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# Pattern and trend in labour use in Indian agriculture: An analysis across major crops and states

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**ABSTRACT**

The technological change in agriculture has made significant impacts on labour absorption, notably since green revolution. In this context the present study analyses the pattern and trend in labour absorption across major states and crops during the period of mid-1970s to 2010. The entire period of analysis has been sub-divided into two, upto mid-90s as first period and post-mid 90s till 2010 as the second period, broadly corresponding to the period of green revolution and market reforms, respectively. The analysis was carried out for rice and wheat, two major food crops and cotton and sugarcane, two major commercial crops. The results indicated that at national level, there is wide variation in the trend in labour absorption among the four crops under study: while a continuous decline has been observed in the case of wheat during the entire period, it has been continuously rising in the case of cotton. On the other hand, paddy and sugarcane depicted varying trends over the time- increasing labour absorption up to mid-1990s, but declining thereafter. This trend at national level corresponds to the spread of technological changes in agriculture.

There was wide variation in the composition of human labour and machine labour use. The share of human labour in total cost of cultivation registered significant increase between TE 1975-76 and TE 1995-96 in most cases and a mixed picture emerged thereafter. Among the states, the highest share of human labour in total cost of cultivation of paddy was observed in Assam and West Bengal at about 42% each, whereas it was the lowest in Punjab at about 18 per cent. The penetration of mechanization in cultivation is the lowest in case of sugarcane and the highest for wheat. During the first phase, labour productivity increased along with increase in labour absorption in most cases. In the latter period, i.e. after mid-1990s, per hectare labour use declined in majority of the cases, while there was increase in per hectare labour use in a few cases like paddy in West Bengal, and cotton in Gujarat and Punjab. Increase in labour productivity during the last 15 years has been much higher than the decline in use of labour per unit of area. The net impact of this is increase in labour earning in crop production in all the crops and everywhere.

The employment elasticity with respect to yield has remained positive for paddy, cotton and sugarcane in the first phase in all states except Punjab. In the second phase, growth in crop productivity was associated with reduced use of labour in most cases with rapid decline in labour use in some cases like in Punjab and Andhra Pradesh. In the context of declining yield for many crops and regions, the study calls for developing non-farm employment avenues along with deepening of technical change. This would cushion the negative implication of labour displacement, while increasing the labour productivity in agriculture.

**Keywords**: Labour use, labour productivity, factor share, employment elasticity, agriculture, green revolution.

Labour use in agriculture has been subjected to intense research and debate in India in the context of green revolution. An important reason for this is the interest in impact of technological change on agricultural labour in an economy characterized by abundance of labour supply. Another reason is the very slow shift in labour force out of agriculture, despite the sharp reduction in the share of agriculture in national income. Factors like slow development of non-farm sector, marginalization of holdings and an increasing number of cultivators becoming agricultural laborers are aggravating the situation. Further, transmission of global agricultural prices to domestic economy due to trade liberalization in agricultural sector puts the agricultural labour class, particularly in areas affected by imports, in a

precarious situation. In these circumstances there was increasing demand for safety net programmes for agricultural laborers. The launching of MGNREG scheme has been a response towards this. While the programme is believed to have affected an improvement in the livelihood security of a significant number of rural labour force, the adverse effect of this programme on agricultural labour availability, notably during the peak agricultural season is also emerging as an issue (Chand and Srivastava 2014). However, the issues related to agricultural labour differ across regions and across production activities or crops. In this context, this paper dissects the trends in the pattern of labour use across major crops and regions, and tries to explain the possible reasons thereof.

The paper is organized into seven sections. Following the above introduction in Section I, Section II briefly reviews the literature on labour use in Indian agriculture. While doing so, we touch upon some of the major debates that happened in Indian agriculture since green revolution. The data and methods used in the study are described in Section III, while Section IV discusses the trend in labour absorption in four major crops namely wheat, paddy, cotton and sugarcane. Section V examines the trend in labour productivity and factor share across crops and states. A detailed examination of the trend in the responsiveness of the yield with respect to employment growth has been discussed in Section VI. The last section concludes the study by highlighting major policy consideartions.

