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NOTES

THE IMPACT OF THE SIZE OF LAND HOLDINGS AND TENURIAL ARRANGEMENTS ON RESOURCE ALLOCATION (A CASE STUDY OF THE PUNJAB)*

In an earlier article in this Journal, the author had presented estimated relationship between net income and the size of the land holding separately for holdings operated by the owner cultivators and the tenant cultivators in a region in the Punjab. This relationship was used to study the profitability of various farms.[1] The objective of the present paper is to examine how far the profitability of these farms will increase if the resources used on these farms were reallocated optimally. To be more specific, we have tried to study (*a*) whether there is any divergence between the actually realised returns to the resources used on a farm and those which would have been realised if the given resources were reallocated optimally; and (*b*) if the divergence is there, how it is influenced by a change in the size of the farm or in the tenurial arrangements under which the farm is being operated. Both those problems have been studied from the private point of view.

For estimating the changes in the realised returns to resources used on a farm belonging to any category (owner cultivated or tenant cultivated) as a result of change in its size, we have made use of the private gross income functions and the total cost functions as described in the above article.[2] The functions, however, as we shall see later, have been used in a different manner in order to study the problem in hand.

For estimating the changes in the returns to given resources under conditions of optimum allocation, we in the first instance, found out the cropping plan for each farm which would maximize the private net income (as defined in the earlier article) with the help of linear programming technique. Gross income from such a cropping plan was then determined for various farms. A functional relation was then determined between this gross income and the size of the holding for each category of holdings.

With the help of actual gross income functions, actual total cost functions and the gross income (under conditions of optimum allocation of resources) functions, misallocation functions—functions indicating a relationship between the divergence of the actually realised returns to resources used, from the returns expected to be earned under conditions of optimum allocation of these resources and the size of the holding—were derived for the two categories of holdings.

In the paragraphs that follow, we first explain the procedure used and the assumptions made in calculating the optimum income for each holding and in estimating its relationship with the size of the holding. This is followed by the discussion of results based on the estimated misallocation functions.

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1. See "Ceiling on Land Holdings—A Case Study of the Punjab," *Indian Journal of Agricultural Economics*, Vol. XXIV, No. 3, July-September, 1969, pp. 19-34. The region selected for study, sources of data, etc., are given in detail in this article.

2. The estimated relationship between the realised gross income and the size of the holding or that between the actual total cost and the size of the holding made use of in the present paper is slightly revised version of those given on pages 25 and 26 (private functions) of the earlier article. The revision consisted in omitting standardisation for irrigation.

THE OPTIMUM

As indicated earlier, we used the linear programming technique for finding out the optimum income for each holding. A few paragraphs that follow describe the nature of the objective function, the resource constraints and the nature of technical coefficients that were used for the purpose.

The Activities

The first important step for applying the technique of linear programming was to determine the major activities for which a farmer could utilize his resources while attempting at the optimum allocation. In order to be as realistic as possible, we assumed each farm to be suitable for producing all those (and also only those) crops which a farmer had actually raised on it. However, some constraints with regard to the crops produced on a farm were considered essential. These are as under:

(*a*) It was assumed that the amount of fodder crops produced and therefore also the resources devoted to them under the optimum plan would be the same as these were under the actual plan. Fodder being a commodity of daily use must be produced on the field itself and as the requirements of fodder were the same even under the optimum plan, no change was needed in its amount produced. The area under sugarcane when it was a recurring crop (old crop running for the second or third year), was also assumed to have remained the same in the optimum plan as it was under the actual plan. This had to be done because land under such a crop could neither be decreased nor increased through reallocation of resources.

(*b*) Crops which did not cover more than 2 per cent of the total area of the holding in the actual plan were ignored.

