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NOTE

Transformations of labour use in Indian agriculture

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1. Introduction

It is common knowledge that the labour force in the rural areas of most developing countries is growing very rapidly; there seems little prospect of an expansion of manufacturing industries and productive services sufficient to absorb the growing labour force. It is therefore generally recognised that additional employment opportunities have to be generated from within agriculture itself.

The use of HYV technology, in addition to the fertilisers and irrigation, is considered an appropriate way of doing this. The experience of several developing countries testifies to the land-augmenting nature of such technological change (see Yudelman and others, 1971; Hayami and Ruttan, 1971; Hanumantha Rao, 1975; Ishikawa, 1978). For instance, the increase in the average labour productivity in countries like India, Japan, Taiwan and Korea is explained by expanded irrigation, increased yield per hectare and the consequent increase in cropping intensity, more than by any other factors. While the new agricultural technology (HYV technology, together with use of fertilisers, irrigation, and improved farm machinery) has significantly increased foodgrain production along with the total costs of cultivation in several developing countries, less is known about its impact on farm employment. This paper is concerned with the possible effects of the new technology on farm employment in the case of Indian agriculture.

2. Methodology and data

This paper is based on comparisons of Farm Management Survey data for different points in time where comparison is possible (e.g. FMS: Punjab (Ferozepur), 1954–57 and 1967–70; UP (Muzaffarnagar), 1954–57 and 1966–69; West Bengal (Hooghly), 1954–57 and 1970–73). The intensity of labour use per hectare of cultivated area as reported by the FMS has increased during the 1960s above that of the 1950s in all the regions referred to above. This increase may be attributed to (a) expansion of irrigation, (b) the so-called 'new technology', and (c) associated changes in the cropping pattern. In the absence of detailed information on (a), we have focussed our attention on items (b) and (c) for which increase of labour use can be worked out separately from the data of the cropping pattern.

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We have tried to isolate the changes in farm employment due to two major factors, namely 'acreage expansion' and 'new technology'. Acreage expansion refers to land augmentation by virture of increase in cropping intensity, and new technology refers to the innovations in agriculture (water-seed-fertiliser based technology, and improved farm machinery).

For each crop in each region we have computed the change in acreage as well as the change in employment during the two time periods for which data are available. Thus, for each crop, the change in employment due to acreage alone is given by: $(\Delta A)L^{50}$ where ΔA is change in acreage and L^{50} is the labour input per hectare in 1950. Similarly, change in employment due to technology alone is given by: $A^{50}(\Delta L)$ where A^{50} is the acreage in 1950 and ΔL is the change in per hectare labour input. Combining all the crops together, we can have the total change in employment due to acreage alone and that due to technology alone for each region. We have then to take separate account of the employment associated with the completely new crops i.e., crops which were grown in the 1970s or in the 1960s but not in the 1950s. We have also to take account of the effect of acreage and technology upon farm employment by computing $\Delta A \times \Delta L$, where ΔA denotes the change in acreage and ΔL denotes the change in per hectare labour input.

3. Empirical results

We shall start by taking a look at the results presented in Tables 1 and 2 for the Punjab. It is seen that, except for unirrigated or 'desi' wheat, the acreages of all the other crops have increased significantly so that total employment due to acreage change alone has also increased considerably.

The overall impact of technology alone upon farm employment is marginally positive, although for some individual crops its contribution is negative. The increased employment due to acreage alone is much higher than the increased employment due to technology alone. But the role of new crops in increasing new employment can at least partly be attributed to technology if the latter has been a key factor in their introduction, as is the case in several instances (viz., paddy, maize etc.).

The data presented in Tables 3 and 4 for the region of Uttar Pradesh show that for all individual crops technology displaces labour to a very large extent, and the higher employment associated with increases in acreage barely compensates for this displacement.