**Past Studies on Labour Absorption in Indian Agriculture**

Kuznets (1965) and Kaldor (1967) postulated that in developing countries, the long term economic growth will be characterized by a fall in the share of agriculture in national income and workforce over time, with an increase in the labour productivity in agriculture. Such a hypothesis is rooted in the presumption of the technology led yield enhancement and faster development of non-farm sector which could absorb large number of surplus laborers from agriculture. This indicates that the extent of labour absorption in agriculture depends on the pace of technological development and growth in the non-farm sector, notably in the secondary sector, which can accommodate large number of skilled and semi/un-skilled labourers with slight improvement in the skills. However, employment elasticity with respect to output growth in the industrial sector has not been much encouraging. It was 0.254 in short term and 0.799 in long term- during 1960s and 1970s (Goldar,1987). The situation has worsened during the later periods which accorded larger emphasis on tertiary sector. The demand from this sector has been dominantly for skilled labourers. The failure of the non-farm sector to absorb laborers from agriculture is a compelling factor for development of the land-augmenting and yield improving technical changes in agriculture, as has been suggested by Ishikawa (1981).

There are various studies both at micro and macro levels that provide information regarding status of employment generation and the factors that explain the variations therein. By reviewing some of the studies, Acharya (1991) indicates that there are mainly two approaches in explaining the labour use in agriculture- institutions and technologies. For example, Ishikawa (1981) highlighted the role of technology and institutions in determining labour absorption. He distinguished between labour saving and land augmenting technologies, and argued that in the initial stages of development, countries embrace land augmenting technologies like irrigation which necessarily increase the labour absorption per unit of land; whereas in the later and advanced stage of development the labour saving technological changes would gain prominence. Among the major institutional factors, he highlighted the role of farm size as a major determinant of labour absorption. Bardhan (1978) by using primary survey data from villages of West Bengal also highlighted the role of technology and institutions in determining the labour absorption. The major technology factors were irrigation, fertilizers and high yielding varieties whereas the major institutional factors were farm size, wage rate, operation of land markets and bargaining power of the farmers. Vaidyanathan (1978) suggested that labour inputs per hectare has risen at a much slower rate than output per hectare and that in some cases have actually declined. He attributed the inter-regional variation in labour absorption to (i) bio-chemical technology and soil moisture, which have the intrinsic capacity to raise land yields, (ii) indirect contribution of the physical (including human)

energy inputs through bio-technology application, and (iii) land yields and relative prices of different inputs. In his study in 1986, he maintained that while technological factors were important, difference in agro-climatic environment is a significant factor that influence the productivity of land and hence intensity of labour use. The role of the agro-climate emerges an important factor, as the farming method in each agro-climatic locality has been evolved over a period of time and has advantageously used the labour resources. For example, the traditional high rainfall areas which are historically densely populated also grow paddy in which higher labour units are deployed. On the other hand, semi-arid zones, which are historically sparsely populated also, grow millets which require less water and crop husbandry, and thereby deploy less labour.

Bhalla (1987) observed that the prospects for increasing labour absorption in agriculture seemed to be receding, as the technological development in Indian agriculture appeared to be labour saving. Sidhu and Byerlee (1991) observed that in Punjab machine labour has rapidly substituted human and animal labour over the period of time. Dramatic changes have occurred in animal labor after tractors largely replaced the use of bullocks in farm operations. The labor input per hectare of wheat has actually fallen by 1.7% annually in the post-green revolution period. Chand *et. al.* (1985) noted that as a result of modernization of Punjab agriculture, the employment pattern has changed considerably. By analyzing the case of wheat in India, Raghavan (2008) argues that there has been a steep decline in the labour hours applied in its cultivation, as also stagnation in casual wages. The decline was pervasive in all major wheat growing states though it was considerably steeper in Punjab, Haryana and Uttar Pradesh. Consistent with this, bullock labour use has almost disappeared from several parts of these states. Further, the estimated average wage cost accounts for the largest segment of all items of operational costs. In a comprehensive study, Sen and Bhatia (2004) found that labour use in agriculture appeared to have either declined or remained constant in per hectare terms in the case of most states and crops. Decline in labour use has occurred in the case of most of the cereals, coarse cereals, pulses and oilseeds. It was also observed that as on 2002, states like Punjab, Haryana and Rajasthan registered lowest labour absorption, whereas, West Bengal and Orissa absorbed the highest. Overall, 1990s saw considerable improvement in labor productivity even as rate of diffusion of yield raising technology slowed and the growth of yield per unit of land decelerated sharply. The realm of agricultural labour is also replete with studies based on micro-level analyses. It is generally observed that the variants of the labour use in agriculture are cropping intensity, cropping pattern, application of bio-technology, mechanization, irrigation, land size distribution and a number of other institutional factors.

