	26.28	-1.46 ^a
Rainfed crops	Groundnut	Uttar Pradesh	0.23	25.94	-8.23 ^c	0.17	32.09	-4.45 ^a	0.18	33.27	-3.34 ^a
		Andhra Pradesh	0.19	13.42	-0.29 ^{ns}	0.16	58.11	-2.29 ^a	0.17	48.22	-1.70 ^a
	Cotton	Gujarat	0.21	35.83	3.61 ^{ns}	0.15	25.50	-0.49 ^{ns}	0.17	34.43	0.62 ^{ns}
		Karnataka	0.20	21.68	-0.90 ^{ns}	0.13	21.28	1.19 ^c	0.15	32.31	-1.62 ^a
			Maharashtra	0.14	22.06	-2.54 ^a	0.10	12.84	0.72 ^c	0.11	23.13

Source and Notes: Same as in Table 2.

the same ranges from 0.40 kg to 4.49 kg for irrigated crops and from 0.10 kg to 0.17 kg for rainfed crops. These results clearly show that the yield of crop generated from every rupee of cost incurred on the labour input has declined in the recent years. This means that the rate of increase in labour cost is higher than the rate of increase in yield of crops in both irrigated and rainfed crops. Interestingly, this has happened even in sugarcane crop which is often treated as high value commercial crop in India; the average labour productivity of sugarcane of the two selected states declined from 6.04 kg in period-I to 4.02 kg in period-II (see, Figure 3). Despite decline in labour productivity in period-II over its level in period-I, it is still found to be much higher among the irrigated crops in all the states as compared to rainfed crops. One thing that clearly comes out from this analysis is that the increased cost of labour appears to have dampened the labour productivity in both irrigated and rainfed crops.

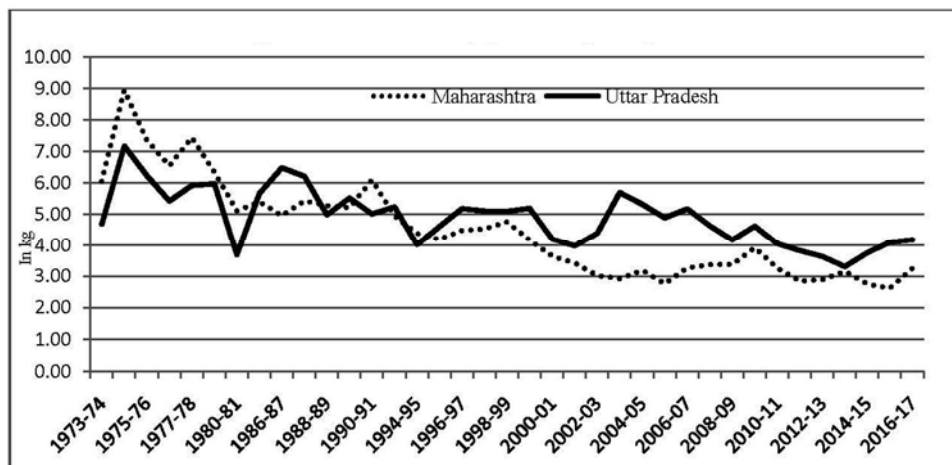


Figure 3. Labour Productivity (Yield/HLC) in Sugarcane.

IV

CONCLUSIONS

The foregoing analyses clearly indicate that the farm labour productivity estimated under four different dimensions are not the same among the irrigated and rainfed crops cultivated in selected 12 states. This was an expected result but what is intriguing is that this difference is changing over years and also when one opts for fine measurement of labour productivity. Despite variations between the crops and within the crop, the labour productivity is found to be higher among the irrigated crops as compared to the rainfed crops in both period-I (1975-76 to 1990-91) and period-II (2000-01 to 2016-17). The labour productivity increases substantially when the estimates are made using labour man-hours as denominator instead of total labour cost incurred for cultivating the crops. That is, the labour productivity both in terms

of value of output (Rs./ha) and yield (kg/ha) increases from every labour man-hour used for cultivating the selected crops. But, this picture changes completely when the estimates are made using the total labour cost (Rs./ha) incurred for cultivating the crops as denominator. The average labour productivity either declines or does not increase appreciably in any of the irrigated and rainfed crops when labour cost spent for the crops increases. It appears that the labour productivity is getting dampened because of slow growth in value of crop output as compared to the increasing rate of labour cost required for cultivating different crops. This means that along with the improvement in production process, there is also need to improve the system that can help increasing the value of crop output. Fixing the minimum support prices in consonance with the cost of cultivation for different crops, timely procurement of crops by state agencies and reducing the marketing expenditures of agricultural commodities will help in augmenting the value of crop output that will help both the farmers and the farm labourers.

The composition of labour used for cultivating different crops has changed considerably over the period. The use of machine labour for carrying out different operations in farming has been increasing at a faster rate. This is particularly more so in the irrigated areas where farming is practiced intensively. This study has not considered the cost of machine labour used for cultivating the selected crops. Given the fast increase mechanical devices, there are possibilities that the labour productivity estimated in this study under four different dimensions might undergo change. But that will unmask the usual errors in computing labour productivity and probably the difference between the two regions may widen as machine labour capital cost may not be spread over the life of the machine. Therefore, a well constructed econometric analysis needs to be carried out by incorporating the machine labour cost to get more solid answers about the farm labour productivity. Field level studies covering the various irrigated and rainfed crops also need to be carried out to assess the real picture of farm labour productivity as CCS data used in this study has certain limitations.

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