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RETURN TO INVESTMENT, OPTIMAL LEVEL OF OPERATIONAL COST, DIRECTION OF ADDITIONAL COSTS AND TOTAL COSTS OF PRODUCTION—ANALYSES BASED ON COMPOSITE DEMONSTRATION DATA RELATING TO IADP DISTRICTS

D. RAMESH*

Assistant Director
Agricultural Prices Commission
Government of India, New Delhi

Objectives

The purpose of this paper is three-fold. Firstly, it is to examine the extent of benefit of the 'package of practices' in the IADP districts measured in terms of returns to investment. Secondly, it is to estimate the optimal level of investment and to examine the directions in which the additional expenditure, below the estimated optimum, should be incurred. Finally, it is to examine the question as to whether improved technology is cost-increasing or cost-reducing.

Data Used

Composite demonstrations are laid on cultivators' fields in the different IADP districts. These involve the use of 'package of improved practices,' and are the principal means used under the package programmes to demonstrate to the cultivators the technical feasibility and the economic soundness of the package being recommended. Under the scheme, a large number of composite demonstrations are laid out in each block for the important crops. These demonstrations are laid in what are known as demonstration plots. In this plot the crop is given the recommended 'package of practices.' In an adjacent plot, the cultivator is free to use his own practices for raising the crops. The latter is called the control plot. It should be noted that the cultivators' practices do not correspond to the 'control' as understood in statistical terminology as, for instance, the control kept in trials held in cultivator's fields to assess the impact of a practice or a combination of practices. Thus, whereas in one case the control treatment remains the same from one trial to another, in the other, though the package of improved practices in a particular region remains the same, the cultivators' practices may vary, even within the same region.

The data collected and tabulated under the scheme relates to the economics of demonstration and studies to ascertain the input-output ratio and factors influencing the cost of cultivation. The estimates of cost all relate to operational expenses only. No estimates regarding the fixed costs are available under this data.

The analyses contained in the present exercise relate to the 1964-65 demonstration data.

* The views expressed and conclusions arrived at in this paper are those of the author only and are not necessarily those of the Commission which he is privileged to serve. The author wishes to express his gratitude to Dr. Jai Krishna for his valuable suggestions.

RETURN TO INVESTMENT

Table I gives for some relatively more important crops the return per rupee of additional investment, obtained as the ratio of the additional income in the demonstration plots (over the control plots) and the additional costs therein.

TABLE I—RETURN PER RUPEE OF ADDITIONAL INVESTMENT

Districts		Return	Districts		Return
	Paddy			Barley	
West Godavari		2.31	Shahabad		3.04
Cachar	*Kharif*	2.51		Gram	
	Aus	1.77	Shahabad		5.12
Shahabad		1.42		*Ragi*	
Surat and Bulsar		3.11	Mandya		4.08
Palghat	*Kharif*	2.37		Maize	
	Rabi	2.57	Shahabad		5.95
Alleppey	I. Crop	2.20	Ludhiana	Hybrid	2.33
	II. Crop	3.26		*Desi*	1.41
	III. Crop	2.07		Cotton	
Raipur	*Kharif*	2.74	Surat and Bulsar	*Kharif*	1.76
	Rabi	4.46		Irrigated *kharif*	1.65
Thanjavur		2.62	Ludhiana	American	2.84
Bhandara		3.22		*Desi*	2.47
Mandya		5.95		Groundnut	
Ludhiana		4.78	Surat and Bulsar		3.19
Burdwan	*Aman*	2.54	Ludhiana		7.63
	Aus	2.32		Sugarcane	
	Wheat		Shahabad	*Rabi*	3.15
Shahabad		4.69	Ludhiana	*Kharif*	6.30
Surat and Bulsar		2.58	Burdwan	*Rabi*	4.53
Burdwan		2.39		Jute	
			Burdwan		3.06
	Jowar			Potato	
Surat and Bulsar	*Kharif I*	1.51	Shahabad		3.43
	Kharif II	2.15	Ludhiana		8.65
	Rabi	3.42	Burdwan		5.93

Broadly speaking, the return per rupee of additional investment in paddy is around Rs. 2.50. Only in Assam and Bihar the return was less than Rs. 2. The highest return (Rs. 5.95) was noticed in the Mandya district of Mysore State. In respect of wheat, the data available relate only to those States which are relatively less important for the production of the crop. The return per rupee of additional investment, however, is Rs. 4.69 in Shahabad and around Rs. 2.50 in Gujarat and West Bengal. In the case of other crops, while the actual figures are presented in the table, it may be stated that broadly, the return per rupee of additional investment is generally more than Rs. 3.00 and, in fact, Rs. 8.65 for potato and Rs. 7.63 for groundnut in Punjab.