## Data and Methods

The data sets used in this paper are drawn from various "Reports of The Commission for Agricultural Costs and Prices, for the Crops Sown During Various Years", Department of Agriculture and Co-operation, Ministry of Agriculture. The present study uses data for four major crops namely paddy, wheat, cotton and sugarcane for the period 1973-74 to 2009-10. By selection of these crops, we are intending to include two major food crops and commercial crops each. It is to be mentioned that as on 2009-10, these four crops together cover around 45% of the gross cropped area, at national level. It needs to mention that these data are the most comprehensive ones on crop wise labour use in different states of India, in their expanse and coverage. In order to depict the trend with minimal effects of the fluctuations, the available data is presented in the form of triennium averages for three points of time viz. 1973-74 to 1975-76, 1993-94 to 1995-96 and 2007-08 to 2009-10. The first triennium marks beginning of green revolution technology in Indian agriculture which continues for about two decades. The years 1993-94 to 1995-96 marks the beginning of an era of market led growth and liberalization and almost an end of the first phase of cereal dominated green revolution technology. The national level figures were arrived at by weighted average method, considering all the major growing states of the crops under study. The states were selected based on the considerations of the highest area under the crops and the regional inclusion.

## Crop Wise Trend In Labour Absorption

The trend in labour absorption across the crops under consideration at national and state level is

provided in Table 1. At this juncture, it is worthwhile to point out that the usual practices of representing the labour in agriculture in man hours by considering eight labour hours as one labour day, across states may not be suitable while describing the data across states, as the rural labour contracts vary across states. Therefore, we consider it fair to continue to represent the labour in terms of labour hours rather than converting it into labour days. Out of the four crops under consideration, all crops other than wheat are generally considered as labour intensive crops (Bhalla, 1987). At national level, there is wide variation in the trend in labour absorption among the four crops under study: while a continuous decline has been observed in the case of wheat during the entire period under the study, it has been continuously rising in the case of cotton. On the other hand, paddy and sugarcane depicted varying trends over the time- increasing labour absorption up to mid-1990s, but declining thereafter. This trend at national level corresponds to the spread of technological changes in agriculture.

**Table 1: Trend in pattern of labour use across crops at all India level and in selected states, 1973 to 2010, unit: hours/ hectare**

| Crop | State | 1973/ 76 | 1993/ 96 | 2007/ 10 |
|---|---|---|---|---|
| Paddy | Andhra Pradesh | 964.2 | 1154.0 | 824.4 |
| | Assam | 672.1 | 698.3 | 699.6 |
| | Bihar | 782.4 | na | 778.3 |
| | Punjab | 961.4 | 545.5 | 419.7 |
| | West Bengal | 825.8 | 1115.3 | 1233.3 |
| | All India | 861.2 | 959.6 | 859.5 |
| Wheat | Madhya Pradesh | 519.1 | 373.3 | 315.9 |
| | Punjab | 587.1 | 336.6 | 183.6 |
| | Uttar Pradesh | 804.6 | 523.4 | 481.8 |
| | All India | 686.1 | 452.9 | 392.9 |
| Cotton | Gujarat | 529.7 | 762.9 | 1152.9 |
| | Madhya Pradesh | na | 754.6 | 595.1 |
| | Maharashtra | 720.9 | 888.4 | 843.6 |
| | Punjab | 754.9 | 728.2 | 745.3 |
| | Rajasthan | na | 522.0 | 653.3 |
| | All India | 592.5 | 744.6 | 833.5 |
| Sugarcane | Maharashtra | 2864.8 | 2103.4 | 1921.1 |
| | Tamil Nadu | na | 2664.5 | 2348.4 |
| | Uttar Pradesh | 1201.6 | 1319.4 | 1276.6 |
| | All India | 1609.9 | 1690.8 | 1602.5 |

