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(3) Maize fodder and paddy are more paying in Summer season. Cauliflower affects the returns from succeeding potato crop adversely to render it comparatively unprofitable. In Autumn season it pays to increase the acreage under potatoes and wheat. Cauliflower and berseem cultivation is not that profitable under such farm situations.

In Spring season potatoes followed by a maize fodder crop and tomatoes intercropped with late cauliflower or cabbage are comparatively more profitable enterprises.

(4) It is possible to enhance the returns to fixed farm resources to the tune of over 29 per cent over the returns from the existing production plan through rationalization of resource use alone even on progressive farms in the suburbs of the cities.

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AND
S. S. JOHL*

EVALUATION OF INTENSIVE AGRICULTURAL DISTRICT PROGRAMME— A CASE STUDY FOR WHEAT IN LUDHIANA DISTRICT†

The Intensive Agricultural District Programme (I.A.D.P.) was initiated in seven districts of India in 1961 (later extended to cover one district in each State) with a view to attain a rapid rate of growth in agricultural production in these districts. An attempt has been made in this paper to suggest a model for evaluating the impact of the I.A.D.P. on the productivity of important crops. The model has been put to test with the help of data on wheat crop in Ludhiana district for the years 1962-63 to 1965-66.

There are many ways in which the impact of the I.A.D.P. activities could be studied. At the aggregate level, one could study changes in aggregate production in the district over time. Using some price weights one could generate estimates of aggregate income and study changes therein. Another measure could be to study changes in yield rates for the major crops grown in the districts. We have concentrated on the study of the yield rates over time in our analysis. Since the I.A.D.P. activities have primarily concentrated on the technical aspect of increasing yields of important crops, changes in yield rates provide a ready reckoner of the impact of the programme. Moreover, if the cropping pattern does not alter substantially over time, change in yield rates of important crops also reflects the trends in aggregate production.

The Model

The principal measures for bringing about an increase in yield rates can be grouped into two broad categories :

(*a*) Streamlining the supplies of modern inputs of production such as improved seeds, fertilizers, pesticides, etc., and

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† The views expressed are the personal views of the author.

(*b*) Improving the managerial ability of the farmer through extension efforts so that the farmers are able to improve productivity per unit of inputs.

In addition to the above two factors a major force influencing the yield of crops in our country is weather. If we let :

Y_o = Per acre yield of wheat in year 0,
X_{io} = Per acre dose of i th input in year 0,
W_o = Weather complex in year 0.

Then,

$$Y_o = f_o (X_i)_o + u \qquad i = 1, \ldots\ldots n \tag{1}$$

$$Y_1 = f_1 (X_i)_1 + v \qquad i = 1, \ldots\ldots n \tag{2}$$

$$Y_1 - Y_o = f_1 (X_i)_1 = f_o (X_i)_o + (v-u) \tag{3}$$

or $$Y_1 - Y_o = f_1 (X_i)_1 - f_o (X_i)_1 + f_o (X_i)_1 - f_o (X_i)_o + (v-u) \tag{4}$$

or $$\triangle Y = \triangle Y_{\triangle f} + \triangle Y_{\triangle x_i} + (v-u) \tag{5}$$

where, $\triangle Y = Y_1 - Y_o$

$$\triangle Y_{\triangle f} = f_i (X_i)_1 - f_o (X_i)_1$$

$$\triangle Y_{\triangle x_i} = f_o (X_i)_1 - f_o (X_i)_o.$$

It may be seen that change in yield from one year to another ($\triangle Y$) can be explained through :

(*a*) change in yield due to change in the efficiency of resource use, assuming input levels to remain unchanged ($\triangle Y_{\triangle f}$),

(*b*) change in yield due to change in the level of inputs, assuming efficiency of resource use to remain unchanged ($\triangle Y_{\triangle x_i}$) ; and

(*c*) change in yield caused by change in weather complex ($\triangle Y_{\triangle w}$) and other unknown causes.

In real world situation the impact of change in yield due to change in the efficiency of resource use ($\triangle Y_{\triangle f}$) alone is difficult to estimate. Such an estimated change ($\triangle Y_{\triangle f}$) reflects the impact of change in weather and other factors also in addition to change in efficiency of resource use. To estimate the contribution of each factor separately is difficult. We have attempted to estimate change in yield due to change in weather complex ($\triangle Y_{\triangle w}$) on the basis of Rao's model.[1] Change in yield ($\triangle Y$) has thus been broken into three components :

1. B. M. Rao, "A Study of the Effect of Some Weather Factors on the Yield of Wheat in Ludhiana District, Punjab," The Silver Jubilee Number of the *Indian Journal of Agricultural Economics*, Vol. XIX, Nos. 3 and 4, July-December, 1964.

$$\triangle Y = \triangle Y_{\triangle x} + \triangle Y_{\triangle f} + \triangle Y_{\triangle w} \quad (6)$$

$$\text{or } \triangle Y_{\triangle f} = \triangle Y - \triangle Y_{\triangle x} - \triangle Y_{\triangle w} \quad (7)$$

It may thus be seen that the impact of the programme on the efficiency of resource use is measured by way of a residual. This residual in fact may reflect the contribution of some other unknown factors also. But by giving the benefit of doubt to the I.A.D.P., the residual is taken to reflect the impact of the programme alone on the efficiency of resource use. Another limitation of the model presented above lies in its inability to take into account the qualitative changes either in a single input or in the package of inputs. For instance, the model is not able to take cognizance of the replacement of existing varieties by high yielding varieties.

