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9. ABSTRACT

An examination of three leading factors of labor use in Indian agriculture: the influence of cropping patterns, technology, and farm size on employment. These three factors in turn influence the variations in cropping intensity -- an important source for expanding employment opportunities. The study found that irrigation has a large potential for increasing employment, even where the development of high-yield varieties has lagged. Seed-fertilizer technology also has increased labor use, but because its spread has been accompanied by mechanization, the substitution of capital for labor has reduced rather than enlarged the need for labor, in turn offset by a shift from less labor-intensive to more labor-intensive crops.

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Some Aspects of Labour Use in Indian Agriculture

By

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I wish to express my gratitude to the Department of Agricultural Economics, Cornell University, for providing me with the facilities for carrying out the present study. I am also grateful to Indraprastha College for Women, Delhi University, for granting me the necessary leave that enabled me to do this work.

Preface

The broad objective of increasing productive employment and the specific potentials in the agricultural sector have been of increasing concern to development economists. Through a major research program under my direction we have been able to shed considerable light on various aspects of this problem through a series of studies in various countries. We have been most fortunate to have Shakuntla Mehra as a visiting research fellow in this program and thus to be able to benefit from her considerable experience with respect to labor and employment analysis. In this particular effort she examines the cropping pattern, nature of technology and farm size as this bears upon employment and bases her analysis upon a substantial and diverse body of data which not only allows her to generalize about these key relationships but also provides the basis for describing the variability and the caveats to generalization. From this analysis Ms. Mehra draws a set of conclusions with respect to irrigation investment, new technology, cropping intensity and their interactions with farm size that are important in policy determinatnion.

It has been a privilege to have Ms. Mehra with us for a year, not only to learn from her directly but also to see this work and its valuable approach and conclusions.

John W. Mellor

Ithaca, New York
October, 1976

SOME ASPECTS OF LABOUR USE IN INDIAN AGRICULTURE

By

Shakuntla Mehra

I. Introduction

One of the central problems of the Indian economy is to expand the opportunities for gainful employment of human labour much more rapidly than the increase in its workforce. The issue bears on the strategy of development. 1/ The purpose of this paper is not to delve into that comprehensive question but to address itself to the more limited one of expansion of employment opportunities within the agricultural sector itself. It is with a view to seeking light on this question that we have attempted to examine here some aspects of labour use in Indian agriculture. Since the possibilities for expansion of cultivated area, one of the most important vehicles for expanding employment in agriculture, seem to be limited in India, the focus has obviously to be on other sources for expanding employment opportunities. We have chosen to limit our examination to three of the leading factors bearing on labour use, namely, the character of the product mix, as reflected in the cropping pattern, the nature of technology and farm size; these three factors have in turn a bearing upon the variations in cropping intensity -- an important source for expanding employment opportunities. The relation of labour use to technology and to farm size is separately examined in the following two sections and the impact of changes in the cropping pattern as well as cropping intensity on labour use is brought out both in relation to changes in technology and in farm size.

II. Labour Use and Improved Technology

The employment implications of modern technology has been, of late, an area of considerable exploration. While the seed-fertilizer based technology has been shown by many to have a favourable direct effect on farm employment, the employment impact of farm mechanisation continues to be a

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1/ See John W. Mellor, The New Economics of Growth, (Cornell University Press, London, 1976).

subject of considerable controversy. 1/ But as C. H. Hanumantha Rao has rightly argued, given the existing size structure of farms, there is a complementarity between these two elements of modern technology and their effects are best considered together. 2/ We shall, therefore, attempt to examine here the employment potential of irrigation, a leading source of improvement within the framework of traditional technology, 3/ and the employment effect of modern technology considered as a mix of seed-fertiliser technology and farm mechanisation which has gone along with it. While irrigation too bears a complementary relationship with modern technology, its effect needs to be considered separately because it can then be seen what difference the induction of modern technology has made to labour use on the farms. Farm management surveys carried out in different parts of the country constitute an important source of data required for the purpose. Since fertiliser use became sizeable only in the 1960's and thereafter, and the same is true of the spread of the high-yielding variety of seeds and farm mechanisation, the employment effect of irrigation is best brought out by focussing on the picture as it obtained in the 1950's.

That the provision of irrigation extends the productive use of inputs including labour and increases output per unit of land is, in a general way, well known. What needs to be ascertained is the quantitative magnitude of the increase, specially in labour use, when an unirrigated acre is converted

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1/ See, for instance, C. H. Hanumantha Rao, Technological Change and Distribution of Gains in Indian Agriculture, (Macmillan, Delhi, 1975); Amartya Sen, Employment, Technology and Development, (Clarendon Press, Oxford, 1975); John W. Mellor, op. cit.; Raj Krishna, "Measurement of the Direct and Indirect Employment Effects of Agricultural Growth with Technical Change," in Externalities in the Transformation of Agriculture, (Iowa State University, Ames, Iowa); S. S. Acharya, "Green Revolution and Farm Employment," Indian Journal of Agricultural Economics, Vol. XXVIII, No. 3, July-September 1973; Martin H. Billings and Arjan Singh, "The Effect of Technology on Farm Employment in India," in Comparative Experience of Agricultural Development in Developing Countries of Asia and the South-East Since World War II, (ed.) M. L. Dantwala, (Indian Society of Agricultural Economics, Bombay, 1972); Ronald G. Ridker, "Agricultural Mechanization in South Asia," in Comparative Experience of Agricultural Development (ed.) M. L. Dantwala; W. B. Donde, "Impact of Farm Mechanisation on Employment," in Comparative Experience of Agricultural Development, (ed.) M. L. Dantwala; Papers on Rural Unemployment presented at the 32nd Annual Conference of the Indian Society of Agricultural Economics, Indian Journal of Agricultural Economics, Vol. XXVII, No. 4, October-December 1972; Impact of Mechanisation in Agriculture on Employment, a study of the National Council of Applied Economic Research, New Delhi, 1973.

2/ C. H. Hanumantha Rao, op. cit., Chap. 9.

3/ See Colin Clark, The Economics of Irrigation, (Pergamon Press, Oxford, 1967), where he points out to one of the great advantages of tubewell irrigation in making possible a fuller use of labour. Also Easter Boserup, The Conditions of Agricultural Growth, (Allen & Unwin, London, 1965), pp. 39-40.

into an irrigated one. We shall do this by comparing the labour input on irrigated and unirrigated areas. In attributing the difference to irrigation, it is not implied that everything else except irrigation is the same on the two areas. Since it is the provision of irrigation which brings about so many improvements in cultivation, what is implied is that the difference is, by and large, attributable to irrigation and all that goes with it and this is what is relevant here. It must, of course, be recognised that soil and climatological conditions have an important bearing on labour use. Indeed there are large differences in the application of labour input on the same crop raised in different parts of the country. The play of such factors, however, is minimised when comparison between the irrigated and unirrigated lands is made for the same, relatively small and therefore relatively homogeneous, geographical area.

There are three important vehicles through which irrigation exerts its effect on labour use. First, depending upon its quality, irrigation increases cropping intensity. Second, since the labour requirements of different crops vary, it bears on labour use by bringing about shifts in the cropping pattern. Third, it enlarges the scope for the productive use of labour on the same crop. The combined effect can be seen in the total labour input per unit of cultivated area. Unfortunately, this information by irrigated and unirrigated areas is available only for the districts of Ferozepur and Amritsar in Punjab but it is revealing. Total labour input in crop production measured in mandays per acre of cultivated land is 150 percent more for irrigated compared to unirrigated area. And even if the difference made by the increase

Table 1. Per acre human labour days used for crop production and intensity of cropping for irrigated and unirrigated areas in Punjab, 1954-55 to 1955-57 1/

	Percentage intensity of cropping	Mandays per acre of cultivated area	Mandays per acre of cropped area
Irrigated area	137.0	31.4	22.9
Unirrigated area	108.0	12.5	11.6

Source: Studies in the Economics of Farm Management in the Punjab, Combined Report, 1954-55 to 1956-57, (Government of India, Directorate of Economics and Statistics, Ministry of Food and Agriculture). Data pertains to the combined sample for Ferozepur and Amritsar districts.

1/ Throughout this study, for the 1950's, we have made use of the data of the Cost Accounting Sample. And in order to minimise the effect of year-to-year fluctuations, we have taken the averages of the data for whatever years it was possible.

in cropping intensity is ignored, the labour input per cropped acre continues to be 100 percent more for irrigated compared to unirrigated areas.