State level data reveal large variations in labour use. During TE 2009-10, labour use in paddy varied from as low as 400 hours per hectare in Punjab to as high as 1233 hours in West Bengal, while in the case of wheat, it ranged between 184 (Punjab) to 482 hours (Uttar Pradesh). The trend in West Bengal is particularly noticeable as this is the major state that registered an increase in labour use. In case of wheat, the highest extent of labour displacement has been noted in Punjab (about 69%). Traditionally, the employment absorption in agriculture has been dominantly accounted for by food crops, notably cereals. But owing to the nature of technological change and slower growth of gross cropped area under cereals, there might be a shift in the profile of employment absorption towards non-cereal crops, notably cash crops and vegetables. Such a trend can be noted from cotton, which has registered an increase in labour intensity by 41% during the period under consideration. For this crop, the labour intensity ranged between 595 hours in Madhya Pradesh to 1153 in Gujarat in the recent period. The increase in labour intensity in cotton exhibited wide inter-state variations as well. While Gujarat registered an increase by 118%, Punjab posted a mild decline. The technological changes are quite sharp and distinct in cotton, as it has witnessed successive introductions of hybrids and Bt technology over years, with distinct effect on labour intensity, predominantly towards increasing labour absorption. Traditionally, it has been noted that in the face of technology change, the demand for labour absorption would increase for certain operations like harvesting.

In the case of sugarcane, the labour absorption at national level remained almost static since early 1970s, again with large inter-state variations. During TE 2009-10, the labour absorption ranged between 2350 labour hours in Tamil Nadu to about half of that in Uttar Pradesh. One notable case is of Maharashtra, which registered a decline by about 33% over a period of 25 years. This point to the influence of agro-climatic factors and technological change on labour absorption pattern. Even if, the technology is labour saving, as long as the cropping pattern shift is in favour of labour intensive crops,

with a substantial increase in area under them, the net effect may not be labour displacing. However, Bhalla (1987), while writing on the trend in labour absorption in Indian agriculture argues that it unlikely that the technological change would continue without affecting the net absorption of labour negatively, as increases in gross cropped area have been heavily contingent on public and private investment in irrigation. Yet another dimension to be factored in is the diversification of agriculture. Indian agriculture is fast diversifying towards high value crops (Joshi et al, 2004), and markets have been main driver of the change. It is noteworthy that vegetable crops like potato, onion, cabbage, cauliflower and tomato absorb more labour per unit of area under cultivation than the cereal crops like rice, wheat, sorghum and pearl millet. Therefore, the strategy to increase the labour absorption lies in promoting high value-labour intensive crops, where, the factor share of labour in value of output is generally lower compared to cereal crops.

The Table 2 shows significant inter-crop variation in the nature of labour absorption. This can be best brought out by comparing the trend in the labour absorption with respect to a crop which has undergone sharp technology changes over years. Since wheat has undergone such a change over years, we have estimated the ratio of labour intensity of all the other crops with respect to that in wheat. The Table 2 clearly points to an increase in the relative intensity of labour absorption for all the crops, with respect to wheat. The most striking one is that of cotton. It implies that the labour displacing technical change has not occurred to that extent in other crops as found in case of wheat. While in the case of wheat mechanization has reached almost all farm operations from sowing to threshing this has not been the case in other crops. Paddy continues to be threshed manually. Same is the case of cotton picking and sugarcane harvesting.

**Table 2. The ratio of labour absorption in various crops with respect to wheat**

| Crop | 1973/76 | 1993/96 | 2007/10 |
|---|---|---|---|
| Paddy | 1.26 | 2.12 | 2.19 |
| Cotton | 0.86 | 1.64 | 2.12 |
| Sugarcane | 2.35 | 3.73 | 4.08 |

The labour impacts of technological change in agriculture can be incisively captured by analyzing the trend in the labour intensity per unit of output over years. It is observed that there has been a decline in the labour intensity over years. At national level, during the entire period under consideration, the labour use per unit of output declined by 44% in paddy and cotton and 66% in wheat and19% in sugarcane production.