The Data

The data for the present study have been taken from the crop cutting experiments conducted each year on wheat crop in Ludhiana district. About 300 crop cuts are taken every year on each of the major crops in the district. Besides recording the yield level, information is also obtained on the level of inputs used and cultural operations performed by the investigators. Information is available on the following input items :

(*a*) Quantity of nitrogenous fertilizers,
(*b*) Quantity of phosphatic fertilizers,
(*c*) Quantity of potassic fertilizers,
(*d*) Quantity of farmyard manure, green manures and other organic manures,
(*e*) Number of irrigations,
(*f*) Date of sowing,
(*g*) Seed rate,
(*h*) Number of ploughings,
(*i*) Use of insecticides and pesticides, and
(*j*) Damage to the crop due to the various natural and other hazards.

The data for 1961-62 have not been used in the present analysis since it was the first year of the operation of the programme and there were some gaps in the data. The variables considered in the study are :

Y = Yield of wheat in quintals per acre
N = Pounds of nitrogen per acre
P = Pounds of phosphoric acid per acre
K = Pounds of potash per acre
I = Number of irrigations
P_1 = Number of ploughings
SR = Seed rate in kilogrammes per acre
DS = Date of sowing. Rankings of 1, 2 and 3 were given to the date of sowing depending on whether the crop was sown before the normal sowing season or during the normal sowing season or after the normal sowing season.

The Results

Several equations with linear and quadratic terms of the variables discussed above were fitted to the data. The results of two equations that fitted the data best and where the signs of the coefficients are in conformity with agronomic logic are presented in Tables I and II.

A perusal of the results presented in these tables indicates that the variables considered in the analysis are not able to explain a large proportion of the variance in yield. The signs of some of the coefficients are also not consistent with agronomic logic. Notwithstanding these limitations an attempt has been made to apportion the observed change in wheat yield per acre as between different years among different components. The results of the analysis are presented in Tables III and IV.

A perusal of these tables indicates that as compared to the base year, *i.e.*, 1962-63, the yield of wheat went up in all the subsequent years. The data show a decline in yield as between 1964-65 and 1965-66. A look at the factors contributing to change in yield indicates that about 1/3 to 1/2 of the observed change in yield over the base year can be explained by the changes in the level of inputs utilized. It may also be noted that the change in yield due to change in the level of inputs is positive for any two years for which comparison may be made (with the exception of change in yield due to change in inputs as between 1963-64 and 1965-66 for function 2). This indicates that the I.A.D.P. has been successful in motivating farmers to use higher levels of inputs. The change in yield due to the change in the efficiency of the resource use as reflected by $\triangle Y_{\triangle f}$ also turns out to be positive for all the years as compared to the base year. It is interesting to note that the proportion of change in yield that may be ascribed to change in the efficiency of resource use goes up over the years as compared to the base year. There is no consistency in the results for the later years. However, it is safe to infer that the programme has been able to improve the managerial skills of the farmers.

Summary

The Intensive Agricultural District Programme was initiated in 1961 to attain a rapid rate of growth in agricultural production in the selected districts. There has been a great deal of argument about the success of the programme. A model has been formulated to evaluate the impact of the programme. The data from crop cutting experiments on wheat in Ludhiana district have been utilized to study the impact of the programme and the factors affecting changes in yield rates. It appears that as a result of the programme farmers are using higher levels of inputs on an aggregate. The results of the study further indicate that there has been some improvement in the managerial skills of the farmers as reflected in aggregate productivity of resources.

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TABLE I—FACTORS AFFECTING YIELD OF WHEAT IN LUDHIANA

$(Y=a+b_1\ N+b_2\ I+b_3\ P_1+b_4\ DS+b_5\ SR+b_6\ I^2)$

Dependent variable	1962-63			1963-64			1964-65			1965-66		
	X_i	b	σ_b	X_i	b	σ_b	X_i	b	σ_b	X_i	b	σ_b
N	24.6	0.0092**	0.0043	19.9	−0.0039	0.0050	18.0	0.0278**	0.0107	18.9	0.0395***	0.0089
I	3.7	0.5573	0.3783	4.5	1.3643***	0.4415	4.3	0.6175	0.4318	4.7	0.9632*	0.4918
P_1	4.9	0.0859	0.0563	5.1	0.0111	0.0558	4.7	0.1794**	0.0740	4.7	0.0621	0.0701
DS	2.1	−0.3244	0.2366	2.0	0.0200	0.2128	2.1	−0.3577	0.2556	2.1	−0.1140	p.3057
SR	31.10	0.0626**	0.0227	33.8	0.1425***	0.0305	35.3	0.0739**	0.0305	34.9	−0.0274	0.0327
I^2	15.3	−0.0137	0.0464	21.7	−0.0962**	0.0468	20.2	0.0074	0.0478	24.2	−0.0642	0.0507
Y	8.07			9.10			10.4			9.74		
R^2	0.154			0.206			0.232			0.121		
a	4.3110			0.2534			4.1361			6.8831		
$F(n_1, n_2)$	9.414*** (6,309)			12.7398*** (6,295)			14.3380*** (6,285)			7.2261*** (16,315)		
Number of observations	316			302			292			322		

* Indicates significance at 10 per cent level of significance.

