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RATIONALITY OF THE USE OF VARIOUS FACTORS OF PRODUCTION ON DIFFERENT SIZES OF FARM IN THE PUNJAB

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Agriculture is one of the most important sectors of the Indian economy. The economic importance of agriculture stems primarily from the fact that it contributes about 44 per cent of the national income and is a source of earning for about 70 per cent[1] of the Indian population. The share of agriculture in the national income can be further increased by making rational use of resources and by raising production on the farms through the adoption of new technological practices.

The population is increasing at a rapid rate in India and consequently the expanding demand for agricultural commodities together with limited availability of farm resources needs a careful exploration of production possibilities and ways for increasing the efficiency of resources on various sizes of farm. In view of the changed farm economy of the Punjab, the possibilities of raising farm earnings through reorganization of the available resources and enterprises cannot be ruled out. To presume that the possibilities of such a reorganization are almost exhausted, seems to be an irrelevant proposition. Although the paucity of finances is the major bottleneck, yet the farmers could raise their earnings through efficient use of available resources.

Since the green revolution has reached almost the saturation point in the Punjab, now more emphasis is being laid on white revolution in the State. The Punjab farmers have partly started practising the dairy enterprise on commercial lines to supplement their income. The rationale of incorporation of this enterprise in the crop mix has also been explored in this paper to suggest the better use of farm resources.

The purpose of the present study is to evaluate the efficiency with which the farmers in the Punjab State use their resources to maximize their farm earnings. An attempt is also made to study the resource use efficiency on different categories of farm for suggesting the shifts in resource use. More specifically, the objectives of the study are (1) to evaluate the economic rationale of resource use on different farm size-groups; and (2) to suggest the shift of resources from one category to another category so that the resources can be optimally used in a given region. The following hypothesis was tested in this study, namely, that the farmers are rational in the use of resources on various categories.

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1. Yogesh C. Mittal, "Significance of Agricultural Credit in New Farm Technology," *Financing Agriculture*, Annual 1975, pp. 68-69.

METHODOLOGY

The study was conducted in the Ludhiana district of the Punjab. The district was selected purposively as an operational area because it is relatively more developed than any other district in the Punjab.

Selection of Cultivators

The multi-stage random sampling technique with block as primary unit of sampling and operational holding as the ultimate unit of the study was followed. At the first stage, 20 per cent of blocks were selected randomly. A complete list of villages in thes elected blocks was obtained and four villages, namely, Dhananu, Kadiayan Kalan, Roomi and Dhamipura were selected at random. In order to develop the size-groups, a compete list of the cultivators of the selected villages along with their size of operational holdings was prepared with the help of the headman of the village. These holdings were arranged in ascending order in respect of the size of holdings and frequency distribution was obtained. Then the cube root of each class frequency was calculated and cumulated and the cultivators were divided into three groups, *viz.*, small, medium and large farm size-groups. Keeping in view the time and other constraints, 15 per cent of the farmers from each category were selected randomly with minimum of six farmers from each category in each selected village. The total sample consisted of 85 farmers comprising 32 small, 28 medium and 25 large farmers. The data pertain to the year 1975-76. Information on the resource position of farms, cropping pattern, level of technology, output of different enterprises and expenditure made on variable inputs was obtained. Information on different aspects was carefully recorded so that it could be logically transferred into different variables.

Cobb-Douglas production function was, therefore, used for analysis which is given as under:

Let the production function be represented by

$$Y = a X_1^{b_1}, \quad X_2^{b_2}, \quad X_3^{b_3}, \ldots\ldots\ldots\ldots, \quad X_n^{b_n}$$

where Y is the dependent variable and X_1 through X_n are explanatory variables, 'a' is constant and b_1 through b_n are the regression coefficients for X_1 through X_n factors of production respectively. The Cobb-Douglas function was converted to the logarithmic form so that it could be solved by least square method.

$$\text{Log } y = \text{Log } a + b_1 \text{ Log } x_1 + b_2 \text{ Log } x_2 + \ldots + b_n \text{ Log } x_n.$$

A separate function was fitted for each farm category to examine the economic rationality of the resource mix. The final choice of production function for

economic analysis was based upon (*i*) coefficient of multiple determination (R^2); (*ii*) significance of regression coefficients; (*iii*) other economic considerations keeping in view the objective of the study, such as the signs of the coefficients.