**Human labour Use in relation to bullock and machine labour**

Use of bullock and machines has a significant bearing on use of human labour. Mechanization is considered as a major labour displacing technological change whereas irrigation is considered as a labour augmenting technical change. Notwithstanding the requirement for skilled labour operating the machines, the relationship between human labour and machine labour is largely negative. The share of human, machine and bullock labour in total cost of production is illustrated in Table 3. At all India level, the human labour accounts for 34% of total cost in case of paddy, 31% in case of cotton, 29% in case of sugarcane and 17% in case of wheat. The share of human labour in total cost of cultivation registered significant increase between TE 1975-76 and TE 1995-96 in most cases and a mixed picture emerged thereafter. Among the states, the highest share of human labour in total cost of cultivation of paddy was observed in Assam and West Bengal at about 42% each, whereas it was the lowest in Punjab at about 18 per cent.

It is also noteworthy that the share of machine labour in cost of cultivation has increased for all the crops. The penetration of mechanization in cultivation is the lowest in case of sugarcane and the highest for wheat. For wheat, at national level, the share of machines in total cost increased from 3% in mid-1970s to 13% in recent years, a trend shared across all the states, most prominently in Punjab and Uttar Pradesh. Share of bullock labour in cost of cultivation shows sharp decline except in cotton in some states after mid 1990s. Mechanisation is replacing bullock labour much more than human labour. Overall, it is noted that human labour continues to be the most important component of cost of crop production despite rise in mechanization, whereas, the use of bullock labour is gradually declining.

**Table 3. Share of human, animal and machine labour in total cost of cultivation, across crops, across states, 1973-2010**

| Crop | State | Share of human labour in total cost | | | Share of machine labour in total cost | | | Share of bullock labour in total cost | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1973/76 | 1993/96 | 2007/ 10 | 1973/76 | 1993/ 96 | 2007/ 10 | 1973/76 | 1993/96 | 2007/10 |
| Paddy | Andhra Pradesh | 21.1 | 33.6 | 32.7 | 1.1 | 5.1 | 9.1 | 6.42 | 3.00 | 1.50 |
| | Assam | 33.9 | 42.9 | 41.7 | 0.0 | 0.5 | 2.9 | 15.58 | 15.14 | 15.62 |
| | Bihar | 24.2 | na | 39.1 | 0.0 | na | 8.5 | 18.90 | na | 3.49 |
| | Punjab | 30.5 | 20.2 | 18.3 | 1.5 | 7.2 | 10.0 | 7.32 | 0.47 | 0.36 |
| | West Bengal | 28.0 | 38.6 | 42.1 | 0.0 | 2.1 | 3.5 | 21.36 | 7.06 | 5.54 |
| | All India | 26.4 | 34.1 | 34.3 | 0.3 | 3.0 | 6.8 | 14.28 | 7.26 | 5.56 |
| Wheat | Madhya Pradesh | 19.8 | 17.2 | 15.8 | 1.7 | 7.8 | 11.9 | 12.52 | 3.90 | 2.94 |
| | Punjab | 18.8 | 17.3 | 10.7 | 5.9 | 9.2 | 15.0 | 8.79 | 0.21 | 0.22 |
| | Uttar Pradesh | 17.4 | 19.2 | 17.8 | 2.6 | 9.6 | 13.5 | 17.10 | 1.77 | 2.20 |
| | All India | 18.6 | 19.1 | 17.4 | 3.3 | 8.9 | 13.0 | 13.02 | 2.02 | 2.16 |
| Cotton | Gujarat | 20.6 | 25.8 | 30.8 | 1.9 | 3.3 | 5.0 | 15.20 | 7.60 | 5.19 |
| | Madhya Pradesh | na | 28.7 | 25.2 | na | 3.2 | 2.2 | na | 4.50 | 9.38 |
| | Maharashtra | 25.8 | 27.6 | 25.5 | 0.0 | 1.7 | 3.2 | 12.32 | 11.76 | 14.38 |
| | Punjab | 31.6 | 25.8 | 26.6 | 4.5 | 4.7 | 8.2 | 8.03 | 0.51 | 0.39 |
| | Rajasthan | na | 28.7 | 36.2 | na | 3.2 | 5.9 | Na | 3.85 | 0.61 |
| | All India | 21.7 | 27.4 | 31.3 | 1.9 | 2.8 | 5.7 | 10.22 | 4.18 | 3.60 |
| Sugar-cane | Maharashtra | 21.1 | 30.7 | 24.2 | 0.6 | 3.0 | 7.1 | 4.26 | 4.93 | 3.55 |
| | Tamil Nadu | na | 39.2 | 21.2 | na | 1.9 | 1.0 | na | 0.44 | 0.40 |
| | Uttar Pradesh | na | 28.8 | 27.4 | Na | 1.5 | 2.0 | 9.68 | 3.27 | 1.99 |
| | All India | 21.1 | 30.0 | 28.7 | 0.6 | 2.0 | 3.0 | 1.51 | 3.04 | 2.95 |

