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types of functions, land concentration ratio and agricultural labour explain about 53 per cent of the inter-district wage differentials.

SUMMARY

The above discussion may be summarised as below :

1. Money wages increased over time in all the districts. But in real terms, it declined in all the districts except Ahmedabad and Surat. However, in most of districts the productivity has also shown an increase, which is slightly lower than the increase in money wages.

2. The changes in productivity have not influenced the real wages. Similar is the case with the money wages except for Jamnagar, Bhavnagar, Amreli and Baroda where it is influenced by the productivity changes probably due to the fact there has been piece rate system of wages particularly for harvesting of groundnut and cotton in these districts.

3. All the variables included in the equations to explain the inter-district wage differentials for the year 1968-69 in Gujarat, have the expected sign. Of course, only the availability of pump-sets and agricultural labour turn out to be significant. The former has positive sign for its coefficients, whereas in the latter the coefficients have negative sign, indicating that the wage rate responds positively to the variations in the availability of pump-sets and negatively to the agricultural labourers.

INTER-TEMPORAL ANALYSIS OF PRODUCTIVITY AND WAGES OF FARM LABOUR IN FEROZEPUR DISTRICT (PUNJAB)

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Punjab agriculture is changing very fast. The introduction of new technology has affected agricultural production, resource use and distribution of gains to the factor owners. Based on the Farm Management Studies data, this paper aims at studying changes in labour productivity and wage rate. The specific objectives of this paper are (*i*) to study the labour production function and its demand for the periods 1954-57 and 1966-70 in Ferozepur district, and (*ii*) to examine the variation in the productivity of labour and its wages for the above period and for the district.

Part II of this study is devoted to the labour production function and demand. The changes in the productivity, wages and prices are described in Part III. The last part is devoted to conclusions.

II

LABOUR PRODUCTION FUNCTIONS AND DEMAND

(a) Labour Production Function

Productivity of farm labour can be analysed by studying production functions. Resource productivity and resource demand curve can also be obtained from the production function.[1] Let :

$$Y = f(x) \quad .. \quad .. \quad .. \quad .. \quad (1)$$

$$\frac{dy}{dx} = \frac{w}{p} \quad .. \quad .. \quad .. \quad .. \quad (2)$$

$$X = \alpha_1 + \alpha_2 \frac{w}{p} \quad .. \quad .. \quad .. \quad (3)$$

where Y=product, X=labour input,
p=price of production and w=farm wages and
α_1 and α_2 = constants.

In the present study production functions were estimated using the following model :

$$Y = f\ (X,\ D_1,\ D_2,\ D_3 \text{ and } D_4) \quad .. \quad .. \quad (4)$$

where Y=average yield of crops in quintal/hectare.
X=quantity of labour used per hectare in days.

D_1= (1 if farm size is less than 2 hectares for the first period and
(less than 6 hectares in the second period.
(
(0 Otherwise.

D_2= (1 if farm size is 2 to less than 4 hectares for the first period
(and less than 6 to 9 hectares in second period.
(
(0 Otherwise.

D_3= (1 if farm size is 4 to less than 8 hectares for the first period
(and 9 to 14 hectares in second period.
(
(0 Otherwise.

and

D_4= (1 if farm size is 8 to less than 20 hectares for the first period
(and 14 to 24 hectares in second period.
(
(0 Otherwise.

1. The procedure is explained in E. O. Heady and J. L. Dillon: Agricultural Production Functions, Iowa State University Press, Ames, Iowa, U.S.A., 1961.

First period denotes 1954 to 1957 while the second period denotes 1967 to 1970.

Two types of functions were estimated : One with hired labour only while the other with total labour.

The data for this study was obtained from the Farm Management Studies in Punjab.[2] The data for the year 1954-57 were combined for the districts of Amritsar and Ferozepur. The data however could not be separated for Ferozepur district alone. This might have introduced some bias in the results.

The crops included in the analysis of the first period, *i.e.*, 1954-57 were irrigated and unirrigated wheat, wheat gram, and American and *desi* cotton. During the second period, *i.e.*, 1966-67 to 1969-70, the crops included were wheat—Mexican and *desi*, cotton—American and *desi*, maize—*desi* and paddy. The farms were classified into five size-groups of which four are given in equation (4) while the fifth size-group in respect of the first period was 20 hectares and more and in the second period it was 24 hectares and above. For the first period the data relate to the districts of Amritsar and Ferozepur while for the second period it was only for Ferozepur district.

The least-square technique was used to estimate functions using the relationship specified in equation 1. It was hypothesized that the contribution of hired and total labour to the output was positive. It was also hypothesized that the productivity of labour was the same on all size-groups. It was also expected that there will be an upward shift in the productivity of labour during the period of 10 years under investigation. The upward shift in the labour productivity might be due to technological development as well as investment in new inputs, such as fertilizers, improved seeds, irrigation water and pesticides, etc.