In the absence of similar information for other centres, we have compiled the cropwise information on labour input for such crops and centres for which it is separately available for irrigated and unirrigated areas. This information presented in Table 2 shows that in the generality of cases the labour input on the irrigated area under the same crop is 100 percent or more of that on unirrigated area. Since a mere extension of labour use by itself connotes little, we consider it in relation to the differences in the output per acre of irrigated and unirrigated areas.

It is, of course, true that the provision of irrigation can increase labour use and output per unit of land up to a point, and if their levels have to be pushed further new technology becomes necessary. It would, therefore, be instructive to examine what difference the induction of new technology has made to labour input and output per hectare. Ideally, such an examination must rest on a comparison between the picture as it obtained before and after the induction of the new technology. Most of the available evidence, however, relates to cross-section comparison for the same period of time between areas devoted to high-yield and traditional varieties of seeds. We have nevertheless assembled this information available from various sources in Tables 3 and 4 to see what light it throws on the comparative force of irrigation and new technology on increasing labour use and output per hectare.

Tables 2, 3 and 4, when compared on a general plane, appear to point out the following: one, the contribution of high-yielding varieties towards increasing labour input per hectare both in absolute and percentage terms, has been of a smaller order than that of irrigation as revealed by the data for the 1950's. The increase in mandays per hectare on farms growing HYV of crops as against traditional has been only 50 percent and below barring HY paddy in Palamau (Bihar) and cotton in Saurashtra. On the other hand, irrigated farms used generally 100 percent or more mandays per hectare as compared to unirrigated farms. In only a few cases does the increase in mandays per hectare on irrigated farms fall short of 100 percent. Two, while irrigation has shown a rather high potential for increasing yields per hectare in percentage terms, HYV of crops have made larger absolute additions to yield per hectare.

For assessing the impact of the new technology, the above evidence pertaining to comparisons at the same point of time during the 1960's and thereafter suffers from the limitation that fertiliser use since the 1950's has spread to traditional varieties also and mechanisation of agricultural operations, likewise, has affected labour input and output per hectare in respect of both traditional and HY varieties. We need, therefore, to examine the change in the situation over time -- between a period of time when farming was characterised by traditional technology and a later one after the introduction of new technology. Since our interest centres on the effect of modern technology -- considered as a mix of seed-fertiliser based technology and farm mechanisation -- on direct farm employment rather than on output it is to this aspect that we shall now confine ourselves. For

Table 2. Human labour days and output per acre of irrigated and unirrigated area, 1954-55 to 1956-57

Crop	Districts	Mandays		Output (maunds)		Percent increase on irrigated over unirrigated	
		Irrigated	Unirrigated	Irrigated	Unirrigated	Mandays	Output
Wheat	Ahmednagar	40.5	16.8	6.9	3.4	141.1	102.9
	Nasik	53.9	13.3	5.9	2.1	305.3	181.0
	Meerut & Muzaffarnagar	34.0	28.0	11.4	6.4	21.4	78.1
	Amritsar	26.6	14.4	10.3	6.7	84.7	53.7
	Ferozepur	27.8	12.9	12.9	5.0	115.9	158.0
Wheat-gram	Amritsar	20.6	14.8	10.5	6.6	39.2	59.1
	Ferozepur	19.4	15.0	9.1	7.4	29.3	23.0
Jowar	Coimbatore & Salem	57.0	17.2	1[illegible].7	5.8	231.4	136.2
	Ahmednagar	34.2	10.0	8.6	1.6	242.0	437.5
Bajra	Coimbatore & Salem	39.7	16.0	7.4	3.0	148.1	146.7
Ragi	Coimbatore & Salem	78.2	30.9	13.3	9.0	153.1	47.8
Gram	Ahmednagar	23.4	10.5	5.1	2.6	122.9	96.2
	Nasik	28.6	15.7	4.3	2.8	82.2	53.6
Cotton	Coimbatore & Salem	75.5	14.6	7.1	2.5	417.1	184.0
All crops	Amritsar & Ferozepur	22.9	11.6	140.6	70.0	97.4	100.8

Sources: Studies in the Economics of Farm Management in the Punjab, Uttar Pradesh, Bombay and Madras.

Data for Coimbatore & Salem is for the years 1954-55 to 1955-56.

Table 3. Comparison of human labour days per hectare for high-yield and traditional varieties of crops

Nature of study	Districts & period	Crop	Mandays HYV	Mandays Traditional	Percent increase for HYV over traditional
Farm Management Studies	1. Ferozepur 1967-68 to 1969-70	Wheat	68.2	52.2	30.7
		Paddy	91.9	91.8	0.1
	2. Muzaffarnagar 1966-67 to 1968-69	Wheat	63.1	58.0	8.8
Individual Studies	3. Kanpur 1966-67 to 1970-71	Wheat	113.5	98.8	14.9
		Paddy	105.2	90.8	15.8
		Maize	102.7	86.0	19.5
	4. Palamau 1970-71	Wheat	138.4	91.4	51.4
		Paddy	279.2	143.3	94.8
		Maize	116.1	81.5	42.4
	5. Juragadh, Amreli & parts of Bhavnagar & Rajkot 1968-69	Wheat	114.3	173.8	-34.2
		Bajra	80.9	74.7	8.3
		Groundnut	83.4	55.8	49.5
		Cotton	157.8	82.5	91.3

Data for paddy in the case of Ferozepur is for the year 1969-70.

Sources: 1 & 2. Studies in the Economics of Farm Management in Ferozepur District (Punjab), and in Mazaffarnagar District (U.P.), combined reports; 3. J. S. Garg, Om Prakash and H. L. Srivastava, "Impact of Modern Technology on Rural Unemployment," Indian Journal of Agricultural Economics, Vol. XXVII, No. 4, October-December 1972; 4. M. L. Singh, "Unemployment in Rural Areas of Palamau District (Bihar): A Case Study in Hussainabad Block," Indian Journal of Agricultural Economics, Vol. XXVII, No. 4, October-December 1972; 5. D. R. Desai, G. A. Patel and R. J. Patel, "Impact of Modern Farming Technology on Rural Employment in Saurashtra," Indian Journal of Agricultural Economics, Vol. XXV, No. 3, July-September 1970.

Table 4. Comparison of output per hectare for high-yield and traditional varieties of crops

Nature of study	Districts	Period	Crop	Output (quintals) HYV	Output (quintals) Traditional	Percent increase for HYV over traditional
Farm Management Studies	Ferozepur	1967 to 1969-70	Wheat	25.40	15.99	58.8
		1969-70	Paddy	41.41	27.14	52.6
	Muzaffarnagar	1966-67 to 1968-69	Wheat	30.50	18.74	62.8
Agro-Economic Research Centre Studies	Kota	1968-69	Wheat (S-64)	8.06	8.39	- 3.9
		1971-72	All HYV	15.41	8.62	78.8
	Karnal	1967-68	Wheat (LR)	27.04	16.76	61.3
		1971-72	All HYV	24.30	13.41	81.2
	Amritsar	1967-68	Wheat (P-V-18)	36.78	16.84	118.5
		1968-69	All HYV	29.96	12.84	133.3
	Saharanpur	1968-69	Wheat (Mexican)	21.16	13.83	53.0
Intensive Agricultural Development Programme Studies	Aligarh	1966-67 to 1968-69	Wheat	23.46	16.70	40.5
	Shahabad	1966-67 to 1968-69	Wheat (Mexican)	16.96	9.26	83.2
	Ludhiana	1966-67	Wheat (Mexican)	47.50	23.60	101.3
		1967-68	Wheat (LR)	36.60	23.20	57.8
		1968-69	Wheat (P-V-18)	32.50	18.80	72.9
	Pali	1967-68	Wheat (S-64)	17.30	11.70	47.9
Cost of Cultivation Study	Haryana	1970-71	Wheat	23.90	19.81	20.6
	Punjab	1970-71	Wheat	24.52	20.04	22.4
Ad-hoc Studies	Budaun	1969-70	Wheat	19.40	9.60	102.1
Small Farmer's Study	Nainital	1969-70	Wheat	22.60	7.80	189.7

Sources: Data for farm management studies is from Studies in the Economics of Farm Management in Ferozepur District (Punjab), and in Muzaffarnagar District (U.P.), Combined Reports. For the rest see, V. S. Vyas, India's High Yielding Varieties Programme in Wheat, 1966-67 to 1971-72, (International Maize and Wheat Improvement Centre, Mexico, 1975), Table 7.2, pp. 12-13.

the purpose we need information on the utilisation of human labour for the same centres at two points of time. Though repeat Farm Management Surveys have been conducted for five different centres during the late sixties, it is in two of these, i.e. Ferozepur (Punjab) and Muzaffarnagar (U.P.) belonging to the region of the wheat revolution, that the new technology has made the greatest headway. But since the U.P. survey of 1950's does not give separate information for Muzaffarnagar, whereas the Punjab survey does for Ferozepur, we have to rely heavily upon the latter for making comparison at two points of time feasible.