**Trend in Labour Productivity**

Theoretically, the extent of agricultural labour use and wage rate are closely related with the land and labour productivity in agriculture. With the introduction of the labour saving technological change and increase in productivity, the returns to labour would increase, in physical terms, while the increase in labour productivity in economic terms would depend on the price of the output, as well. The nature of technological change and its effect on agricultural labour productivity in India has not received the attention it warrants. Here, we analyze the behavior of labour productivity in agriculture for different crops over time. We first present the change in labour productivity measured in physical terms per hour of total labour application in agriculture (Table 4) and then discuss factor share of labour i.e. share of wage bill in value of output.

Labour productivity in physical terms can increase due to mechanization that results in lower use of labour use and to due to technological change which increases productivity or output per unit of resources. Both these changes have been experienced in Indian agriculture. Changes in labour productivity presented in Table 4 below can be appreciated better if they are seen in relation to level of labour absorption presented in Table 1. In the first phase of green revolution, between TE 1975-76 and TE 1995-96 in our study, labour productivity increased along with increase in labour absorption in most cases. In Andhra Pradesh labour use in paddy in the said period increased from 964 hours per hectare to 1154 hours per hectare while productivity per hour of labour time increased from 2.5 kg to 4.0 kg. Similar trends are observed in Assam and West Bengal. In the case of Punjab labour absorption declined by about 40% but productivity increased by about 3 times, again showing impact of increase in productivity brought by high yielding varieties.

**Table 4: Crop wise labour productivity in different states of India**

| Crop | State | Labour Productivity (Kg of output / hr) | | | Factor share of labour% | | |
|---|---|---|---|---|---|---|---|
| | | 1973/76 | 1993/96 | 2007/ 10 | 1973/76 | 1993/96 | 2007/ 10 |
| Paddy | Andhra Pradesh | 2.5 | 4.0 | 6.7 | 17.9 | 30.9 | 27.2 |
| | Assam | 2.4 | 3.0 | 3.7 | 24.1 | 40.4 | 41.9 |
| | Bihar | 2.1 | Na | 3.2 | 16.8 | Na | 32.7 |
| | Punjab | 3.2 | 9.3 | 15.9 | 35.8 | 16.4 | 12.2 |
| | West Bengal | 2.2 | 2.8 | 3.1 | 22.5 | 32.5 | 40.8 |
| | All India | 2.3 | 3.8 | 5.1 | 20.9 | 29.6 | 30.2 |
| Wheat | Madhya Pradesh | 2.1 | 5.0 | 7.7 | 15.5 | 15.1 | 11.1 |
| | Punjab | 4.3 | 11.2 | 23.1 | 15.3 | 15.0 | 7.6 |
| | Uttar Pradesh | 2.5 | 5.6 | 7.1 | 13.6 | 16.2 | 13.3 |
| | All India | 2.8 | 6.8 | 9.8 | 14.9 | 16.2 | 12.6 |
| Cotton | Gujarat | 0.9 | 1.2 | 1.6 | 17.7 | 16.4 | 21.7 |
| | Madhya Pradesh | Na | 0.7 | 2.4 | na | 24.1 | 19.0 |
| | Maharashtra | 0.5 | 0.8 | 1.5 | 21.1 | 19.6 | 23.2 |
| | Punjab | 1.2 | 1.6 | 3.0 | 27.2 | 20.4 | 20.5 |
| | Rajasthan | Na | 2.4 | 2.5 | Na | 14.1 | 22.2 |
| | All India | 0.8 | 1.4 | 2.3 | 18.3 | 18.8 | 24.1 |
| Sugarcane | Maharashtra | 26.9 | 39.8 | 45.7 | 12.0 | 23.7 | 17.8 |
| | Tamil Nadu | Na | 43.8 | 43.8 | na | 22.6 | 33.5 |
| | Uttar Pradesh | 29.7 | 35.8 | 38.8 | 13.0 | 19.3 | 15.2 |
| | All India | 24.2 | 39.2 | 41.8 | 10.7 | 20.3 | 18.4 |