** Indicates significance at 5 per cent level of significance.

*** Indicates significance at 1 per cent level of significance.

TABLE II—FACTORS AFFECTING YIELD OF WHEAT IN LUDHIANA

$(Y=a+b_1\ N+b_2\ P+b_3\ K+b_4\ I+b_5\ P_1+b_6\ DS+b_7\ SR+b_8\ DS^2+b_9\ I^2)$

Dependent variable	1962-63			1963-64			1964-65			1965-66		
	X_i	b	σ_b	X_i	b	σ_b	X_i	b	σ_b	X_i	b	σ_b
N	24.6	0.0138	0.0095	18.9	0.0098	0.0172	18.0	0.0386**	0.0169	18.9	0.0503**	0.0135
P	11.5	0.0947***	0.0192	10.3	0.0985***	0.0327	7.5	0.0308	0.0245	4.8	0.0949***	0.0300
K	18.5	−0.0533***	0.0099	15.3	−0.0586***	0.0163	6.0	−0.0293*	0.0159	5.0	−0.0594***	0.0163
I	3.7	0.4319	0.3640	4.5	1.3045***	0.4347	4.3	0.5748	0.4321	4.7	0.7071	0.4902
P_1	4.9	0.0894	0.0543	5.1	−0.0256	0.0564	4.7	0.1823**	0.0741	4.7	0.0605	0.0690
DS	2.1	0.1083	0.8120	2.0	−0.5137	0.4847	2.1	−0.5381	0.9076	2.1	0.3893	1.2810
SR	31.0	0.0353	0.0227	33.8	0.1102***	0.0314	35.3	0.0674**	0.0308	34.9	−0.0415	0.0325
DS^2	4.5	−0.1129	0.1762	4.5	0.0559	0.0589	4.8	0.0351	0.1863	4.6	−0.0894	0.2564
I^2	15.3	−0.0006	0.0446	21.7	−0.0933*	0.0461	20.2	0.0102	0.0478	24.2	−0.041	0.0504
Y	8.07			9.10			10.14			9.74		
R^2	0.231			0.241			0.241			0.158		
a	4.7885			2.2004			4.4378			6.9679		
F (n_1, n_2)	10.2183 (9,306)			10.3015 (9,292)			9.9736 (9,282)			6.4874 (9,312)		
Number of observations	316			302			292			322		

* Indicates significance at 10 per cent level.
** Indicates significance at 5 per cent level.
*** Indicates significance at 1 per cent level.

TABLE III—CHANGE IN WHEAT YIELD IN LUDHIANA DISTRICT

$(Y=a+b_1\ N+b_2\ I+b_3\ P_1+b_4\ DS+b_5\ SR+b_6\ I^2)$

	1963-64				1964-65				1965-66			
	$\Delta Y_{\Delta X}$	$\Delta Y_{\Delta W}$	$\Delta Y_{\Delta f}$	ΔY	$\Delta Y_{\Delta X}$	$\Delta Y_{\Delta W}$	$\Delta Y_{\Delta f}$	ΔY	ΔY_{X}	$\Delta Y_{\Delta W}$	$\Delta Y_{\Delta f}$	ΔY
1962-63	53	24	26	103	46	10	151	207	61	−7	113	167
1963-64					9	−14	109	104	19	−31	76	64
1964-65									27	−17	−50	−40

Yield is in lbs. per acre

ΔY = Change in yield between any two years.

$\Delta Y_{\Delta X}$ = Change in yield due to change in the level of inputs.

$\Delta Y_{\Delta W}$ = Change in yield due to change in the weather complex.

$\Delta Y_{\Delta f}$ = Change in yield due to change in efficiency of resource use.

TABLE IV—CHANGE IN WHEAT YIELD IN LUDHIANA DISTRICT

$(Y=a+b_1\ N+b_2\ P+b_3\ K+b_4\ I+b_5\ P_1+b_6\ DS+b_7\ SR+b_8\ DS^2+b_9\ I^2)$

	1963-64				1964-65				1965-66			
	$\Delta Y_{\Delta X}$	$\Delta Y_{\Delta W}$	$\Delta Y_{\Delta f}$	ΔY	$\Delta Y_{\Delta X}$	$\Delta Y_{\Delta W}$	$\Delta Y_{\Delta f}$	ΔY	$\Delta Y_{\Delta X}$	$\Delta Y_{\Delta W}$	$\Delta Y_{\Delta f}$	ΔY
1962-63	43	24	36	103	55	10	142	207	54	− 7	120	167
1963-64					28	−14	90	104	−10	−31	105	64
1964-65									22	−17	−45	−40