Overall labour input per cultivated hectare in Ferozepur increased by about 40 percent during the period 1966-67 to 1969-70 over that of the 1950's. We propose to examine the factors that could bring this about and to make an attempt towards quantifying the effect of these so as to ascertain what part of this increase in employment could be attributed to the new technology.

Table 5. Comparison of employment of human labour days per hectare, Ferozepur

Average for the period	Mandays per hectare of		Percentage intensity of cropping
	Cultivated area	Cropped area	
(1) 1967-68 to 1969-70	80.56	60.0	128.31
(2) 1954-55 & 1956-57[1/]	57.62	47.8	121.15
(1) - (2)	22.94	12.2	7.16

Sources: Studies in the Economics of Farm Management in Ferozepur District (Punjab), Three-year Consolidated Report, 1967-68 to 1969-70, pp. 70, 71 and 29; Studies in Economics of Farm Management in Punjab, Report for the year 1954-55 and 1956-57.

[1/] We have taken the average of these two years as the Farm Management Report for the year 1955-56 was not available and the combined report for Punjab, 1954-55 to 1956-57, does not give most of the data required separately for Ferozepur. The three year consolidated Farm Management Report, 1967-68 to 1969-70, for Ferozepur district gives some data for Ferozepur for 1950's for purposes of comparison but again not all that we require. Hence the average of only two years has been taken.

Since cropping intensity increased over this period from 121.15 to 128.31, a part of the increase of 22.94 mandays in labour input per cultivated hectare was obviously the result of increase in cropping intensity. If cropping intensity had not increased, labour input per cultivated hectare in the 1960's would have been 72.69 mandays. 1/ Actually during 1967-68 to 1969-70 labour input per cultivated hectare was 80.56 mandays. That component of this labour input per cultivated hectare which can be attributed to increase in cropping intensity over this period, therefore, works out to 7.87 mandays.

The actual increase in mandays per cultivated hectare during the 1960's over that of the 1950's is 22.94 mandays. Since out of this 7.87 mandays may be attributed to increase in cropping intensity, the rest, i.e. 15.07 mandays per cultivated hectare may be attributed to increased application of labour under individual crops. The latter may be due to (a) expansion of irrigation, (b) new technology, and (c) associated changes in the cropping pattern.

The effect of irrigation on application of labour to land, however, is not only via the increase in the application of labour to individual crops but also via an increase in cropping intensity. We need to work out now the extent to which the two components of increase in labour input per cultivated hectare worked out above, i.e. 7.87 and 15.07 mandays, can be attributed to the expansion of irrigation.

A. We first take up the effect of irrigation on cropping intensity.

Table 6. Comparison of cropping intensity during 1950's between irrigated and unirrigated areas, and of percentage of net irrigated area between 1950's and 1960's

	Percentage intensity of cropping Average of years 1954-55 & 1956-57		Percentage of net irrigated area to total cultivated area Average for the period
(1) Irrigated area	128.3	(1) 1967-68 to 1969-70	87.03
(2) Unirrigated area	105.7	(2) 1954-55 & 1956-57	68.05
(1) - (2)	22.6	(1) - (2)	18.98

Sources: Studies in Economics of Farm Management in Punjab, Report for the year 1954-55 and 1956-57; Studies in the Economics of Farm Management in Ferozepur District, 1967-68 to 1969-70, p. 27

1/ $\frac{60.0 \times 121.15}{100} = 72.69.$

With a difference of 22.6 percentage points between the cropping intensity of irrigated and unirrigated areas, an increase in the percentage of net irrigated area to total cultivated area in the 1960's over that of the 1950's by 18.98 would lead to an increase in cropping intensity by 4.29 percentage points. 1/ The increase in irrigated area considered here gives only a quantitative dimension of the change without going into the quality of irrigation which is important from the point of view of cropping intensity. While there were no tubewells during 1955-56, 18.4 percent of the net area under irrigation came to be served by tubewells during 1969-70. 2/ And the intensity of cropping of farms under tubewell irrigation for 1968-69 to 1969-70 was 148.0 percent as compared to the much lower cropping intensity of canal irrigated farms at 110.8 percent for the same period. 3/ The contribution of irrigation expansion to the increase in cropping intensity estimated above is, therefore, an underestimate. This means that 4.29 out of 7.16 4/ percentage points, i.e. at least 60 percent of the increase in cropping intensity can be attributed to expansion of irrigation and the rest to new technology.

1/ $\frac{22.6 \times 18.98}{100} = 4.29.$

2/ Percentage of net area under irrigation, Ferozepur District.

Years	Government Canals	Wells	Tubewells	Total
1955-56	88.6	11.4	-	100.0
1969-70	72.7	8.9	18.4	100.0

Source: Ferozepur district consolidated report, 1967-68 to 1969-70, p. 11.

3/ Average cropping intensity for tractor and bullock operated farms. See Ferozepur district consolidated report, 1967-68 to 1969-70, p. 232.

4/ See p. 8, Table 5.

B. Effect of irrigation on labour input to individual crops.

Table 7. Comparison of employment of human labour days during 1950's between irrigated and unirrigated areas and of percentage of gross irrigated area between 1950's and 1960's

	Mandays per hectare of cropped area Average of years 1954-55 & 1956-57		Average for the period	Percentage of gross irrigated area to total cropped area
(1) Irrigated area	55.2	(1)	1967-68 to 1969-70	90.23
(2) Unirrigated area	29.2	(2)	1954-55 & 1956-57	72.00
(1) - (2)	26.0		(1) - (2)	18.23

Sources: Studies in Economics of Farm Management in Punjab, Report for the year 1954-55 and 1956-57; Studies in the Economics of Farm Management in Ferozepur District, 1967-68 to 1969-70, p. 27

With a difference of 26 mandays per cropped hectare between the labour input of irrigated and unirrigated cropped area during the 1950's, the increase in the percentage of gross irrigated area to total cropped area by 18.23 would lead to an increase in the labour input per hectare under crops by 4.73 mandays. 1/ The actual increase in labour input per cropped hectare in the 1960's over that of the 1950's is 12.2 2/ mandays. This means that 4.73 out of 12.2, i.e. 38.8 percent of the increase in labour input per cropped hectare can be attributed to the expansion of irrigation.

C. Total effect of irrigation

Of the increase of 22.94 mandays per cultivated hectare in the 1960's over that of the 1950's, we find that 60 percent of 7.87 3/ mandays, i.e. 4.72 mandays may be attributed to irrigation via the increase in cropping intensity, and 38.8 percent of 15.07 mandays, i.e. 5.84 mandays may be attributed to irrigation via the increase in labour input to individual crops. Thus the increase of 10.56 mandays out of 22.94 mandays per cultivated hectare, i.e. 46 percent of the total increase may be explained by the expansion of irrigation. The remaining 54 percent of the increase may then be due to the introduction of new technology and changes in the cropping pattern induced by it.

1/ $\frac{26.0 \times 18.23}{100} = 4.73.$

2/ See p. 8, Table 5.

3/ See p. 9.

Let us now turn to the other component of increase in labour input per cultivated hectare which is not accounted for by the expansion in irrigation and see how far it reflects the contribution of new technology.

Since the new technology -- considered as a mix of seed-fertiliser based technology and mechanisation of farm operations -- facilitates multiple cropping, that component of the increase in labour input which is associated with the increase in cropping intensity not accounted for by expansion of irrigation, i.e. 3.15 mandays per cultivated hectare is attributable to the new technology. But this is only about one-third of the increase not explained by expansion of irrigation. The question, therefore, is how far the remaining increase of over 9 mandays per cultivated hectare reflects the contribution of new technology? To examine whether the new technology has led to increased application of labour on individual crops, we turn to crops where the HYV of seeds have made an important headway. Among such crops in Ferozepur, information on labour input for the 1960's is available only for the HYV of wheat and paddy but for the latter information on labour input is not available for the 1950's. Thus we are left with the comparative picture only for wheat. Fortunately, however, wheat is quantitatively the most important of the crops to have benefitted from the new seeds; out of 36 percent of total cropped area that was under HYV of crops during 1968-69 to 1969-70, almost 90 percent was under wheat. 1/ It would be seen from the table below that although labour input per hectare of HY wheat during 1960's was 31 percent higher than that under the desi varieties, it was no more than what the desi irrigated wheat absorbed during the 1950's, while desi wheat during the 1960's absorbed much less labour than it did during the 1950's.