In case of cotton increase in labour productivity happened along with higher employment. Per hectare labour use in wheat declined in all the states by about one third but increase in productivity has been more than 200%. This shows that major source of increase in labour productivity of wheat has been technological change on output side. In the later period, i.e. after mid 1990s, per hectare labour use followed decline in majority of the cases while there was increase in per hectare labour use in a few cases like paddy in West Bengal, and cotton in Gujarat and Punjab. Increase in labour productivity during the last 15 years has been much higher than the decline in use of labour per unit of area. The net impact of this is increase in labour earning in crop production in all the crops and everywhere.

The table paints a picture of raise in the labour productivity at national level for all the crops, in physical terms, over a long period of time (notwithstanding some variations in between). Though the physical productivities of various crops are not comparable as such, the extent of improvement in relative terms can be a good indicator of improvement in labour productivity. At national level, the highest improvement in labour productivity during the overall period under consideration was observed in wheat (250%), followed by cotton (187%), paddy (122%) and sugarcane (73%). However, these changes have to be reflected against the trend in labour intensity per hectare. In that context, it is worthwhile to note that the highest labour productivity growth in case of wheat has come at the cost of labour displacement (to the tune of 43%). In case of cotton, the labour productivity improvement has come with an increase in the labour intensity by about 41 per cent. This indicates that the improvement in labour productivity is associated with varying trends in labour absorption- increasing labour intensity in case of cotton, stagnant in case of paddy and sugarcane and declining labour absorption for wheat.

**Trend in the factor share of labour in value of output**

The trend in the factor share of labour in value of outputs provided in Table 4 reveals that the technical change is also associated with percolation of significant benefits to labour. However, it is worthwhile to note that the period between 1993-96 and 2007-10 is characterized with a dip or no significant improvement in the factor shares, except for cotton. For example, the factor share declined from 16.2 to 12.6% in case of wheat; and from 20.3% to 18.4 in case of sugarcane. In case of paddy, the factor share registered a mild improvement at national level.

Changes in factor share depict two types of patterns. One, crops and states where labour productivity improved due to technological change in output, leading to higher employment of labour. Factor share of labour in output in this pattern witnessed sizable increase. Examples are paddy, sugarcane and cotton in all states between TE 1975-76 and TE 1995-96. Second pattern is where labour productivity increased largely due to mechanization which resulted in displacement of labour. Labour earnings in this type of pattern increase at a slower pace than increase in value of output leading to fall in share of labour in output. Example is wheat in second phase of green revolution after mid 1990s.

Overall, it can be concluded that the technological changes and associated productivity improvement has been able to arrogate increasing share of the output to the laborers over a long term, except for wheat. The same trend continued in recent years in crops like cotton which witnessed significant increase in productivity a la adoption of Bt cotton technology.

**Trend in Elasticity of Employment with Respect to Yield**

Elasticity of employment with respect to the yield growth is a valuable parameter that could be used to examine the nature of the labour absorption associated with technical change. Three sets of elasticities corresponding to different periods are presented in Table 5. These include two sets of short term elasticities covering the periods from early 1970s to early 1990s and from 1995-96 till 2009-10 and a set of long term elasticities representing total period from 1973-74 to 2009-10. Elasticities in the first period represent effect of rapid technological change and those in the second period represent effect of mechanization, market forces and slowdown in technological change except in cotton. Sign of elasticities are on expected line. The employment elasticity with respect to yield has remained positive for paddy, cotton and sugarcane in the first phase in all states except Punjab. In the second phase, growth in crop productivity was associated with reduced use of labour in most cases with rapid decline in labour use in some cases like in Punjab and Andhra Pradesh.