The Variables

The concepts and definitions of variables used in this study are discussed as follows:

$$Y = a\, x_1^{b_1}\, x_2^{b_2}\, x_3^{b_3}\, x_4^{b_4}\, x_5^{b_5}\, x_6^{b_6}\, x_7^{b_7}\, x_8^{b_8}$$

Gross returns (Y): Physical products were not used as dependent variable because it was not possible to aggregate them. So in order to quantify the production variable, gross returns were calculated by converting the physical products into value terms by multiplying the yields of different crops with their respective harvest prices. These gross returns were treated as dependent variable. Moreover, it also included income from the dairy and poultry, if any.

Operational area (X_1): The land input was measured as acres of land being operated per farm and was calculated by considering the acres of land owned by the cultivator plus leased-in minus leased-out area. The land input measured in simple acreage would not give appropriate results because of wide variation in fertility and productivity of different fields from area to area, from farm to farm and even on the same farm. So, while taking land as an explanatory variable, irrigation status was taken into consideration and unirrigated land was adjusted by taking into account 1.67 acres[2] of unirrigated land equal to one acre of irrigated land.

Expenditure on seeds (X_2): This variable is defined as the sum of the value of seeds used for different enterprises calculated by multiplying the physical quantities of seeds with their respective prices.

Expenditure on manures and fertilizers (X_3): The physical quantities of different manures and fertilizers used on the farm during the year 1975-76 were multiplied with their respective prices. The total expenditure on these items was considered as an explanatory variable in the analysis.

Labour days used (X_4): The labour input was recorded in terms of work hours of men, women and children employed for different farm operations during the agricultural year. In this study, labour was measured in terms of

2. Raj Krishna, "Some Production Functions for the Punjab," *Indian Journal of Agricultural Economics*, Vol. XIX, Nos. 3 and 4, July-December, 1964, pp. 79-89.

adult man-days of eight hours. It included family labour, permanent and casually hired labour. The difference in the efficiency of labour has been taken into account by converting female and child days into adult man-days on the criterion that three female (over 16 years) labour days equal two-man labour days and two-child (12-16 years) labour days are equal to one man-day.[3]

Expenditure on irrigation facilities (X_5): This variable constituted the fuel cost of engine, electricity charges of electric motor, annual repairs, canal water charges, depreciation, interest on capital invested on irrigation structures (of electric motor, engine, building and fitting, etc.). The amount paid for irrigation water hired from other people was also included in this variable, whereas manual labour engaged on irrigation was not included in this variable.

Expenditure on implements and machinery (X_6): This variable constituted annual depreciation, annual repairs, interest on capital invested on farm implements and machinery, such as threshers, shellers, crushers, trolley, cultivators, disc-harrows, plant protection equipments like sprayers, dusters and other implements like 'triphali,' carts, fodder cutters, bar-harrows, improved ploughs, hand-hoe, etc. The expenditure on electric motor and diesel engine other than those used for irrigation was also included. The amount paid for hiring the machinery and implements was also included in this variable. The fuel cost of tractor was also added under this head.

Investment on draught animals (X_7): This variable included depreciation on draught animals and interest on capital borrowed for this purpose. The veterinary charges were also included in it.

Investment on milch animals (X_8): The annual depreciation, interest and veterinary charges were included under this head.

Problem of multicollinearity: As a first step to ascertain the problem of multicollinearity, a zero-order correlation matrix for all the explanatory variables was obtained for each function for different categories of farmers. The following rule was applied to visualize the magnitude of multicollinearity. "The correlation coefficient between a pair of explanatory variables was considered serious if it was greater than 0.8"[4] It was found that no correlation coefficient was greater than 0.8, thus satisfying the above criterion for non-seriousness of multicollinearity.

Marginal value productivity: The MVP of a particular resource represents "the expected addition to the gross returns caused by an addition of one unit of that resource, while other inputs are held constant." The most reliable and perhaps the most useful estimate of MVP is obtained by taking the resources (X_1) as well as gross returns (Y) at their geometric means.

3. J. P. Singh, "Resource Use, Farm Size and Returns to Scale in a Backward Agriculture," *Indian Journal of Agricultural Economics*, Vol. XXX, No. 2, April-June, 1975, pp. 32-46.
4. E. O. Heady and John L. Dillon: Agricultural Production Functions, Kalyani Publishers, Ludhiana, 1961, p 136.

The MVP was computed by multiplying the regression coefficient of the given resource with the ratio of geometric mean of gross returns to the geometric mean of the given resource. For example, the MVP of x_1 would be:[5]

$$MVP(x_1) = b_1 \frac{\overline{Y}\ (GM)}{\overline{x_1}\ (GM)}$$ where GM represents the geometric mean.