Table I presents the estimated hired labour production functions for the periods 1954-57 and 1967-70. Labour variable was included in quadratic form. Four dummy variables were introduced to represent farm sizes. The dependent variable was quantity of produce per hectare measured in quintal. The examination of Table I reveals that the coefficient of the linear term hired labour was negative for the years 1954-55 and 1955-56. It was, however, positive in 1956-57. The quadratic terms had opposite sign in all the cases. But none of these coefficients were statistically significant. The negative coefficients for the linear term in the first two equations indicated that the marginal productivity of labour was negative upto some level of employment. The exact amount could be determined from the size of the

2. Studies in the Economics of Farm Management in the Punjab, Combined Report, 1954-55—1956-57, Ministry of Agriculture, Government of India, New Delhi, 1963; Studies in the Economics of Farm Management in Ferozepur District (Punjab), 1967-68 to 1969-70, Ministry of Agriculture, Government of India, New Delhi, 1973.

TABLE I—ESTIMATED PRODUCTION FUNCTIONS FOR HIRED LABOUR(a)

Year	Constant intercept	Coefficient of						
		Hired labour	Square of hired labour	D_1	D_2	D_3	D_4	R^2
1954-55 ..	10.919	—.109 (.208)b	.00097 (.005)	—1.408 (2.810)	—2.099 (2.469)	—2.164 (2.412)	—1.049 (2.350)	.073
1955-56 ..	5.616	—.003 (.223)	.001 (.005)	1.668 (2.880)	—.128 (+2.621)	.937 (2.611)	.586 (2.401)	.087
1956-57 ..	9.261	.324 (.355)	—.009 (.007)	—3.231 (3.380)	—4.811 (3.283)	—4.323 (2.662)	—3.097 (2.194)	.316
1967-68 ..	—1.950	.379** (.170)	—.003** (+.001)	—1.149 (2.155)	—1.412 (1.830)	—1.293 (1.840)	1.503 (1.949)	.342
1968-69 ..	—6.208	.532** (.179)	—.005** (.002)	—.0008 (2.065)	—2.153 (1.759)	—.160 (1.746)	.403 (1.756)	.390
1969-70 ..	9.685	.050 (.341)	—.001 (.003)	—.027 (2.440)	—1.893 (2.075)	—.648 (2.081)	1.039 (2.139)	.287

(a) Form of equation : $\hat{Y}=\hat{a}+\hat{b}_1 x_1+\hat{b}_2 x_1^2+\hat{b}_3 D_1+\hat{b}_4 D_2+b_5 D_3+\hat{b}_6 D_4$

(b) Standard Errors are shown in brackets.

** Significant at .01 level.

coefficients. The coefficients associated with hired labour for the years 1967-68 to 1969-70 had the expected sign, *i.e.*, the positive sign for the linear term and the negative for the quadratic term. These coefficients for the years 1967-68 and 1968-69 were statistically significant. These two years showed negative intercept term implying negative or zero output when hired labour was not utilized. The coefficients associated with the dummy variables representing farm sizes were mostly negative. But they were statistically insignificant. This indicates that the labour productivity was not related with the size of the farms in question. The value of R^2 was 0.073 and 0.87 for the years 1954-55 and 1955-56 respectively. The value of R^2 for other years was relatively higher. It varied from 0.287 to 0.390.

Table II presents estimated production functions for total labour for the two periods under investigations. Total labour was used as explanatory variable in linear as well as quadratic forms. The dummy variables were the same as in the previous example. The constant term was positive in all equations. The linear term of total labour was negative in two equations while it was positive in the other. None of the coefficients in linear and quadratic terms was statistically significant. Like the previous case, all coefficients of dummy variables had mixed signs—some positive and other negatives. But none of them was significant indicating no perceptible influence of farm sizes on total labour productivity. The value of R^2 varied from 0.055 to 0.166.

A comparison of the equations shown in Tables I and II indicates that equations containing hired labour as an explanatory variable were superior

TABLE II—ESTIMATED PRODUCTION FUNCTION FOR TOTAL LABOUR(a)

Year	Constant	Coefficients of						
		Total labour	Square of total labour	D_1	D_2	D_3	D_4	R^2
1954-55 ..	1.009	.642 (.602)	—.005 (.008)	3.542 (5.491)	2.376 (5.008)	—1.198 (4.923)	—2.165 (5.224)	.166
1955-56 ..	16.584	—.198 (.698)	.006 (.011)	—.708 (4.511)	—2.384 (4.380)	—2.303 (4.402)	—2.294 (4.541)	.087
1956-57 ..	10.238	.015 (.648)	.002 (.008)	4.110 (4.558)	1.733 (4.105)	3.865 (4.122)	4.314 (4.301)	.108
1967-68 ..	36.611	—.617 (.724)	.005 (.005)	—.631 (6.169)	1.379 (5.401)	—2.151 (5.594)	—1.572 (5.650)	.066
1968-69 ..	8.759	.296 (.473)	—.002 (.004)	—2.449 (4.865)	—4.082 (4.517)	—3.609 (4.651)	—1.503 (4.641)	.051
1969-70 ..	10.760	.058 (.661)	—.00009 (.004)	1.317 (4.909)	.448 (4.265)	2.684 (4.186)	3.859 (4.419)	.055

(a) Form of Function $\hat{Y}=\hat{a}+\hat{b}_1x_1+\hat{b}_2x_2+\hat{b}_3D_1+\hat{b}_4D_2+\hat{b}_5D_3+\hat{b}_6D_4$.