**Table 5. Employment elasticity wrt output growth, across crops and states in different phases of agriculture progress**

| Crop | State | Short run elasticity | | Long run elasticity |
|---|---|---|---|---|
| | | Green revolution phase TE 1975-76 to TE 1995-96 | Post green revolution phase TE 1995-96 to TE 2009-10 | TE 1975-76 to TE 2009-10 |
| Paddy | Andhra Pradesh | 0.28 | -1.88 | -0.19 |
| | Assam | 0.14 | 0.01 | 0.08 |
| | Bihar | | | -0.02 |
| | Punjab | -1.14 | -0.93 | -1.07 |
| | West Bengal | 0.55 | 0.47 | 0.53 |
| Wheat | Madhya Pradesh | -0.61 | -0.64 | -0.62 |
| | Punjab | -1.32 | -4.93 | -2.14 |
| | Uttar Pradesh | -1.09 | -0.59 | -0.96 |
| Cotton | Gujarat | 0.50 | 0.63 | 0.56 |
| | Madhya Pradesh | | -0.23 | |
| | Maharashtra | 0.34 | -0.08 | 0.13 |
| | Punjab | -0.18 | 0.03 | -0.02 |
| | Rajasthan | | 0.91 | |
| Sugar-cane | Maharashtra | -3.67 | -1.91 | -3.03 |
| | Tamil Nadu | | 1.00 | |
| | Uttar Pradesh | 0.33 | -0.73 | 0.19 |

In the long run, growth in agricultural productivity must result in release of labour for non agricultural employment. This is happening in almost all the states with noticeable technological change and growth in

crop productivity. However, there were significant regional variations. Some states like West Bengal and Assam continues to register increase in labour absorption in agriculture mainly because of slow technological change associated with low growth in crop productivity. Further the effect of technological change on labour has been significantly affected by the local settings in terms of agro climates, factor endowments, mechanization and growth of non-farm opportunities.

## Conclusion

Our study shows that labour absorption in Indian agriculture is closely following Ishikawa's (1981) proposition of labour augmenting technological change that characterizes the initial stages of development which would give way to introduction of labour saving technologies during later stages, resulting in gradual replacement of the agricultural labour. It has been found that, on per hectare basis, the labour absorption has been declining continuously only in case of wheat from the initial years of 1970s. As far as paddy and sugarcane are concerned the labour absorption has been increasing till mid-1990s, and a decline has been noted after that. For cotton, the labour absorption has increased, notably during 2000s, mainly because of the Bt technology, that improved the yields. There were significant inter-state and inter-crop differences. Such differences can be attributed to the difference in the spread of technology to a large extent. Though it appears that the trend corresponds with the hypothesis of displacement of labour in agriculture with progression of technology, it cannot be generalized, as the technology is not always labour displacing, as has been proved in case of cotton. Moreover, the technical change, that have been proved labour displacing in states like Punjab, for crops like paddy, has been labour absorbing along with yield enhancement in the Eastern Indian states like West Bengal and Assam. Similarly, for cotton, while the general trend has been labour absorbing, states like Punjab and Maharashtra, displayed quite opposite trends. This leads us to believe that the impact of technical changes on the nature of labour has been towards negative side on a per hectare basis, it varied significantly depending on the local settings shaped by agro-environment and the extant nature of the labour markets. Also, the mechanization of farm operations is a significant factor in determining the extent of labour intensity. It is also noted that mechanization, as a major factor in labour displacement has been noted only in case of wheat and to a lesser extent in paddy, and is not strong other crops. But the share of wage as a component of cost of cultivation has increased for all the crops, and all the states. The study revealed significant improvement of labour productivity in physical terms over years. This has resulted in increase in factor share of labour in value of output as well.

It is worthwhile to point out that the yield growth in recent years has slowed down for the crops other than cotton in many states. This indicates that, the concept of technological change, defined as outward shift of production function, is not happening in Indian agriculture for some crops and some regions. The miracle of the biochemical technology as noted during green revolution has ceased to operate for such crops and places. Perhaps this might be the most significant factor that limits the labour absorption than any other factors like mechanization. Strong need is felt for developing the avenues for non-farm employment along with deepening of technical change in agriculture which may be eventually labour saving. This would cushion the negative implications of labour displacement while improving the labour productivity.

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