The marginal value productivity for land was measured in rupees per acre and marginal value product of labour was measured in rupees per man-day of labour. For all other variables, the marginal value productivities were measured in term of rupees, per rupee of expenditure.

Economic efficiency of resources: In order to evaluate the economic efficiency of farmers as users of resources, the marginal value products of input factors were compared with their respective acquisition costs. The cost of land (rental value) was taken at Rs. 450 per acre. The estimated wage rate in the study area was Rs. 8 per man per day. Assuming 10 per cent rate of interest, the cost of all other variables which were expressed in rupees (*i.e.*, cost of a rupee) was Rs. 1.10.

Then the ratios of marginal value productivities of different resources to their acquisition costs were calculated. A ratio, that is equal to unity, indicates the optimum use of that factor. A ratio of more than unity indicates that the returns could be increased by using more of that resource and a less than unity ratio indicates the unprofitable level of resource which should be decreased to minimize the losses.

RESULTS AND DISCUSSION

The main objective of the functional analysis was to evaluate the economic rationale of resource mix on different categories of farm. This aim was met by calculating marginal value productivities (MVPs) of different resources and then comparing them with their acquisition cost.

Marginal Value Productivity and Economic Efficiency

Small farm groups: The estimated production equation for the small farms is given in Table I. It is clear from the table that the coefficient of land was 0.3135, which was significant at 5 per cent level, indicating that if land was increased by one per cent, there would be an increase in gross income by 0.3235 per cent. The coefficient of labour was non-significant as well as negative. This suggested excessive use of labour on the small farms. The coefficients of expenditure on irrigation facilities, implements and machinery were also not significant. The regression coefficient of expenditure on draught

5. Earl R. Swanson, "Determining Optimum Size of Business from Production Functions," n Earl O. Heady, Glenn L. Johnson and Lowell S. Hardin (Eds.): Resource Productivity, Returns to Scale, and Farm Size, Iowa State College Press, Ames, U.S.A., 1956.

animals was negative and significant at 10 per cent level. This was attributed to higher fixed cost per acre of this resource in the wake of low volume of business on the small farms. Again, despite the growing popularity of the custom-hiring services, the small farmers do keep a pair of bullocks because of uncertainty in the timely availability of these services. The coefficients of both expenditure on milch animals and expenditure on seeds, manures and fertilizers were significant at 5 per cent level. The value of R^2 was 0.8103 which was significant at one per cent level.

It is obvious from Table I that the MVP of land was Rs. 467.79 per acre. The MVPs of expenditure on implements and machinery, milch animals, and seeds and manures and fertilizers were Rs. 1.66, Rs. 2.89 and Rs. 1.76

TABLE I—COEFFICIENTS OF PARAMETERS, MVPs OF FACTORS OF PRODUCTION, RATIOS OF MVPs TO THEIR FACTOR COSTS AND GEOMETRIC MEANS OF OUTPUT AND INPUTS FOR SMALL FARM GROUPS, STUDY AREA, LUDHIANA, 1975-76

	Variables	Regression coefficient	MVPs of factors of production	Geometric means	Ratios of MVPs to their costs
(*i*)	Intercept	3.3051	—	—	—
(*ii*)	Gross returns (Y)	—	—	7,649.26 (Rs.)	—
(*iii*)	Operational area (X_1) ..	0.3135** (0.1610)†	467.79	5.13 (acres)	1.04
(*iv*)	Labour days used (X_4) ..	—0.1865 (0.2322)	—6.10	234.57 (man-days)	—0.76
(*v*)	Expenditure on irrigation facilities (X_5)	0.0935 (0.0836)	0.55	292.96 (Rs.)	0.50***
(*vi*)	Investment on draught animals (X_7)	—0.1103* (0.0551)	—0.53	159.51 (Rs.)	—0.48***
(*vii*)	Expenditure on implements and machinery (X_6)	0.1168 (0.1028)	1.66	539.82 (Rs.)	1.51***
(*viii*)	Investment on milch animals (X_8)	0.1753** (0.0635)	2.89	465.93 (Rs.)	2.62***
(*ix*)	Expenditure on seed plus manures and fertilizers (X_2) ..	0.3245** (0.0984)	1.76	1,390.18 (Rs.)	1.60***
(*x*)	Coefficient of multiple determination (R^2)	0.8103***			

† Figures in parentheses indicate the respective standard errors.
* Significant at 10 per cent level.
** Significant at 5 per cent level.
*** Significant at 1 per cent level.

respectively. The MVP of expenditure on milch cattle was higher than that of any other resource. It meant that there was good scope for raising income through dairy farming as well as through intensive use of seed, fertilizer technology on the small farms.