It was observed from the basic data that even in the successful demonstrations, there were considerable variations in the level of yield obtained from the same package in a given region. For instance, the coefficient of variation in the demonstration yield in respect of paddy in Madras was 9 per cent, in Andhra Pradesh 15 per cent and in respect of groundnut in Gujarat, 33 per cent. These variations arise out of differences in the quality of soil, differences in cropping rotations, extent of availability and utilization of irrigation facilities and the managerial ability to skilfully use the package of practices. Thus, the above figures hold good only as an average.

OPTIMAL LEVEL OF COST AND OUTPUT-INPUT RELATIONS

An attempt is made in this section to estimate (a) the optimal level of operational cost per acre, and (b) direction of additional costs.

(*a*) *Optimal Level of Investment*

The exercise relates only to paddy crop in the Thanjavur district of Madras. But with the generality of the model, it can be extended to the other crops and districts.

Let $y = f(x)$ be the usual cost function, with y = total operational cost per acre and x = the corresponding level of yield per acre in quintals, with the given level of technology and the given package of practices. For the purpose of this exercise, we assume that $f(x)$ is a second degree curve. Now, $\frac{dy}{dx_i} = f'(x_i)$ gives the marginal cost of production at the level of output x_i. The production process will continue to be profitable till the marginal cost of production, plus a margin for risk and uncertainty, equals the expected price. This optimal level of production x_0 is actually reached when

$$\left(\frac{dy}{dx_i}\right) + m = P,$$

where P is the expected price of the output and m is the risk and uncertainty margin. By substituting this level of x, *viz.*, x_0 in the original function $y = f(x)$, we obtain the optimal level of total operational cost per acre y_0.

This model has been applied in respect of the paddy crop for Madras (Thanjavur district). The function obtained, for the demonstration plots, was

$$y = -89.25 + 2.012\, x + 1.323\, x^2$$

$$R^2 = 0.61.$$

By assuming a price of Rs. 40 per quintal of paddy (which was the farm harvest price per quintal of paddy in Thanjavur in 1964-65), and 40 per cent margin on cost for risk and uncertainty, the level of optimal output comes to about 16.05 quintals per acre, giving a level of optimum operational cost of Rs. 295 per acre. At present, the average investment per acre in the demonstration plots in the Thanjavur district is about Rs. 205. Thus, there is scope for further intensification of the operational expenses investment. It should be noted that this level of optimum corresponds to the given level of technology and the package of practices. y_0 will shift, depending upon improvement in the level of technology and the 'size' and 'contents' of the 'package.'

(b) Direction of Additional Cost

The four important inputs which go with the package of practices are fertilizers, improved seeds, pesticides and other plant protection measures and irrigation. The other constituents of operational cost included were preparatory tillage, sowing and harvesting. With a view to examine the return to investment for each of the different items of inputs and the directional changes in input use level required to achieve the cost level that gives the optimum yield obtained under (a) above, a production function (Cobb-Douglas) of the form

$$y = b_0 x_1^{b_1}\, x_2^{b_2}\, x_3^{b_3}\, x_4^{b_4}\, x_5^{b_5}, \text{ where}$$

y = gross income per acre,
x_1 = value of seeds per acre,
x_2 = value of fertilizers and manures per acre,
x_3 = insecticides per acre,
x_4 = irrigation charges, and
x_5 = preparatory tillage, sowing and harvesting, was fitted.

This function fitted for the data relating to Thanjavur (paddy), for which the optimal level of investment was estimated above, was :

$$y = 217.92\, x_1^{0.571}\, x_2^{1.132}\, x_3^{0.936}\, x_4^{0.013}\, x_5^{-0.072}$$

$$(R^2 = 0.57)$$

The marginal productivities of each of these input factors work out to Rs. 0.921, 2.423, 1.863, 0.231 and —0.413 respectively for x_1, x_2, x_3, x_4, x_5. Assuming a return of 12 per cent on alternative investment, these marginal productivities indicate that the directions of additional investment should be towards manures and fertilizers (x_2) and pesticides, etc. (x_3). The marginal productivities of irrigation (x_4) and preparatory tillage, etc. (x_5) are very low, suggesting that investments on these items should be reduced.