Table 8. Comparison of the employment of human labour per hectare of Desi and Mexican wheat, Ferozepur 2/

- - - - - - - Mandays per hectare - - - - - - - - - -		
1954-55 to 1956-57	1967-68 to 1969-70	
Desi wheat	Desi wheat	Mexican wheat
68.9	52.2	68.2

Source: Ferozepur district consolidated report, 1967-68 to 1969-70, pp. 106 and 93.

1/ Ferozepur district consolidated report, 1967-68 to 1969-70. Calculated from Table 10.1, p. 226 and Table 6.2, p. 84.

2/ Employment of human labour days per hectare for Mexican wheat and for desi wheat during 1954-55 to 1956-57 is for irrigated areas, but for desi wheat during 1967-68 to 1969-70, with 93.9 percent of its area under irrigation, the labour input per hectare given here is an average of that for irrigated and unirrigated areas.

The comparison is revealing for while the excess in the labour input per hectare of Mexican wheat over that of desi wheat during the 1960's brings out the contribution of the seed-fertiliser component of the new technology in extending labour use per unit of land, the comparison between the picture for the 1960's with that in the 1950's strongly suggests that mechanisation had the opposite effect on labour use in the case of this crop. 1/ Indeed the suggestion finds support in the evidence of decline in the labour input per hectare over the two periods in the case of American cotton and desi cotton for which such a comparison is possible.

Table 9. Employment of human labour for American and desi cotton

	Mandays per hectare	
	1954-55 to 1956-57	1967-68 to 1969-70
American cotton	87.08	68.77
Desi cotton	95.96	81.43

Source: Ferozepur district consolidated report, 1967-68 to 1969-70, pp. 118 and 131.

1/ In Muzaffarnagar also HYV of wheat absorbed 63.0 mandays per hectare as against 58.0 mandays by other traditional varieties during 1966-67 to 1968-69 showing an increase of about 9 percent more mandays per hectare (Studies in the Economics of Farm Management in Muzaffarnagar District (U.P.), combined report, 1966-67 to 1968-69, p. 133). Area under traditional varieties of wheat, however, is irrigated to the extent of 93.9 percent so that 58 mandays is the average of labour input per hectare of both irrigated and unirrigated areas. Area under Mexican wheat, on the other hand, is 100 percent irrigated. A comparison of labour input for irrigated desi wheat for the year 1966-67 with that of Mexican wheat for the same year reveals surprisingly a decline in mandays per hectare from 70 mandays for irrigated wheat to 66 mandays for Mexican wheat. Even the figure of 66 mandays is due to the very high labour input on the smaller farms.

Per hectare utilization of human labour days by holding size-groups

	Holding size-groups (in hectares)					
	Below 2.87	2.87-4.71	4.72-6.96	6.97-10.65	10.66 & above	All farms
Desi wheat	110	80	76	74	52	70
Mexican wheat	205	95	68	58	56	66

Source: Studies in the Economics of Farm Management in Muzaffarnagar District (Uttar Pradesh), Report for the year 1966-67, pp. 214 and 237.

The decline in the labour input per hectare in the 1960's over that of the 1950's is about 24 percent in desi wheat, 21 percent in American cotton and 15 percent in desi cotton. An examination of the labour input per hectare operationwise for these crops shows that the most sizeable declines have occurred in preparatory tillage and interculture, and in the case of desi wheat and Mexican wheat in threshing too -- precisely the operations which have been most extensively mechanised. 1/

Table 10. Operationwise distribution of human labour days for wheat and cotton

	Mandays per hectare						
	Mexican wheat	Desi wheat		American cotton		Desi cotton	
Operation	1968-69 to 1969-70	1954-55 to 1956-57	1968-69 to 1969-70	1954-55 to 1956-57	1968-69 to 1969-70	1954-55 to 1956-57	1968-69 to 1969-70
Preparatory tillage	11.16	16.90	13.60	14.01	8.17	11.18	12.87
Sowing	2.83	4.46	3.14	3.79	1.68	4.04	2.89
Manuring	1.22	1.48	0.67	3.30	0.74	1.89	0.45
Interculture	6.90	6.18	3.10	17.13	8.78	21.66	12.91
Irrigation	12.20	8.58	7.07	8.65	7.31	9.80	8.54
Harvesting	14.06	13.06	12.61	-	-	-	-
Threshing & winnowing	14.25	18.05	10.50	-	-	-	-
Picking	-	-	-	35.25	34.07	38.96	40.44
Harvesting of sticks	-	-	-	4.94	6.44	7.99	3.00
Others	2.30	0.25	1.62	-	1.41	0.44	0.88
Total	64.92	68.86	52.31	87.07	68.60	95.96	81.98

Source: Ferozepur district consolidated report, 1967-68 to 1969-70, pp. 94, 107, 119 and 131.

1/ A comparison over time becomes possible for Muzaffarnagar also for maize which absorbed 47.5 mandays per hectare during 1966-67 to 1968-69 as against 74.1 mandays during the year 1954-55 showing a decline of almost 36 percent. Since we have information regarding labour input for maize for only one year during the 1950's, taking the highest labour input of 49.9 mandays per hectare in the year 1967-68 out of the three years of the 1960's for which data is available, decline in labour input still works out to about 33 percent presumably reflecting the mechanisation of the shelling operation. However, we have not been able to pursue the point here owing to the non-availability of operationwise data for the 1950's. See Studies in the Economics of Farm Management in Muzaffarnagar district (U.P.), combined report, 1966-67 to 1968-69, p. 151, and Studies in the Economics of Farm Management in Uttar Pradesh, combined report, 1954-55 to 1956-57, p. 147.

We have seen that new technology has not increased labour input per hectare on individual crops; Mexican wheat is absorbing only about the same labour input in the 1960's as irrigated wheat did in the 1950's, while desi wheat, American cotton and desi cotton show a decline. What then explains the unaccounted part of the increase in overall labour use per hectare? 1/ The secret of the increase in labour input apparently lies in the changes in the cropping pattern over the two periods. The most conspicuous of these changes consists in the relative shift of acreage from gram, wheat-gram mixed and desi wheat to Mexican wheat.

Table 11. Comparison of the percentage of area under different crops for the two periods

Crops	1967-68 to 1969-70	1954-55 to 1956-57
Desi wheat	10.63	14.3
Mexican wheat	25.19	-
Wheat-gram	3.85	20.7
Gram	3.96	13.4

Source: Ferozepur district consolidated report, 1967-68 to 1969-70, Table 4.15, p. 30.

However, abstracting from the effect of irrigation, a mere shift of area from desi wheat to Mexican cannot explain the increase in labour input per hectare for the latter absorbed about the same labour in the 1960's as irrigated wheat did in the 1950's. Wheat-gram and gram, on the other hand, are grown with much less labour input per hectare.

Table 12. Employment of human labour for different crops

	Mandays per hectare				
			1954-55 & 1956-57		
Crops	1967-68 to 1969-70	1954-55 to 1956-57	Irrigated	Unirrigated	Average of irrigated and unirrigated
Desi wheat	52.2	68.9			
Mexican wheat	68.2	-			
Wheat-gram	N.A.		47.9	37.1	42.5
Gram	N.A.	N.A.			

Source: Ferozepur district consolidated report, 1967-68 to 1969-70; and Studies in Economics of Farm Management, Punjab, for the years 1954-55 and 1956-57.

1/ See p. 12.

This shift in area from 14.3 percent under wheat in the 1950's to 35.8 percent in the 1960's, and decline from 34.1 percent under wheat-gram mixed and gram to a mere 7.8 percent over the same period is capable of bringing about by itself an overall increase in the labour input per hectare from 50.3 mandays to 64.2 mandays, 1/ i.e. 13.9 mandays. Since wheat and gram together cover 43.6 percent of the total area in the 1960's and 48.4 percent in the 1950's, varying little around the average of 46 percent, the increase of 13.9 mandays would be spread over the entire area thus giving us roughly an increase of 7 mandays per hectare in the 1960's over that of the 1950's. Thus the explanation of the bulk of the unaccounted part of the increase, i.e. 9.23 mandays 2/ per hectare lies in the relative shift of acreage from wheat-gram and gram to wheat. The remaining increase of 2.23 mandays could well be due to the relative shift of area in favour of other labour intensive crops like IR-8 paddy the effect of which we have not been able to explicitly consider here. The hand of new technology in increasing the employment of human labour on farms does not in the main appear to be operating directly but indirectly via induced changes in the cropping pattern. In fact, the rapid expansion of tubewell irrigation on private initiative was itself induced by the greater profitability of high-yield varieties. The profitability of HYV in conjunction with irrigation, being much greater than the profitability of irrigation alone, changes in the cropping pattern became more significant with the introduction of high-yield varieties. Indeed, they became so large as to more than offset the labour displacement effect of mechanisation.