The ratio of MVP of land to its factor cost was 1.04, which was not significantly different from unity. The ratio of MVP of labour to its acquisition cost was 0.76 which was negative as well as not significantly different from unity. However, the ratio of MVP to the cost of investment on draught animals was —0.48 which was significant at one per cent level. This indicated that the cost of draught animals was higher on the small farms than its contribution to production and consequently farm income could be raised through minimization of this cost. This could be possible through governmental help by way of setting up sufficient number of custom-service centres for performing various kinds of farm operations at reasonable costs.

The ratio of MVP of expenditure on irrigation to its cost indicated that investment on irrigation structure on the small farms was more than warranted by the operational area and intensity of cropping.

Overall, the functional analysis brought out that the small farmers were rational in making investment on implements and machinery, milch animals and seeds and manures and fertilizers as the ratios of MVPs of these resources to their costs were significantly greater than unity. This conforms to the earlier findings that small farmers can further raise their earnings by incurring more expenditure on these technological inputs. However, these farmers incurred heavy expenditure on labour, draught animals and irrigation facilities because of rigidities imposed by the fixed nature of these resources and limited off-farm employment opportunities for these resources.

Medium farm groups: The estimated production equation for the medium farm group is given in Table II. It shows that the coefficient of land was 0.4168, which was significant at 5 per cent level. This indicates that if the land resource is increased by one per cent, there would be an increase in gross return by 0.4168 per cent. The coefficient of irrigation was negative and significant at 5 per cent level. This showed excessive investments on irrigation structure in relation to the volume of business. The variable for the expenditure on implements and machinery was not significant, while those for the expenditure on milch animals and fertilizers were significant at one per cent and 5 per cent levels respectively.

The MVPs of different resources and the ratios of those MVPs to respective acquisition costs are given in Table II. The MVP of land was Rs. 553.19 per acre. The MVP of labour was Rs. 8.95 per man-day. Further, the MVPs of expenditure on implements and machinery, milch animals, and seeds and manures and fertilizers were Rs. 1.10, Rs. 4.58 and

TABLE II—COEFFICIENTS OF PARAMETERS, MVPs OF FACTORS OF PRODUCTION, RATIOS OF MVPs TO THEIR FACTOR COSTS AND GEOMETRIC MEANS OF OUTPUT AND INPUTS FOR MEDIUM FARM GROUPS, STUDY AREA, LUDHIANA, 1975-76

	Variables	Regression coefficients	MVPs of factors of production	Geometric means	Ratios of MVPs to their costs
(*i*)	Intercept	3.6244	—	—	—
(*ii*)	Gross returns (Y)	—	—	15,175.41 (Rs.)	—
(*iii*)	Operational area (X_1) ..	0.4168** (0.1830)	553.19	11.42 (acres)	1.22
(*iv*)	Labour days used (X_4) ..	0.2643* (0.1284)	8.95	448.03 (man-days)	1.18
(*v*)	Expenditure on irrigation (X_5)	—0.3319** (0.1572)	—2.42	2,068.72 (Rs.)	—2.20***
(*vi*)	Expenditure on implements and machinery (X_6)	0.0621 (0.0618)	1.10	855.20 (Rs.)	1.10
(*vii*)	Expenditure on milch animals (X_8)	0.2104*** (0.0650)	4.58	695.80 (Rs.)	4.17***
(*viii*)	Expenditure on seed plus manures and fertilizers (X_2)	0.2880** (0.1118)	1.53	2,854.51 (Rs.)	1.39***
(*ix*)	Coefficient of multiple determination (R^2)	0.7963***	—	—	—

* Significant at 10 per cent level.
** Significant at 5 per cent level.
*** Significant at 1 per cent level.

Rs. 1.53 respectively. Thus, the MVP of milch animals was the highest indicating bright scope of raising the income through the expansion of dairy enterprise on the medium size farms in the study area.

The ratio of MVP of land to its cost was 1.22 which was statistically not different from unity. The ratios of labour and machinery were, however, greater than unity (1.18 and 1.10 respectively). It is concluded that the use of these resources were rational on these farms. However, the MVP of expenditure on irrigation facilities to its cost was 2.20 which was significantly different from unity. This shows that investment on irrigation structure was relatively high compared with the volume of business and the farm income could be raised through reduction in the cost by making more intensive use of this resource.