TOTAL COST OF PRODUCTION

A question has often been raised as to whether improved technology is cost-reducing or cost-increasing. To examine this question, an estimate of total cost is obtained as follows. Let,

$C_T = C_O + C_F$, where

C_T = total cost per acre,

C_O = operational cost per acre, and

C_F = fixed cost per acre.

Under the demonstration data, C_O is recorded while C_F is not. For purposes of the present exercise, an estimate of fixed cost per acre, relating to the base period of study, was first worked out for a given crop and district, from the farm management data of the Directorate of Economics and Statistics. These estimates are inflated to the period 1964-65 through the Index Numbers of Wholesale Prices for All Commodities (Economic Adviser's Indices) to allow for the variations in the prices received and prices paid by the farmers. Here, it should be noted that while inflation through these indices would take into account the increase in the general level of prices during the period, the possible changes in the input structure itself are ignored. The fixed cost utilized for estimating total cost in the IADP district does not always relate to the same district but may relate to a district lying in the same region, on the assumption that a district is broadly representative of the institutional factors, the level of technology and input use level of the region.

Table II gives the cost per quintal in demonstration plots and control plots, separately for operational and total expenses, as also the farm harvest price prevailing during that period.

It is seen from Table II that the operational cost in the demonstration plots is substantially more than that in the control plots. However, the total cost per quintal in respect of all crops is less in the demonstration plots, explained by the higher yields in these plots. It is also seen that the costs of production, both in the control and demonstration plots, are fully covered by the farm harvest prices prevailing at the time.

CONCLUSION

The purpose of this paper was to examine the return to investment in the package of practices in the IADP districts, the level of profitable investment and estimating total cost of production. The estimates of cost obtained under the demonstration data relate only to the operational expenses. Given the variation in yield in the demonstration plots for the same package of practices in the region, the results hold good only on an average.

TABLE II—ESTIMATED TOTAL COST OF PRODUCTION OF CROPS

Crops	States	Cost of production per quintal				Farm harvest prices
		Operational		Total		
		Demon-stration	Control	Demon-stration	Control	
Paddy	Andhra Pradesh	13.06	12.49	27.29	29.43	63.96*
	Bihar	12.31	11.91	16.93	19.25	39.95† (Winter)
	Kerala	17.73	17.40	27.39	30.97	65.78
	Madhya Pradesh—I ..	10.98	9.69	19.43	21.16	74.49
	(Raipur)—II ..	11.74	12.54	18.17	20.81	74.49
	Madras (Thanjavur) ..	15.09	14.85	25.99	28.49	37.47†
	West Bengal—*Aman* paddy	19.01	18.79	25.38	26.39	72.99*
Wheat	Bihar	24.59	31.08	31.86	47.18	80.24
	Gujarat	34.12	32.35	43.01	44.26	65.78*
Gram	Bihar	21.29	27.00	32.25	49.70	77.83
Ragi	Mysore	24.00	21.18	74.33	88.59	69.36
Jute	West Bengal	36.83	40.11	47.79	54.09	91.25*
Cotton	Punjab—American ..	39.17	37.06	63.62	72.32	116.15
	Desi	31.69	28.17	52.04	56.61	111.86
	Uttar Pradesh	30.57	39.99	32.37	43.06	102.86
Sugarcane	Punjab	1.95	2.35	2.43	3.13	8.59

* Relates to 1963-64.

† Per quintal of paddy. Other figures relate to rice.

From the analyses made above, it is seen that the efficacy of the package of practices is fully vindicated. The return to a rupee of additional investment is generally over Rs. 2.

With the given level of technology and package of practices, the optimal level of operational cost per acre is about Rs. 295 per acre in Madras (paddy), against the present level of Rs. 205. There is, therefore, scope for further intensification of the inputs package. Estimated marginal productivities indicate that the additional investment should be made in fertilizers and pesticides.

Finally, while the operational cost per quintal in the demonstration plots is much more than that in the control plots, the total cost per quintal in the demonstration plots works out to less than that in the control plots indicating that improved technology is cost-reducing. The farm harvest prices were at a level high enough to cover the cost of production even in the control plots.