Table 1. *Cultivated area and intensity of labour input of major crops in the Punjab (Ferozepur), 1955–56 and 1968–69*

Crops	Cultivated area (in hectares)		Labour input per hectare (in days)	
	1955–56	1968–69	1955–56	1968–69
(1)	(2)	(3)	(4)	(5)
(a) Irrigated or Mexican wheat	437·40	702·24	55·24	62·20
(b) Unirrigated or Desi wheat	230·91	170·70	33·95	50·55
(c) American cotton	251·92	373·44	82·00	57·06
(d) Desi cotton	37·07	71·31	86·45	84·52
(e) Paddy	—	78·05	—	64·92
(f) Desi maize	—	87·39	—	70·13

Table 2. *Changes in employment in the Punjab (Ferozepur) between 1955–56 and 1968–69*

Crops	Change due to old and new crops	Acreage effect: $(A^{69}-A^{56})L^{56}$	Technology effect: $(L^{69}-L^{56})A^{56}$	Interaction effect: $(A^{69}-A^{56})$ $(L^{69}-L^{56})$	Total change in employment: $(A^{69}L^{69}-A^{56}L^{56})$
(1)	(2)	(3)	(4)	(5)	(6)
Old:	—				—
New:					
(a) Improved paddy	+5067·01				+5067·01
(b) Desi maize	+6128·66				+6128·66
Present both in 1956 and 1969:					
(a) Irrigated or Mexican wheat		+14568·85 (+74·26)	+3144·91 (+16·03)	+1904·20 (+9·71)	+19617·96
(b) Unirrigated or Desi wheat		−2044·13 (−258·92)	+3833·11 (+485·52)	−999·49 (−126·60)	+789·49
(c) American cotton		+9964·64 (+1530·55)	−6282·88 (−965·04)	+3030·71 (−465·51)	+651·05
(d) Desi cotton		+2960·05 (+104·88)	−71·55 (−2·54)	−66·08 (−2·34)	+2822·42
All crops	+11195·67 (+31·92)	+25449·41 (+72·55)	+623·59 (+1·78)	−2192·08 (−6·25)	+35076·59

Note: Figures in brackets indicate percentage of total change in employment.

Table 3. *Cultivated area and intensity of labour input of major crops in Uttar Pradesh (Muzaffarnagar), 1954–55 and 1968–69*

Crops	Cultivated area (in hectares)		Labour input per hectare (in days)	
	1954–55	1968–69	1954–55	1968–69
(1)	(2)	(3)	(4)	(5)
(a) Sugarcane planted	110·53	217·92	196·37	114·00
(b) Sugarcane ratoon	89·07	140·91	140·79	99·00
(c) Paddy	47·00	130·95	92·63	69·00
(d) Unirrigated or Desi wheat	79·76	280·69	76·57	54·45
(e) Irrigated or HY wheat	168·83	70·21	106·21	62·18
(f) Maize	72·04	52·83	74·10	46·14
(g) Gram	75·14	55·19	34·58	31·00
(h) Cotton	12·57	—	83·98	—
(i) Pea	—	54·35	—	27·53
(j) Gochani	—	22·32	—	55·84

Table 4. *Changes in employment in Uttar Pradesh (Muzaffarnagar) between 1954–55 and 1968–69*

Crops	Change due to old and new crops	Acreage effect: $(A^{68}-A^{55})L^{55}$	Technology effect: $(L^{68}-L^{55})A^{55}$	Interaction effect: $(A^{68}-A^{55})(L^{68}-L^{55})$	Total change in employment: $(A^{68}L^{68}-A^{55}L^{55})$
(1)	(2)	(3)	(4)	(5)	(6)
Old: Cotton	−1053·62				−1053·62
New: (a) Pea	+1496·26				+1496·26
(b) Gochani	+1246·35				+1246·35
Present both in 1955 and 1969:					
(a) Sugarcane planted		+21088·17 (+672·00)	−9104·36 (−290·12)	−8845·71 (−281·88)	+3138·10
(b) Sugarcane ratoon		+7298·55 (+517·65)	−3722·24 (−264·00)	−2166·39 (−153·65)	+1409·92
(c) Paddy		+7776·29 (+166·09)	−1110·61 (−23·72)	−1983·74 (−42·37)	+4681·94
(d) Unirrigated or Desi wheat		+15385·21 (+167·66)	−1764·29 (−19·23)	−4444·57 (−48·43)	+9176·35
(e) Irrigated or HY wheat		−10475·42 (+77·21)	−7433·59 (+54·79)	+4342·24 (−32·00)	−13566·77
(f) Maize		−1423·46 (+49·07)	−2014·24 (+69·44)	+537·11 (−18·51)	−2900·59
(g) Gram		−689·87 (+77·74)	−269·00 (+30·31)	+71·42 (−8·05)	−887·45
All crops	+1638·99 (+61·63)	+38959·47 (+1421·62)	−25418·33 (−927·51)	−12489·64 (−455·74)	+2740·49

Note: Figures in brackets indicate percentage of total change in employment.