THE OBJECTIVE FUNCTION

As indicated earlier, private net income was our maximand. The coefficients of the objective function, however, could not be expressed in terms of net income as defined earlier because of the existence of certain costs which were treated as fixed for the purpose of optimization. These costs included the cost of permanent labour including family labour, land revenue, the cost of maintenance of bullocks and the interest on capital. The coefficients of the objective function for a particular farm were derived by deducting costs other than the fixed costs, *i.e.*, the costs incurred on hired labour (both human and bullock), seed, manure, fertilizers, insecticides, irrigation, payment made to the artisan and rent (one-third of the value of the gross produce, fixed by law) from the value of the gross output of a crop in question. The coefficients were expressed in terms of returns per acre (as derived above) for various crops that were included in the activity schedule.

Objective functions were derived for each farm separately according to this methodology.

RESOURCE CONSTRAINTS AND THE TECHNICAL COEFFICIENTS

Following constraints on the availability of resources were assumed.

Land

The most important limiting factor is land. The maximum area of land available on a farm for a particular crop was determined by the nature of the soil of the holding. If, however, a farmer had actually grown a crop on a piece of land which according to the experts was not suitable for that crop, we presumed that the given crop could also be produced on that type of land so far as the particular farm was concerned, thus raising the limit of land available for that crop. Such cases were, however, very few.

Irrigation

Irrigation facilities on a farm were taken as another constraint. Actual irrigation hours availed of by a farmer during the peak months of September, October and November were taken as three additional constraints for the purpose.

Labour

Under Indian conditions, one may be tempted to ignore labour as a constraint. We, however, had to use it as such because of our assumption that the resources in total as well as in terms of their major constituents were fixed and were equal to the amount used by a particular farmer in the actual plan. Accordingly, the amount of labour actually used on a farm during the two peak periods, namely, 15th April to 15th June and 15th September to 15th November, was considered as having a limiting effect on production.

Cash

The fund from which variable costs were met by a farmer was considered as fixed and was treated as a constraint. We shall call this fund as cash even if all the items included in it are not monetized. This fund was meant to cover the expenses incurred on hired labour (human as well as bullock), manure, seeds, artisan, irrigation and depreciation of farm equipment.

It may be noted that for determining the above resource constraints, the amount of various resources devoted to fodder and sugarcane (recurring) crops was excluded, these being not available for any other crop.

Technical Coefficients

As we were interested in estimating the optimum income which could be compared with the income actually realised on a given farm, it was felt desirable that the optimum income should be estimated on the basis of the same technical coefficients as were responsible for the actual income. We, therefore, considered each farm separately and determined the technical coefficients concerning the crops produced on it on the basis of the actual quantity of different resources used for producing an acre of a particular crop. Such a procedure meant an altogether different input-output matrix for each individual farm.

Based upon these considerations concerning resource and activity constraints, technical coefficients and coefficients of the objective function, input-output matrices were prepared for all the 48 farms under study. Optimum values were then obtained by the Simplex Method of Linear Programming.

THE GROSS INCOME (UNDER OPTIMUM CONDITIONS) FUNCTIONS

Though with the help of linear programming technique, we estimated the optimum net income, for estimating the misallocation of resources, as we shall see later, we have made use of the gross income which would ensure this maximum net income. For estimating this gross income, for each farm, the gross value of fodder and sugarcane (recurring)—crops which were assumed to be produced on the same scale as was in the actual plan—was added to the gross value of the crops which were indicated to be produced under the optimum plan as derived above. Cash saved was also added to the value of gross output so obtained. The amount added, however, was not equal to the one indicated by the final plan. It was rather 3/2 of this amount. This was so because the costs that are required to be deducted from the gross income in order to find out the net income include rent which is equal to one-third of the value of gross output. In order to ensure that the addition to the net income is exactly equal to the amount of cash saved as indicated by the final plan, when all costs including rent have been deducted from the gross income, it was essential that the gross income was increased by 3/2 of the cash saved (as shown by the final plan).