Large farm groups: The equation estimated for the large group is given in Table III. A close perusal of this table shows that all the explanatory variables included in the equation explains 96 per cent of variation in the gross returns. The coefficients of land, expenditure on manures and fertilizers, expenditure on implements and machinery, and expenditure on milch animals were all significant at 5 per cent level, whereas the coefficients of

TABLE III—COEFFICIENTS OF PARAMETERS, MVPs OF FACTORS OF PRODUCTION, RATIOS OF MVPs TO THEIR FACTOR COSTS AND GEOMETRIC MEANS OF OUTPUT AND INPUTS FOR LARGE FARM GROUPS, STUDY AREA, LUDHIANA, 1975-76

	Variables	Regression coefficients	MVPs of resources	Geometric means	Ratios of MVPs To their costs
(*i*)	Intercept	3.9977	—	—	—
(*ii*)	Gross returns (Y)	—	—	—	—
(*iii*)	Operational area (X_1) ..	0.5639** (0.1019)	787.73	24.93 (acres)	1.74***
(*iv*)	Expenditure on manures and fertilizers (X_3)	0.1714** (0.0436)	1.17	5,041.11 (Rs.)	1.06
(*v*)	Labour days used (X_4) ..	0.1880 (10.91)	8.91	726.82 (man-days)	1.11
(*vi*)	Expenditure on irrigation (X_5)	0.1243 (0.0782)	1.28	3,335.66 (Rs.)	1.16***
(*vii*)	Expenditure on implements and machinery (X_6)	0.1278** (0.0392)	1.59	2,766.33 (Rs.)	1.44***
(*viii*)	Expenditure on milch animals (X_8)	0.1194** (0.04443)	3.63	1,131.99 (Rs.)	3.30***
(*ix*)	Coefficient of multiple determination (R^2)	0.9610***			

** Significant at 5 per cent level.
*** Significant at 1 per cent level.

labour and expenditure on irrigation facilities were neither significant nor negative as they were on the small and medium farms.

The ratio of MVP of land to its cost was 1.74 and it was significantly greater than unity. This indicated that land input in relation to the use of other resources was below the optimum level. It implied that income could be raised considerably by using more land. The ratios of MVPs of expenditure on manures and fertilizers and labour to their respective costs were 1.06 and 1.11 respectively, which were statistically not different from unity. This indicated that these resources were being used efficiently. Since the ratios of expenditure on irrigation facilities, milch animals and machinery were significantly greater than unity, the large farmers could enhance their incomes through more intensive use of these inputs on their farms. It is concluded that the large farmers used almost all the resources efficiently.

CONCLUSIONS

The functional analysis of small, medium and large farm organizations brought out that land resource was efficiently used on the small and medium farms. On the large organizations income could, however, be raised by expanding the operational size of farm. Furthermore, the small farmers should

curtail the use of human labour, expenditure on irrigation and draught animals, on the one hand, and increase the expenditure on seeds and manures and fertilizers and milch animals, on the other hand. Owing to the fixed nature of some resources, such as family labour, irrigation structure and draught animals, it might not, however, be possible to reduce the cost through curtailment of the use of these resources because of limited off-farm employment. The medium and large farmers were rational in making expenditure on almost all the resources, the exception being expenditure on irrigation structure in the case of the medium farms. The medium farm group could achieve this objective by either hiring-in land from the neighbouring farmers or by increasing the intensity of cropping through a system of multible cropping.

All the categories of farms could increase their income by more investments on milch animals and through intensive use of chemical fertilizers. The latter would enable better utilization of available labour and irrigation resources. Thus the hypothesis that "the farmers are rational in the use of their resources" is partially accepted.

IMPACT OF INTEGRATED AREA DEVELOPMENT SCHEME ON SMALL FARMERS' ECONOMY IN TASGAON TALUKA OF SANGLI DISTRICT IN MAHARASHTRA

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This paper seeks to examine the changes in income, expenditure, savings and capital investment of small farmers as well as to estimate their production functions for studying the resource productivities due to the execution of the Integrated Area Development (IAD) scheme pilot project in Tasgaon block of Sangli district in Maharashtra.

SALIENT FEATURES OF THE SCHEME

Shri V.S. Page, Chairman of the Maharashtra Legislative Council formulated a scheme, *viz.*, 'Integrated Area Development Scheme' popularly known as 'Page Scheme' for economic upliftment of the weaker sections by a multi-pronged attack to solve their problems. The purpose of the scheme is to help the small farmers and agricultural labourers so as to make them economically viable by increasing productivity, employment and income. To be specific, the scheme aimed at increasing the annual income of the beneficiaries by ten per cent through liberal financial assistance.

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