Although recently the new crops have contributed towards greater employment, this is offset by the disappearance of other crops which were grown in the 1950s. Thus it appears that the impact of technology upon farm employment is negative in this region.

The results of our analysis with respect to West Bengal (Hooghly) present a somewhat different picture. Tables 5 and 6 show that, for two of the three major crops in this region, the cropped area has decreased. As a result, employment has decreased significantly over time owing to acreage changes; employment has also decreased as a result of technology change, but not to the same extent. As elsewhere, in West Bengal new crops have provided new employment, but the decrease in employment due to the change in acreage as well as to the change in technology is much higher. Thus, in the case of West Bengal, a large amount of labour displacement seems to have taken place over time, largely as a result of the changes in the cropping pattern.

Thus, the data for the three regions of India give three distinct pictures of farm employment. In the case of Uttar Pradesh, farm technology is the most important factor accounting for change in farm employment; in the case of West Bengal, change in the cropping pattern is the most important factor; and in the case of the Punjab, changes in farm technology and in cropping pattern combine to aggravate labour displacement. One thing that we may

Table 5. *Cultivated area and intensity of labour input of major crops in West Bengal (Hooghly), 1954–55 and 1970–71*

Crops	Cultivated area (in hectares)		Labour input per hectare (in days)	
	1954–55	1970–71	1954–55	1970–71
(1)	(2)	(3)	(4)	(5)
(a) Paddy	91·43	47·79	130·20	125·30
(b) Jute	17·69	16·61	206·79	200·76
(c) Potatoes	3·96	9·28	442·53	278·07
(d) Pulses	9·82	—	50·29	—
(e) Improved paddy	—	13·40	—	204·07
(f) Wheat	—	2·92	—	126·02

Table 6. *Changes in employment in West Bengal (Hooghly) between 1954–55 and 1970–71*

Crops	Change due to old and new crops	Acreage effect: $(A^{71}-A^{55})L^{55}$	Technology effect: $(L^{71}-L^{55})A^{55}$	Interaction effect: $(A^{71}-A^{55})(L^{71}-L^{55})$	Total change in employment: $(A^{71}L^{71}-A^{55}L^{55})$
(1)	(2)	(3)	(4)	(5)	(6)
Old:					
Pulses	−493·85				−493·85
New:					
(a) Improved paddy	+2734·54				+2734·54
(b) Wheat	+367·98				+367·98
Present both in 1955 and 1971:					
(a) Paddy		−5681·93 (+96·04)	−448·01 (+7·57)	+213·84 (−3·61)	−5916·10
(b) Jute		−223·33 (+69·04)	−106·67 (+32·97)	+6·51 (−2·01)	−323·49
(c) Potatoes		+2354·26 (+284·31)	−651·26 (−78·65)	−874·93 (−105·66)	+828·07
All crops	+2608·67 (−93·07)	−3551·00 (+126·69)	−1205·94 (+43·03)	−654·58 (+23·35)	−2802·85

Note: Figures in brackets indicate percentage of total change in employment.

conclude is that the implications for farm employment of different kinds of technical input vary from one region to another, and it is wrong to treat specific effects as universal ones.

Our analysis suggests that modern farm technology (water–seed–fertiliser technology including the use of modern farm machinery) mostly displaces labour. This displacement of labour is sometimes minimised or even nullified by the increased employment resulting from increases in acreage, changes in cropping pattern etc. The hypothesis which suggests

itself is that whenever there is a substantial increase in labour use it is associated with shifts in cropping patterns and or in irrigation.

In the next section we shall review briefly the work that has been done and the conclusions that have been drawn by other research workers in the Indian context.

4. Discussion and conclusion

In studying the farm-employment implications of technological change, some studies have examined the effects of HYV technology viewed narrowly (i.e., the 'water–seed–fertiliser' innovations) whereas some others have examined exclusively the effects of mechanisation, or the combined effects of the water–seed–fertiliser technology and mechanisation. The methodology that has been mostly used in these studies has been cross-section comparisons of various types of farms at the same point in time.