Since tractor service can be purchased and the services of mechanical threshers availed even by the non-tractor farms, the labour displacement effect of mechanisation cuts across the tractor and non-tractor farms. That is why labour input per hectare on individual crops in the 1960's is seen to be lower than in the 1950's on both types of farms. Even so, if we make a direct comparison between the tractor and non-tractor farms of the same-size class, we find that in the canal irrigated areas, labour input per hectare for individual crops is generally lower in the case of tractor compared to non-tractor farms. In the case of tubewell irrigated farms, however, the picture is a mixed one but even here it can be said that in the majority of cases the tractor farms are not using more labour per hectare under individual crops than non-tractor farms (Table 13).

1/ This is arrived at by applying the labour input per hectare for desi wheat in the 1950's to area under both desi and Mexican wheat during the 1960's, and average of the labour input per hectare of irrigated and unirrigated area under wheat-gram during the 1950's to area under both wheat-gram and gram in the 1960's. 68.9 mandays for wheat desi is for irrigated areas. Since area under wheat in the 1960's is mostly irrigated, we are applying the figure of mandays for irrigated areas. But in the case of wheat-gram and gram, the area under irrigation is only a little more than half of the total area under wheat-gram and gram during the 1960's. Therefore, we have taken the average of labour input for irrigated and unirrigated area under wheat-gram and gram for the 1950's.

2/ See p. 12.

Table 13: Employment of human labour on individual crops in different types of holdings

Holding size group (Hectares)	Mandays per hectare			
	Tubewell irrigated		Canal irrigated	
	Tractor farms	Bullock farms	Tractor farms	Bullock farms
Desi wheat	1968-69 to 1969-70			
6-9	46.93	46.30		
9-14	68.99	52.74		
14-24	37.91	48.78	44.54	52.39
24 & above	45.23	31.69	36.81	51.74
Average	45.20	48.07	40.55	56.34
Mexican wheat	1968-69 to 1969-70			
6-9	60.10	63.66		
9-14	63.86	67.21		
14-24	60.35	62.50	61.89	61.40
24 & above	68.82	64.68	54.12	68.51
Average	58.09	71.14	56.51	68.85
American cotton	1968-69			
14-24	-	-	68.73	70.19
24 & above	-	-	63.83	62.05
Average	-	-	64.54	75.37
Desi cotton	1969-70			
6-9	127.96	98.20		
9-14	92.08	92.05		
14-24	95.24	97.24		
24 & above	68.84	-	49.34	57.50
Average	95.40	94.87	49.34	71.74
Desi maize	1969-70			
6-9	89.22	92.79		
9-14	64.62	80.35		
14-24	68.06	57.40		
24 & above	75.55	-		
Average	70.17	87.29		
Paddy local	1969-70			
9-14	71.57	71.08		
14-24	97.20	86.97		
24 & above	77.40	-		
Average	91.26	89.70		

Source: Ferozepur district consolidated report, 1967-68 to 1969-70.

If despite this, overall labour input per cultivated hectare is found to be more on tractor compared to non-tractor farms, it is partly because of the higher cropping intensity on the former type of farm and partly because they have a larger proportion of cropped area under irrigation and under HY varieties (Table 14).

Table 14. Comparison of the employment of human labour, cropping intensity, and percentage area under irrigation and HYV on different types of holdings

Holding size group (Hectares)	Mandays per hectare: On all farms (1969-70)		Mandays per hectare: On tubewell irrigated farms (1968-69 to 1969-70)	
	Tractor	Non-tractor	Tractor	Non-tractor
6-9	106.5	90.7	115.28	93.99
9-14	104.0	107.8	111.25	96.78
14-24	96.3	67.6	82.60	68.04
24 & above	53.6	55.4	59.10	52.94
Average	76.3	87.4	93.83	96.31
Percentage of gross cropped area to operational holding				
6 & above	133.90	123.61		
Percentage of cropped area irrigated				
6 & above	93.21	90.38		
Percentage of cropped area under Mexican wheat				
6 & above	45.27	24.38		

Source: Ferozepur district consolidated report, 1967-68 to 1969-70, pp. 238, 234 and 237.

Thus, while the spread of the seed-fertiliser based technology has had the effect of promoting labour use importantly by increasing the proportion of the cropped area devoted to more labor-intensive crops, mechanisation has tended to work in the opposite direction thereby moderating the overall increase in labour use per unit of cultivated area that can be attributed to new technology.

Given the existing size-structure of the ownership and operation of cultivated area, the complementarity between seed-fertiliser technology, irrigation through private investment and mechanisation to which HanumanthatRao refers is a real one. The question, however, is whether the existing size-structure of farms should not be altered if it can minimise mechanisation, at this stage of India's agricultural development at any rate, to that which is technically necessary to increase cropping intensity and foster the spread of the seed-fertiliser technology so that its employment potential is fully reaped. Since the expansion of irrigation can in any case be promoted through state initiative and aid, and we have shown that its employment increasing potential, even by itself, is so sizeable, it deserves an enhanced emphasis even where there is a lag in developing high-yield varieties.

III. Labour Use and Farm Size

The size of farm is usually found to have a negative relationship with the employment of human labour per unit of land. Labour unit per hectare may increase with a decrease in the size of holding in one or more of three ways: one, through an increase in the intensity of cropping; two, through the adoption of a more labour intensive cropping pattern; and three, through a greater use of labour per hectare under individual crops.

It would be seen from Table 15 that increase in the intensity of cropping is resorted to by smaller farmers everywhere. Greater availability of irrigation in relation to operated area is, of course, one explanation. But that this is not all can be seen from the fact that cropping intensity is greater on smaller holdings even on unirrigated areas. And labour input per unit of land is higher on smaller farms even after allowing for the differences in the intensity of cropping in respect of both irrigated and unirrigated areas.

In so far as the increase in cropping intensity takes the form of raising another crop in the rabi season, the fact that the rabi crops are generally raised on a smaller area than the kharif thus reducing the demand for hired labour in the rabi season, and hence reducing the opportunity cost of family labour in smaller farms, makes it more advantageous for small farmers to use their labour to raise another crop on their own farms rather than to hire it out to others. Inasmuch as the differences among holding-size groups in respect of labour input per unit of cultivated area reflect the differences in cropping intensity, we would have allowed an approximate correction for the latter if we express labour input per unit of cropped area. In Table 16 we have done this for the six different centres in which farm management studies have been carried out and show that the inverse relationship persists between holding-size and labour input per cropped hectare.

The fact that even in respect of cropped area there is inverse relationship between farm size and labour input per hectare implies that it is either due to the adoption of a more labour intensive cropping pattern on the part of small farmers or because they are using more labour per hectare under individual crops. It would be instructive to examine how far it is the one

Table 15: Percentage intensity of cropping and employment of labour per acre cropped for irrigated and unirrigated areas during 1954-55 to 1956-57 for Amritsar and Ferozepur districts of Punjab and during 1967-68 to 1969-70 for Punjab as a whole

Holding-size group (acres)	Percentage intensity of cropping			Employment of mandays on crop production		
	Irrigated areas	Unirrigated areas	Overall	Irrigated areas	Unirrigated areas	Overall
Punjab 1954-55 to 1956-57						
0-5	164	145	162	24.4	12.3	23.8
5-10	155	122	152	24.0	13.3	22.9
10-20	144	112	136	23.9	13.1	22.0
20-50	133	105	124	23.1	10.8	19.6
50 & above	111	104	109	18.4	7.9	16.7
Punjab 1967-68 to 1969-70						
0-10.0	165.3	128.3	152.6	34.7	22.0	32.0
10.0-17.5	148.5	121.9	140.7	29.7	19.8	28.3
17.5-25.0	147.8	115.1	138.0	31.3	18.4	28.6
25 & above	139.5	94.8	125.0	27.3	16.6	25.4

Sources: 1. Studies in Economics of Farm Management in Punjab, combined report, p. 20 and 21; 2. Economics of Agricultural Production and Farm Management in Punjab, reports for the years 1967-68, 1968-69 and 1969-70, Economic and Statistical Organisation, Government of Punjab, India.