Yet another adjustment was needed in the value of gross output so obtained. We have indicated that rent is equal to one-third of the value of the gross output. As under the optimum plan, the gross income itself is likely to be higher than that under the actual plan, rent would also increase. In other words, there would be an increase in the total costs also. However, if we allow an increase in the total costs, we shall be violating our basic assumption, *i.e.*, the total resources remain the same under both the actual as well as the optimum plan. In order to ensure that the total costs would remain after the resources have been reallocated optimally and also that the optimum net income would be the same as would have obtained after the total cost had been increased by one-third of the additional income earned through reallocation of resources, the gross income as obtained above, was itself reduced by the amount of the additional rent.

A functional relationship between the gross income that emerged after this adjustment and the size of the holding was then determined for the two categories of holdings separately. The following relationships emerged :

$$Y_{o.0} = 127.1\ S_o^{1.089837} \qquad (R^2 = 0.91)$$

$$Y_{t.0} = 369.3\ S_t^{0.654635} \qquad (R^2 = 0.57)$$

(Y in the above functions stands for gross income. Subscripts o and t refer to owner cultivator and the tenants. Subscript 0 indicates that the function relates to optimum income. S stands for the size of the holding. Both the functions are a good fit at 5 per cent probability level).

THE MISALLOCATION FUNCTIONS

As indicated earlier, our ultimate object was to measure the misallocation of resources on various farms. We measured misallocation in relative terms. It was indicated by a ratio of the difference between the income earned per unit of cost in the optimum plan and that in the actual plan, to the income earned per unit of cost in the actual plan. In other words, we could measure misallocation with the following formula:

$$\text{Degree of misallocation} = \frac{\dfrac{\text{Gross income (Optimum plan)}}{\text{Total costs}} - \dfrac{\text{Gross income (Actual plan)}}{\text{Total costs}}}{\dfrac{\text{Gross income (Actual plan)}}{\text{Total costs}}}$$

(Total costs remain the same both under the actual plan as well as the optimum plan.)

Following the above formula and making use of the gross income (under the optimum as well as under the actual plan) functions and the actual total cost functions,[3] as derived earlier, we got the following misallocation functions for the two categories of holdings.

$$ML_0 = \frac{\dfrac{127.1\ S_0^{1.089837}}{189.1\ S_0^{0.936785}} - \dfrac{120.0\ S_0^{1.094110}}{189.1\ S_0^{0.936785}}}{\dfrac{120.0\ S_0^{1.094110}}{189.1\ S_0^{0.936785}}}$$

$$ML_t = \frac{\dfrac{369.3\ S_t^{0.654635}}{419.5\ S_t^{0.608266}} - \dfrac{366.9\ S_t^{0.644382}}{419.5\ S_t^{0.608266}}}{\dfrac{366.9\ S_t^{0.664382}}{419.5\ S_t^{0.608266}}}$$

(ML in the above functions stands for degree of misallocation).

Some very important conclusions emerge from the study of these misallocation functions. These are as follows:

(A) On the owner cultivated holdings, the degree of misallocation of resources, as defined above, declines as the size of the holding increases. This is what we should normally expect. Larger farms are more market-oriented simply because they have to depend much on the market for the purchase of inputs as well as for the sale of farm output.

The above tendency, however, is not indicated by the misallocation functions for the tenant cultivated holdings. For this category of holdings, the degree of misallocation increases as the size of the farm increases.

(B) Comparison of the two misallocation functions reveals yet another important fact. We have pointed out above that the misallocation of resources on owner cultivated holdings decreases with the increase in their size and on the tenant cultivated holdings, it increases as their size is enlarged. In fact, the misallocation functions for the two categories of holdings intersect each other.

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3. Following are the gross income and the total cost functions under the actual plan for the two categories of holdings.