(b) Standard Errors are shown in brackets.

in many cases. This could be seen from the sign of coefficients, their significance and the value of R^2. This might be due to the basis of some economic considerations while the unpaid family labour which was one of the constituents of total labour was not employed strictly on economic considerations.

(b) *Demand Curve for Farm Labour*

As explained earlier, the demand curve for farm labour can be determined from the production function. The demand for any input by the farm is a derived demand. The demand function for the labour can be obtained by equating the marginal product of labour to the ratio of product price and wage rate. The demand functions for hired labour and total labour have been obtained for the selected years. The results are as shown in Table III.

One can observe the upward shift in the demand curves for labour in the second period. This shift is due to the increase in the productivity of hired labour on farms.

III

CHANGES IN PRODUCTIVITY, WAGES AND PRICES

The changes in productivity of labour, wages and prices have been compared in this section. As compared to the productivity of hired labour in the year 1956-57, it was 23 per cent and 70 per cent higher in the years 1967-68 and 1968-69 respectively. The productivity of labour as evident from the

TABLE III—DEMAND FUNCTIONS FOR HIRED LABOUR AND TOTAL LABOUR

Year	Demand function
	Hired labour
1956-57	$X = \frac{0.324}{0.018} - \frac{W}{P}\ (.018)$
1967-68	$X = \frac{.379}{.006} - \frac{W}{P}\ (.006)$
1969-70	$X = \frac{.050}{.002} - \frac{W}{P}\ (.002)$
	Total labour
1956-57	$X = \frac{.015}{(.004)} - \frac{W}{P}\ (.004)$
1968-69	$X = \frac{.269}{.004} - \frac{W}{P}\ (\cdot 004)$
1969-70	$X = \frac{.058}{.00018} - \frac{W}{P}\ (.00018)$

equations, however, was not consistent and stable in all the years. Fluctuations were very wide. This might be due to the fact that the labour productivity depends on use of other inputs and factors. But this analysis did not consider these associated factors. As compared to the years 1954-57, the nominal money wages were 2.3 times more in the years 1967-70. This wage increase can be compared with the rise in the index of consumer prices for agricultural labour. During the year 1957, this index number for Punjab, Delhi and Himachal Pradesh was 99. It ranged from 191 to 194 during the period of 1967-69.[4] This shows that the consumer prices for agricultural labour have become approximately twice (93 per cent). In other words, the nominal wages had increased to 230 per cent while the consumer prices for somewhat similar periods had risen to 193 per cent. Thus, the major part of the increase in wages might be due to the price rise while a small portion of increase might be due to the rise in the productivity. The condition of agricultural worker might not improve much even if the nominal wages are rising, because most of the gains might be absorbed in price rise.

CONCLUSION

This study was based on the data furnished by the Farm Management Studies in Ferozepur district of Punjab. The study shows that production functions containing hired labour as explanatory variable gave better results

3. Basic Statistics Relating to the Indian Economy, 1950-51 to 1970-71, Planning Commission, New Delhi, p. 21.

than those based on total labour. Probably, farmers base their decision on the basis of expenditure involved in hiring the farm labour. There was some upward shift in the productivity of labour during the period of investigation. However, the shift was not stable and it varied from year to year. During the period, wages rose by 130 per cent while the consumer prices increased approximately by 93 per cent. Some of the increase in wages might be attributed to the rise, though irregular in the productivity.

IMPACT OF GREEN REVOLUTION ON AGRICULTURAL WAGES IN THE PUNJAB

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Quite a large proportion of population in our country is below the poverty line. The Government has been endeavouring to narrow down inequalities in distribution of wealth and income with a view to ameliorating the conditions of the poorer sections of the population. The poverty problem is particularly severe among the landless classes in the rural areas. The agricultural labourers constitute a big majority of the weaker sections in the rural areas. A view is often expressed that fast rise in the prices of consumption goods is eroding the real earnings of labour class. It is important to probe this aspect.

An attempt has been made in this paper to examine the wage pattern of agricultural labour in the Punjab State—a premier State in experiencing the green revolution. Agricultural labour population is quite high in the State; the population was 7.86 lakhs in 1971 and constituted 32.09 per cent of the combined population of cultivators and agricultural labourers.

Hypothesis Tested and Source of Data

The main hypothesis sought to be tested in this paper is that technological break-through in agriculture has improved the real earnings of farm labour and increased the volume of employment. The empirical evidence to test this hypothesis was obtained from the Statistical Abstracts of Punjab issued by the Economic and Statistical Adviser, Government of Punjab and Farm Management reports for Punjab State published by the Economic and Statistical Adviser, Ministry of Agriculture, Government of India.