Table 16. Percentage intensity of cropping and employment of labour per cultivated and cropped hectare

Holding-size group (hectares)	Percentage intensity of cropping	Mandays per hectare of	
		Cultivated area	Cropped area (set 1)
Ferozepur 1968-69 to 1969-70[1/]			
Below 6	143.7	103.9	76.5
6 - 9	135.0	84.6	67.9
9 - 14	134.0	83.9	64.7
14 - 24	130.9	71.6	54.7
24 & above	109.6	53.9	46.7
Deoria 1966-67 to 1968-69			
0.01 - 1.04	142.6	182.7	128.7
1.05 - 1.79	135.1	151.4	111.7
1.80 - 3.07	133.8	136.3	101.7
3.08 & above	123.2	118.8	96.8
Muzaffarnagar 1966-67 to 1968-69			
Below 2.87	147.5	142.3	97.3
2.88 - 4.71	143.5	115.8	82.0
4.72 - 6.96	144.3	110.6	78.5
6.97 - 10.65	138.8	89.9	66.1
10.66 & above	131.5	87.4	68.4
Thanjavur 1967-68 to 1969-70[2/]			
Up to 1.16	167	248.1	144.0
1.17 - 2.02	169	218.7	127.1
2.03 - 3.05	169	211.3	117.5
3.06 - 5.71	162	214.6	125.8
Above 5.71	128	145.4	107.1
Cuddapah 1967-68 to 1969-70			
Below 1.62	111.9	157.5	141.7
1.63 - 3.23	96.8	109.1	112.7
3.24 - 6.07	93.0	93.5	100.2
6.08 - 11.33	92.2	69.7	72.7
11.34 & above	91.7	67.6	74.1

Table 16. (continued)

Holding-size group (hectares)	Percentage intensity of cropping	Mandays per hectare of Cultivated area	Mandays per hectare of Cropped area (set 1)
Nowgong 1968-69 to 1969-70			
0.01 - 1.82	140.6	131.4	92.9
1.83 - 2.43	137.4	118.7	86.1
2.44 - 3.24	127.8	112.6	88.7
3.25 - 4.45	123.4	96.1	77.8
Above 4.45	117.0	91.8	77.8

1/ Percentage intensity of cropping for Ferozepur is for the years 1967-68 to 1969-70.

2/ Mandays per hectare of cultivated area for Thanjavur are for the years 1968-69 to 1969-70.

Sources: Studies in the Economics of Farm Management in Ferozepur District (Punjab), three year consolidated report 1967-68 to 1969-70; Studies in Economics of Farm Management in Deoria (Uttar Pradesh), combined report 1966-67 to 1968-69; Studies in the Economics of Farm Management in Muzaffanagar District (U.P.), reports for the years 1966-67, 1967-68 and 1968-69; Studies in the Economics of Farm Management in Thanjavur (Tamil Nadu), reports for the years 1967-68, 1968-69 and 1969-70; Studies in the Economics of Farm Management in Cuddapah District (Andhra Pradesh), reports for the years 1967-68, 1968-69 and 1969-70; Studies in the Economics of Farm Management in Nowgong District (Assam), reports for the years 1968-69 and 1969-70.

or the other or both. Let us first see to what extent, if at all, labour input per hectare varies as between size holdings for each individual crop (Table 17).

There is enough evidence to bring out a broad inverse relationship between labour input per hectare under individual crops and farm size but this relationship is by no means uniform. For example, certain irregularities exist as in the case of desi cotton (Ferozepur), paddy (Muzaffaranagar), unirrigated jowar and irrigated bajra (Cuddapah), but a more clear deviation from the general pattern is visible in the case of paddy IR-8 (Ferozepur) and that of banana (Cuddapah). Positive relationship between labour input per hectare and farm size, however, can be singled out only for irrigated sugarcane ratoon in Deoria. In view of this broad inverse relationship and the fact that some farms may apply more labour to one crop and some to another, if we hold the cropping pattern constant we will be able to see more clearly if there is a relationship between farm size and the application of labour

Table 17. Employment of mandays per hectare for individual crops[1/]

Ferozepur 1967-68 to 1969-70

Holding-size	Mexican wheat	Desi wheat	American cotton	Desi cotton	Maize desi	Paddy local	Paddy[2/] IR-8
Below 6	80.0	59.6	78.5	72.8	95.0	84.7	131.4
6 - 9	81.7	52.5	69.1	74.1	76.2	72.9	54.9
9 - 14	73.2	54.8	73.0	76.7	73.3	89.6	95.3
14 - 24	64.4	44.3	68.5	91.5	53.8	77.1	95.2
24 & above	58.2	47.3	62.3	57.5	53.6	72.6	111.4
All farms	68.2	52.2	68.8	81.4	72.2	78.9	91.9

Deoria 1966-67 to 1968-69

	Paddy		Wheat		Sugarcane			
					Planted		Ratoon	
	Early unirrigated	Late unirrigated	Unir-rigated	Irri-gated	Unir-rigated	Irri-gated	Unri-rigated	Irri-gated
0.01 - 1.04	116.3	83.0	78.3	149.4	303.3	512.0	195.0	52.8
1.05 - 1.79	100.0	93.5	79.8	101.4	246.0	307.2	142.3	131.0
1.80 - 3.07	97.0	66.0	64.5	103.0	206.4	304.9	117.7	166.1
3.08 & above	77.1	61.7	45.3	96.5	185.2	319.8	111.4	188.4
All farms	85.8	65.1	57.6	100.1	199.2	318.2	118.1	176.9

Muzaffarnagar 1966-67 to 1968-69

	Sugarcane		HY Wheat	Other Wheat	Paddy	Maize	Gram	Pea	Gochani
	Planted	Ratoon							
Below 2.87	187.7	126.0	129.3	84.7	71.0	69.1	44.1	43.0	69.3
2.88 - 4.71	169.7	117.0	68.6	63.8	69.0	57.5	38.3	41.2	54.9
4.72 - 6.96	150.3	106.3	66.7	66.3	71.3	58.8	41.9	42.1	55.4
6.97 - 10.65	130.3	102.3	66.7	58.8	65.3	40.7	35.3	39.3	56.4
10.66 & above	146.0	82.3	55.9	45.9	71.3	39.7	38.0	42.2	49.0
All farms	147.0	99.0	63.1	58.0	69.3	47.5	38.2	40.8	54.9

Thanjavur 1967-68 to 1969-70

	Kuruvai ADT - 27	Samba Co - 25	Samba local	Thaladi Co - 25	Thaladi local
Up to 1.16	157.1	163.1	165.1	133.8	156.8
1.17 - 2.02	157.8	137.9	139.2	122.8	130.8
2.03 - 3.05	143.4	135.5	137.1	113.1	135.3
3.06 - 5.71	155.2	135.2	152.8	127.4	148.9
Above 5.71	117.0	115.6	131.8	102.3	113.9
All farms	141.5	129.6	138.0	116.0	134.3

Table 17. (Continued)

Cuddapah 1967-68 to 1969-70

	Paddy Irrigated	Jowar Unirrigated	Groundnut Unirrigated	Bajra Irrigated	Bajra Unirrigated	Banana[3/]
Below 1.62	197.8	33.8	74.2	108.8	55.1	371.4
1.63 - 3.23	189.8	31.1	54.4	86.2	68.0	N.A.
3.24 - 6.07	151.7	36.0	75.8	121.9	47.6	333.5
6.08 - 11.33	148.0	34.1	60.9	108.0	47.5	170.4
11.34 & above	127.8	33.2	54.6	74.8	43.2	414.2
All farms	143.7	34.1	60.5	98.4	50.6	237.0

Nowgong 1968-69 to 1969-70

	Winter Paddy		Autumn paddy	
	Sali	Bao	Ahu	Jute
0.01 - 1.82	78.2	84.5	91.4	172.1
1.83 - 2.43	76.4	70.1	91.7	167.7
2.44 - 3.24	75.5	61.3	88.8	170.4
3.25 - 4.45	69.9	61.2	80.1	151.5
Above 4.45	75.7	52.2	83.7	156.8
All farms	74.5	60.3	86.4	161.9

[1/] The crops listed here are those for which labour input per hectare was available in the reports of the farm management studies.

[2/] Data for paddy IR-8 pertains to the year 1969-70.

[3/] Data for banana is for the year 1969-70.

Sources: See Table 16

to individual crops taken together. We, therefore, estimate the area for each crop for farms of various size holdings on the assumption that they distribute their area as between various crops in the same proportion as the average for all farms. Multiplying the estimated areas under these crops by the actual labour input for the respective crops given by holding-size groups in Table 17, we can arrive at the pattern of labour inputs per hectare which would have obtained in the absence of differences in the cropping pattern among holding-size groups.