No one seriously doubts that the HYV technology (water–seed–fertiliser based technology) has substantially increased employment in agriculture. But there has been controversy about the employment impact of farm mechanisation. While some investigators have observed that the intensity of labour use on tractorised farms is higher than on bullock-operated farms (Sarkar and Prahladachar, 1966; Wills, 1971; Grewal and Kahlon, 1972; Sharma, R. K., 1972; Acharya, 1973; Randhawa, 1974), others, making similar studies in the same regions, have reported the opposite results (Singh, 1968; Singh and Singh, 1972; Sharma, A. C., 1976).

The basic objection to both kinds of studies mentioned above is that they attribute to tractorisation increments in yield, output, employment, productivity and profitability per unit of land, when strictly speaking none of these result from tractorisation per se but reflect the effects of irrigation, intensity of cropping, cropping pattern etc. Only a few studies (e.g. Billings and Singh, 1969, 1970; Raj Krishna, 1974) sort out the effects of tractorisation from these other effects.

The studies undertaken by Billings and Singh (1969, 1970) show that HYV seeds appear to have increased the demand for human labour in the Punjab, but mechanical appliances like pump-sets, tractors, and threshers appear to have reduced labour demand. They conclude that a change in technology displaces labour, but this loss must be offset by the additional labour required by the increase in cropping pattern and cropping intensity. Our results have similar implications, but with an important difference. Our analysis suggests that not only changes in technology and cropping pattern but also acreage change for the same crops play a major role in changing labour absorption.

An exercise done by Raj Krishna (1974) provides a somewhat different picture. The exercise, carried out with data from the same region, considered the employment effects for all crops taken together in terms of cropping pattern, cropping intensity, specified items of mechanisation, and the interaction between these factors. He considered an extreme case where mechanisation has been introduced into every agricultural operation. The employment effect of tractorisation was found to be negative and this displacement of labour not offset by the additional labour required by changes in cropping intensity and cropping pattern.

According to Hanumantha Rao (1975), a complementary relationship exists between certain modern inputs and the tractor, particularly in the larger farm size groups. His important finding is that labour displacement takes place in the larger-sized farms but not in the smaller ones. Data relating to Ferozepur for 1968–69 and 1969–70 show that, among the farms characterised by partial tractorisation, direct displacement of labour associated

with tractor use seems to have been more or less compensated for by the indirect increase in employment consequent on the associated increase in yield.

We may here refer to the results of our own analysis demonstrating that the impact of technology on labour use may be neutralised by factors such as increased acreage, cropping patterns, irrigation, new crops etc. This suggests that there is no basis for assuming the existence of a complementary relationship as a general phenomenon, for the following reasons:

(a) It is not true that all larger-sized farms in all regions substitute capital for labour whether or not modern inputs have been used. There is empirical evidence that the larger farms in many places even in the agriculturally better-endowed regions like the Punjab, Uttar Pradesh etc., devote more labour and apply less capital and other non-monetised inputs than smaller-sized farms and obtain the same or greater amounts of production (Chattopadhyay and Rudra, 1976).

(b) There is no dearth of evidence to show that farmers other than the biggest also use tractors (either hired or owned) for some specific agricultural operations, for time-scheduling and for intensive cultivation. They also choose cropping patterns which promise high returns.

(c) Although wide-scale tractor use on larger-sized farms in some particular areas (Punjab, Uttar Pradesh etc.) is obviously a recent phenomenon, evidence presented by some authors indicates that there are many instances in which tractor use preceded the innovation of HYV seeds especially on larger farms and in the Punjab (Iyenger, 1949; Patil, 1949; Sivaswamy, 1949). Tractors were used here without HYV seeds for better management and intensive cultivation.

Thus it is our view that the process of mechanisation does not follow any rigid pattern. Farmers who own more productive capital and who can obtain other non-monetised inputs have better access to modern inputs. This is likely to lead to greater use of irrigation and purchased inputs, and thus to higher cropping intensities and yields. Furthermore, on tractor-operated farms, the cropping patterns might emphasise crops which yield high returns but at the same time require relatively large amounts of purchased inputs. All these effects may lead to higher production, higher intensity of cropping and even greater use of bullock and human labour.

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