ACTUAL GROSS INCOME FUNCTIONS

$$Y_{0.A} = 120.0\ S^{1.094110} \qquad (R^2 = 0.90)$$

$$Y_{t.A} = 366.9\ S^{0.644382} \qquad (R^2 = 0.60)$$

TOTAL COST FUNCTIONS

$$C_{0.A} = 189.1\ S_0^{0.936785} \qquad (R^2 = 0.91)$$

$$C_{t.A} = 419.5\ S_t^{0.608266} \qquad (R^2 = 0.58)$$

(Subscript A stands for the actual income or the total cost (as against optimum). All the functions are a good fit at 5 per cent probability level.)

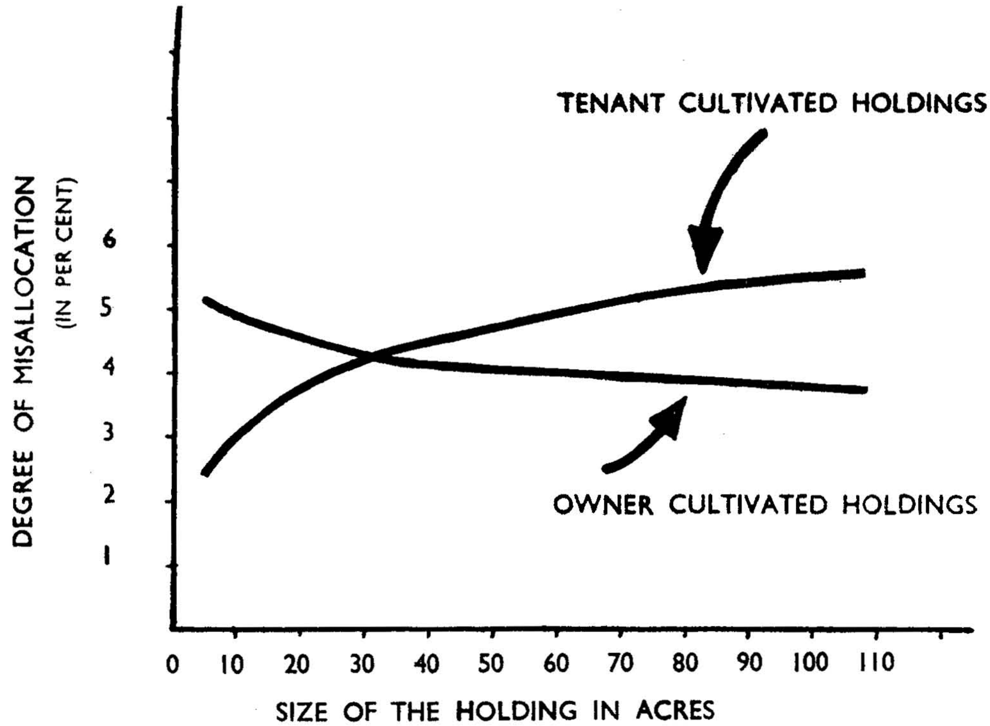

Figure 1—The Degree of Misallocation of Resources on Owner Cultivated and Tenant Cultivated Holdings

The degree of misallocation is smaller on the tenant cultivated holdings as compared with that on the owner cultivated ones so long as the size of the farm is below 33 acres (approximately). Beyond this limit, owner cultivated farms indicate a better allocation of resources. In other words, we can say that for farms up to 33 acres in size, it is the tenancy and not the owner cultivation which is favourable to the optimum allocation of resources.

CONCLUSIONS

The study points to certain facts which have important theoretical implications. In the first instance, it raises doubts about the general impression that large farms are more market-oriented than the small ones. Large size of the farm, in some cases, does seem to have a favourable influence on the allocation of resources. But this is not always the case. Secondly, the study also gives no support to the idea that the owner cultivator is always the best allocator of resources.[4] A tenant can be a better allocator of resources at his command under certain circumstances. What these circumstances are, is, however, a question which can be answered only after another thorough empirical study.

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4. See Earl O. Heady: Economics of Agricultural Production and Resource Use, Prentice-Hall of India Pvt. Ltd., New Delhi, 1964, Chapter 20.

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