That the small farmers bestow more care and effort in raising individual crops is clear enough. What needs to be ascertained now is whether they are also able to adopt a more labour intensive cropping pattern. To examine this question we take the actual cropping pattern for the different holding-size

Table 18. Estimated labour input per hectare of cropped area with a uniform cropping pattern for all farms (Set 2)

Ferozepur		Deoria		Muzaffarnagar	
Holding-size	Mandays	Holding-size	Mandays	Holding-size	Mandays
Below 6	77.9	0.01 - 1.04	158.6	Below 2.87	103.5
6 - 9	70.6	1.05 - 1.79	126.7	2.88 - 4.71	87.6
9 - 14	71.4	1.80 - 3.07	114.3	4.72 - 6.96	84.0
14 - 24	64.2	3.08 & above	102.9	6.97 - 10.65	75.0
24 & above	58.8			10.66 & above	72.0
Thanjavur		**Cuddapah**[1/]		**Nowgong**	
Up to 1.16	155.4	Below 1.62	98.5	0.01 - 1.82	92.5
1.17 - 2.02	140.4	1.63 - 3.23	77.8	1.83 - 2.43	88.0
2.03 - 3.05	134.1	3.24 - 6.07	88.6	2.44 - 3.24	85.2
3.06 - 5.71	143.0	6.08 - 11.33	76.6	3.25 - 4.45	78.8
Above 5.71	114.6	11.34 & above	75.2	Above 4.45	80.7

[1/] Labour input for banana for farms belonging to the holding-size group 1.63 - 3.23 is not available and hence the mandays devoted to this crop are not included in the estimated figure of 77.8 mandays for this group of farms. The latter, therefore, is not strictly comparable with the estimated mandays for farms belonging to the other holding-size groups.

groups but hold the labour inputs for the individual crops constant at the level of the individual crop averages for all farms. Multiplying these average labour inputs for the individual crops with the actual areas under the respective crops in the different holding-size groups, we obtain the farm size-group wise pattern of the total labour input per cropped hectare. The picture that emerges is interesting. The inverse relationship between farm size and labour input per hectare no longer obtains for all the centres.

In the case of Ferozepur there does not seem to be any relationship with farm size, whereas for Deoria and Muzaffarnagar, specially for Deoria, some positive relationship between labour input and size of holding is visible. For the other three centres, however, the inverse relationship persists -- mildly for Thanjavur, more clearly for Cuddapah and to some extent for Nowgong. Of the first three, Ferozepur and Muzaffarnagar have had a vigorous impact of technological change, with the result that both small and big farmers have taken extensively to high-yielding variety of crops thus reducing the differences in the cropping pattern of the different holding-size groups. On the other hand, Thanjavur and Nowgong are monoculture economies -- the first one almost completely and the second predominantly. The influence of the labour intensity of the cropping pattern is thus most visible in the case of Deoria and Cuddapah, pointing to the adoption of a less labour intensive cropping pattern in Deoria and a more labour intensive

Table 19. Estimated labour input per hectare of cropped area with a uniform labour input to individual crops for all farm (Set 3)

Ferozepur		Deoria		Muzaffarnagar	
Holding-size	Mandays	Holding-size	Mandays	Holding-size	Mandays
Below 6	67.1	0.01 - 1.04	102.5	Below 2.87	76.3
6 - 9	68.3	1.05 - 1.79	108.4	2.88 - 4.71	78.9
9 - 14	67.1	1.80 - 3.07	105.7	4.72 - 6.96	77.2
14 - 24	68.1	3.08 & above	110.3	6.97 - 10.65	78.3
24 & above	67.1			10.66 & above	78.8
Thanjavur		**Cuddapah**		**Nowgong**	
Up to 1.16	133.0	Below 1.62	93.9	0.01 - 1.82	84.3
1.17 - 2.02	132.5	1.63 - 3.23	82.8	1.83 - 2.43	85.6
2.03 - 3.05	132.2	3.24 - 6.07	86.1	2.44 - 3.24	84.5
3.06 - 5.71	131.8	6.08 - 11.33	74.6	3.25 - 4.45	83.8
Above 5.71	131.9	11.34 & above	72.3	Above 4.45	79.8

cropping pattern in Cuddapah by the small farmers. A comparison between Deoria and Cuddapah, therefore, should help throw light on why the small farmers opt for a more labour intensive cropping pattern in some places and not in others. Is it because labour intensive crops in some places require irrigation and the small farmers there have a lower proportion of their area under irrigation or is it because these crops demand more cash expenditure. Another factor could be the risky character of the labour intensive crops. In short, what are the constraints in the case of small farmers which prevent them from taking to a more labour intensive cropping pattern everywhere.

Let us analyse the case of Deoria and Cuddapah. In Deoria the small farmers are applying a much larger number of labour days per hectare to individual crops as compared to bigger farmers except in the case of irrigated sugarcane (ratoon). The latter, however, can be ignored as the small farmers have only 0.07 hectares under irrigated sugarcane (ratoon) out of a total of about 27 hectares under the crops considered here. In other words, the small farmer is devoting more labour to individual crops but allocating his land relatively more to less labour intensive crops. The reason for the latter seems to lie partly in the lower level of irrigation in his case as compared to bigger farmers and partly in the fact that more labour intensive crops are also the more demanding in terms of cash expenditure.

The percentage of gross irrigated area to gross cropped area shows a positive relationship with farm size in Deoria unlike the usual pattern of negative relationship elsewhere. Second, it would be seen that there is a perfect rank correlation between the labour intensity of crops and their requirement in terms of cash expenditure per hectare. As a result of both these factors, the small farmers in Deoria are devoting only 22 percent of their area to the labour intensive crops, i.e. sugarcane and irrigated wheat,

Table 20. Percentage of gross irrigated area to gross cropped area, and employment of labour and cash expenditure per hectare on individual crops in Deoria, 1966-67 to 1968-69

Percentage of gross irrigated area to gross cropped area
Holding-size group (hectares)

0.01 - 1.04	1.05 - 1.79	1.80 - 3.07	3.08 & above	All farms
22.1	28.2	29.3	32.4	30.9

Crops	Employment of labour (mandays per hectare)	Cash expenditure (Rs. per hectare)
Irrigated sugarcane planted	318.2	657.3
Unirrigated " "	199.2	403.6
Irrigated sugarcane ratoon	176.9	298.2
Unirrigated " "	118.1	208.4
Irrigated wheat	100.1	177.9
Unirrigated paddy early	85.8	166.6
" " late	65.1	134.4
Unirrigated wheat	57.6	125.2

Source: Studies in Economics of Farm Management in Deoria (Uttar Pradesh) combined report 1966-67 to 1968-69.

as against 31 percent by the bigger farmers. In spite of this we find a negative relationship between labour input and farm size. In other words, the lower labour intensity of the cropping pattern on the smaller farms has been offset by the higher labour input applied to the individual crops. Even so, in spite of the inclusion of days spent on social and family affairs, an adult male family worker is able to get work for only 180 days in the year on a small farm 1/ thus making for that poverty which prevents him from

1/ Employment per adult male family worker per annum in Deoria by size of farms during 1966-67 to 1968-69.

Size of farms (hectares)

0.01 - 1.04	1.05 - 1.79	1.80 - 3.07	3.08 & above	All farms
179.84	211.13	226.39	227.23	214.80

Source: Studies in Economics of Farm Management in Deoria (U.P.) combined report 1966-67 to 1968-69, p. 67.

taking to more labour intensive but also more resource intensive crops. With the softening of the resource constraint and with the expansion of irrigation, the small farmer could also resort to a more labour intensive cropping pattern and thus utilise his time more fully. Unlike the advanced western districts of U.P., technological changes have had a slow impact on its eastern districts like Deoria. The average size of farm in Deoria is small (2.86 hectares) and fragmented (4.91 fragments per hectare of cultivated area) with poor, expensive and insecure facilities of irrigation over a limited area. 1/

In Cuddapah, on the other hand, with a larger average size of farm (5.85 hectares) and with farms much less fragmented (0.99 fragments per hectare), the farmers, especially the smaller ones, have a comparatively higher level of irrigation 2/ and are able to go in for a more labour intensive cropping pattern. The distribution of total area amongst crops shows that the small farms are devoting 30.2 percent of their total area to irrigated paddy, irrigated bajra and banana -- the three more labour intensive crops -- as against 18.4 percent by the large farms. This is despite the fact that in Cuddapah too, like Deoria, there is a positive relationship between the labour intensity of crops and their requirement in terms of cash expenditure per hectare.

A higher level of irrigation on the smaller farms also reduces the element of risk which inhibits going in for more expensive crops.

Thus small farmers everywhere put in more labour per hectare on individual crops and wherever possible also go in for a more labour intensive cropping pattern. Greater availability of family labour in conjunction with the income effect (arising out of low incomes) induces them to do their utmost in increasing output by maximising their labour input. Large farmers, on the other hand, with smaller families per unit of operated area and higher incomes, are induced to mechanize farming operations especially in those areas where the introduction of seed-fertiliser technology has increased labour requirements and the shortage of labour has had the effect of pushing up wages. In Ferozepur, for example, the adoption of seed-fertiliser technology has gone along with mechanisation to a great extent, especially on the large farms, and on large farms the leisure preference of the family workers has been an accentuating force in bringing about mechanisation. The fact of leisure preference is brought out both by a comparison of the contribution of hired and family labour in total labour input per hectare, and of the annual employment days of a family worker, as found during the 1960's with that of the 1950's. Table 22 shows that in spite of a decline in total labour input per hectare for each of the three crops, i.e. desi wheat, American cotton and desi cotton during the 1960's over that of the 1950's, hired

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1/ See, Studies in Economics of Farm Management in Deoria (U.P.), combined report 1966-67 to 1968-69, p. 249.

2/ Gross irrigated area in the smallest holding-size category in Cuddapah constitutes 52 percent of gross cropped area as against the corresponding figure of 22.1 percent for Deoria.

Table 21. Employment of labour and cash expenditure per hectare on individual crops in Cuddapah, 1967-68 to 1969-70

Crops	Employment of labour (mandays per hectare)	Cash expenditure (Rs. per hectare)
Banana 1/	237.0	498.7
Paddy irrigated	143.7	403.4
Bajra "	98.4	189.5
Groundnut unirrigated	60.5	137.9
Bajra "	50.6	94.5
Jowar "	34.1	53.4

1/Data for banana pertains to the year 1969-70.

Source: Studies in the Economics of Farm Management in Cuddapah District (Andhra Pradesh), reports for the years 1967-68, 1968-69 and 1969-70.

Table 22. Employment of family and hired labour per hectare in Ferozepur on an average for all farms and on the largest farm

	Mandays per hectare					
	1954-55 to 1956-57			1967-68 to 1969-70		
Crop	Family labour	Hired labour	Total	Family labour	Hired labour	Total
	Average of all farms					
Cotton American	52.2	34.4	87.1	23.2	45.5	68.8
Cotton desi	73.6	22.2	96.0	38.0	43.4	81.4
Desi wheat	55.9	15.0	68.9	24.4	27.9	52.2
Mexican wheat	-	-	-	30.5	27.7	68.2
All crops 1/	35.3	12.6	47.8	30.7	29.3	60.0
	Largest farm					
	(20 hectares & above)			(24 hectares & above)		
Cotton American	21.7	48.4	70.1	10.6	51.6	62.3
Cotton desi	30.4	32.9	63.3	17.7	39.9	57.5
Desi wheat	20.0	35.1	55.1	12.7	34.6	47.3
Mexican wheat	-	-	-	18.3	39.8	58.2
All crops 2/	14.6	26.7	41.3	12.0	34.7	46.7

1/Data for all crops during the 1950's is an average for the years 1954-55 and 1956-57. See Footnote 1 to p. 8.

2/Data for all crops during the 1960's is an average for the year 1968-69 to 1969-70.

Sources: Studies in the Economics of Farm Management in the Punjab, combined report 1954-55 to 1956-57, and reports for the years 1954-55 and 1956-57; Studies in the Economics of Farm Management in Ferozepur District (Punjab), three year consolidated report 1967-68 to 1969-70

labour use per hectare has risen and family labour input has fallen over this period. Such is the case not only for the average of all farms but also for farms belonging to the largest holding-size. 1/

Mexican wheat is able to arrest this decline in total labour input per hectare, and even increase the total labour input on the largest farms, but still there is a decline in the labour input per hectare by family workers as compared to that for desi wheat during the 1950's and a further rise in the labour input by hired workers.

This leisure preference also reflects itself in reduced working days in the year by a family worker both on an average for all farms as well as for the largest farm. In constrast, the small farmer who can hardly afford leisure is found to devote more working days in the year to the farm as compared to the 1950's. 2/

Table 23. Annual employment per family worker (in 8 hour days)

	Smallest farm		Largest farm		All farms
	Holding size	Days	Holding size	Days	Days
1956-57	0 - 5 (acres)	267.1	50 & above (acres)	379.9	316.0
1969-70	Below 6 (Ha)	292.0	24 & above (Ha)	226.4	302.0

Sources: Studies in Economics of Farm Management in Punjab, 1956-57, p. 212 and 41; Studies in the Economics of Farm Management in Ferozepur District (Punjab), Report for the year 1969-70, p. 59

It is not only the family worker who is working for a smaller number of days in the year now but also a permanent farm servant. Annual employment of a farm worker has, therefore, fallen from 340.3 mandays during the 1950's to 308.4 mandays during the 1960's (Table 24).

1/ A comparison for farms belonging to the largest holding-size group in Ferozepur between the 1950's and the 1960's becomes possible because in this group there were no farms in Amritsar during the 1950's.

2/ Labour input per farm worker in Ferozepur by holding-size groups is available for the year 1956-57. Since there were no hired workers in the holding-size group of 0 - 5 acres, labour input per farm worker is actually that of a family worker. A comparison between labour input per family worker for farms of the smallest holding-size group thus becomes possible for 1956-57 with a later year during the 1960's.

Table 24. Annual employment per family worker, farm servant and farm worker (in 8 hour days)

Holding-size (acres)	Average for the years 1954-55 and 1956-57			Holding-size (hectares)	Average for the period 1968-69 to 1969-70		
	Family worker	Hired worker	Farm worker		Family worker	Hired worker	Farm worker
50 & above	392.9	537.0	473.6	24 & above	225.4	311.7	275.9
All farms	323.0	421.9	340.3	All farms	297.9	322.6	308.4

Sources: Studies in Economics of Farm Management in Punjab, 1954-55 and 1956-57; Studies in the Economics of Farm Management in Ferozepur District, (Punjab), consolidated report 1967-68 to 1969-70, p. 45

It is thus not only the increased labour requirements of the seed-fertiliser technology that induced mechanisation but also the leisure preference on the part of family workers along with a reduced annual labour input by a hired worker -- presumably reflecting an increase in his bargaining power -- that acted as an accentuating force in inducing mechanisation, inasmuch as it increased the number of workers required to carry out a particular quantum of work. From the point of view of the employment of hired workers, a reduced annual labour input on the part of family as well as hired workers is a welcome development, but the fact remains that in the absence of excessive mechanisation the much greater employment opportunities for hired labour, that the seed-fertiliser technology throws up, could have materialised. In any case, insofar as the tendency to mechanise is accentuated by the bigger farmers whether through their leisure preference or via the complementarity between seed-fertiliser technology and mechanisation, there is need for keeping the farm size relatively small.

IV. Conclusion

The potential of irrigation in extending the productive use of labour on farms is large. Seed-fertiliser technology too increases labour use but since its spread has accompanied mechanisation, the substitution of capital for labour has led to a reduction rather than an increase in labour input per hectare on individual crops. But via an increase in cropping intensity and even more importantly, by inducing shifts in the cropping pattern from less labour intensive to more labour intensive crops, it has extended labour use. Moreover, since the spread of new technology has accompanied expansion of irrigation, there has been, on balance, an overall increase in the application of labour per unit of cultivated area. However, abstracting from the employment effect of irrigation and cropping pattern changes, the direct effect of new technology -- taken as a mix of seed fertiliser technology cum

mechanisation -- would seem to be rather limited. The more important cont bution of new technology is in lifting yield levels -- and even more, the levels of incomes per hectare -- beyond those to which irrigation is able push them.

Thus the employment increasing potential of irrigation being sizeable it deserves an enhanced emphasis even where there is a lag in developing high-yield varieties. Further, since the spread of high-yield varieties and mechanisation assume a certain complementarity with an increase in the size of the farm, and the income effect in the case of the bigger farmers tends to accentuate mechanisation thereby moderating the overall increase labour use per unit of cultivated area, there is need for keeping the farm size relatively small in order to exploit more fully the employment potential of the seed-fertiliser technology.