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RESOURCE RETURNS IN TELENGANA FARMS

A PRODUCTION FUNCTION STUDY*

By

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In many phases of economic theory, recent years have witnessed a shift from a purely qualitative to quantitative basis. In production economics, for instance, we are often concerned with the question : How much of a factor can be used so that it just pays to use it? That the limits to the use of a factor are set because of the operation of the principle of diminishing returns has been known. But we have to investigate how the principle applies with respect to different factors and how soon and how seriously we encounter its effects. These effects, physical and economic, permeate all production and though the relationships are broadly known, their magnitudes have not been determined.

A number of attempts have been made to establish economically important relationships between inputs and outputs like feed inputs and milk outputs or fertiliser inputs and yield outputs in order to use them for economic analysis of the farming enterprise. Such investigations represent an attempt to accomplish quantitative verification of theory and to obtain data that will be useful in determining the most economic organisation of production. Usually these studies have tried to establish the relationship by statistical treatment of data obtained from farm survey and cost accounting records.[1]

We need to know the type of function which determines how output changes with varying quantities of factor inputs, say, labour. How much of additional output do we get for each additional unit of labour applied to land and how does this rate of return change as we approach the limit of land's ability to produce ? In other words, if the intensity of labour use is increased how does land respond in production ? Is there a constant relationship between labour input used and yield outputs obtained or is there a more gradual change in the response of land to increased factor use ? From general experience in other fields, we are inclined to assume that the real situation corresponds more or less to this second assumption—that there is a gradual decline in response to each additional unit of factor input until a point is reached where nothing more can be gained by intensification of labour use.

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* This research paper has been prepared under the guidance of Dr. A. M. Khusro, now Professor of Rural Development, Delhi School of Economics. It has been based on the data originally collected in 1954-55 for a research project—"Economic and Social Effects of Jagir Abolition and Land Reforms in Hyderabad", sponsored by the Planning Commission and conducted by the Osmania University.

1. Utilising the technique indicated by H. R. Tolley, J. D. Black and M. J. B. Ezekiel : Input as Related to Output in Farm Organization and Cost of Production Studies, U.S.D.A., Bul. 1277, 1924 ; several other studies have been made, mostly available as unpublished theses. As an example of this type of study may be listed : S. E. Johnson, J. C. Tretsven, Mordecai Ezekiel and O. V. Wells : Organisation and Feeding Methods and Other Practices affecting Returns on Irrigated Dairy Farms in Western Montana, Mont. Agr. Expt. Sta. Bul. 264, June'32.

MATERIAL AND METHODS

Land holdings records (*i.e.*, cultivated farms in 1953-54) for sampled villages of Telengana Districts in Andhra Pradesh (erstwhile Hyderabad) constitute the data for this investigation. The relationship sought to be investigated is between output per acre and input factor per acre and acreage here refers to actual acreage used to produce the crop, corrected for soil heterogeneity with an index of fertility. In other words, our regression line describes the average relationship between factor inputs and yield outputs (gross returns) after taking into account differences in the productivity of land. In making this analysis first for each district and then for all the three districts combined, we have fitted to the observations a curve of the Cobb-Douglas (power) type : $Y=aX^b$. Also, the combined data of the three districts were separated on the basis of type of farm (wet, dry and mixed) and separate curves were fitted to the data of each type of farm. These two studies, *viz.*, districtwise and type-wise, will explain the variations in the productivity of factors due to regions and farming types.

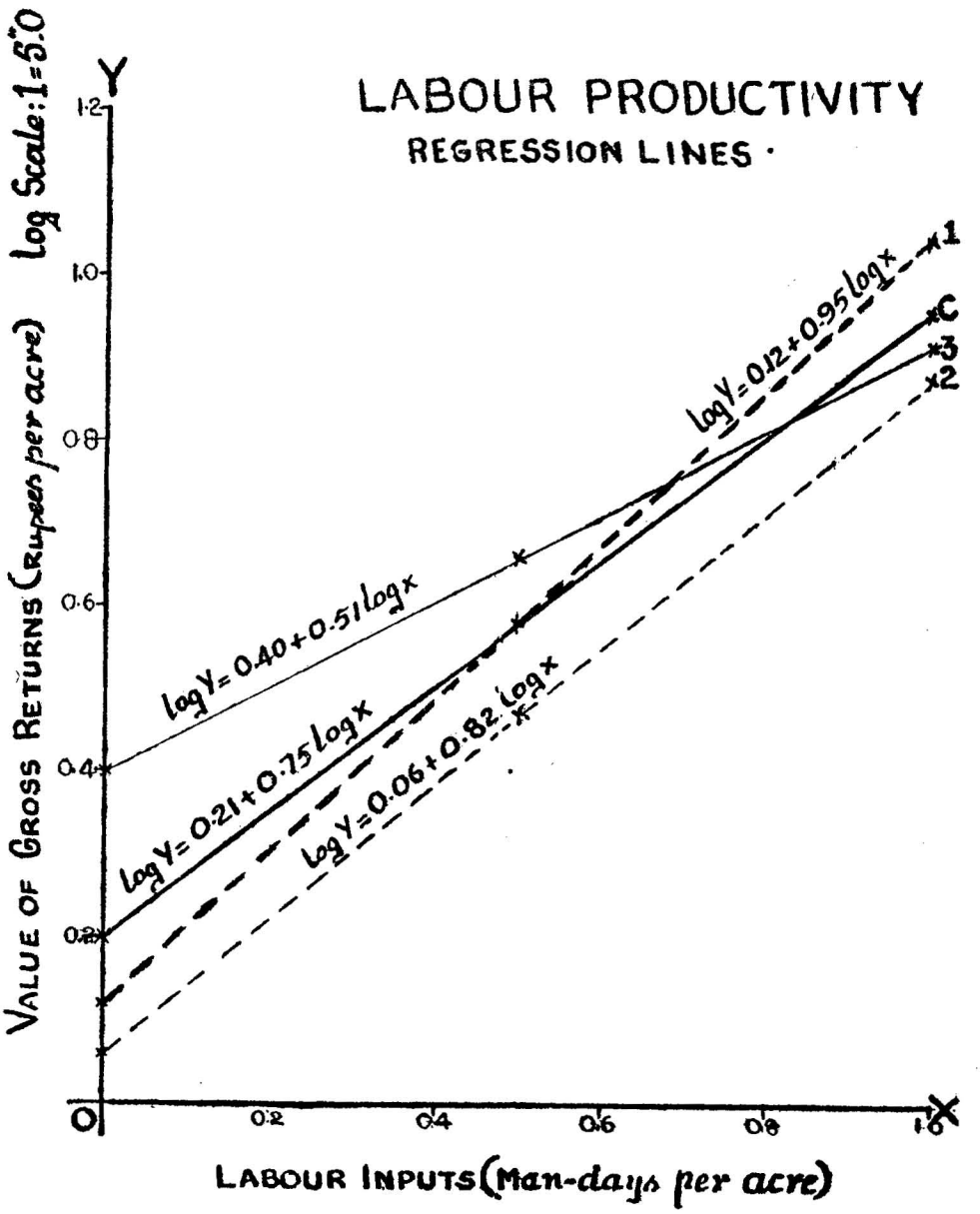
RESULTS

(1) *Three Districts*

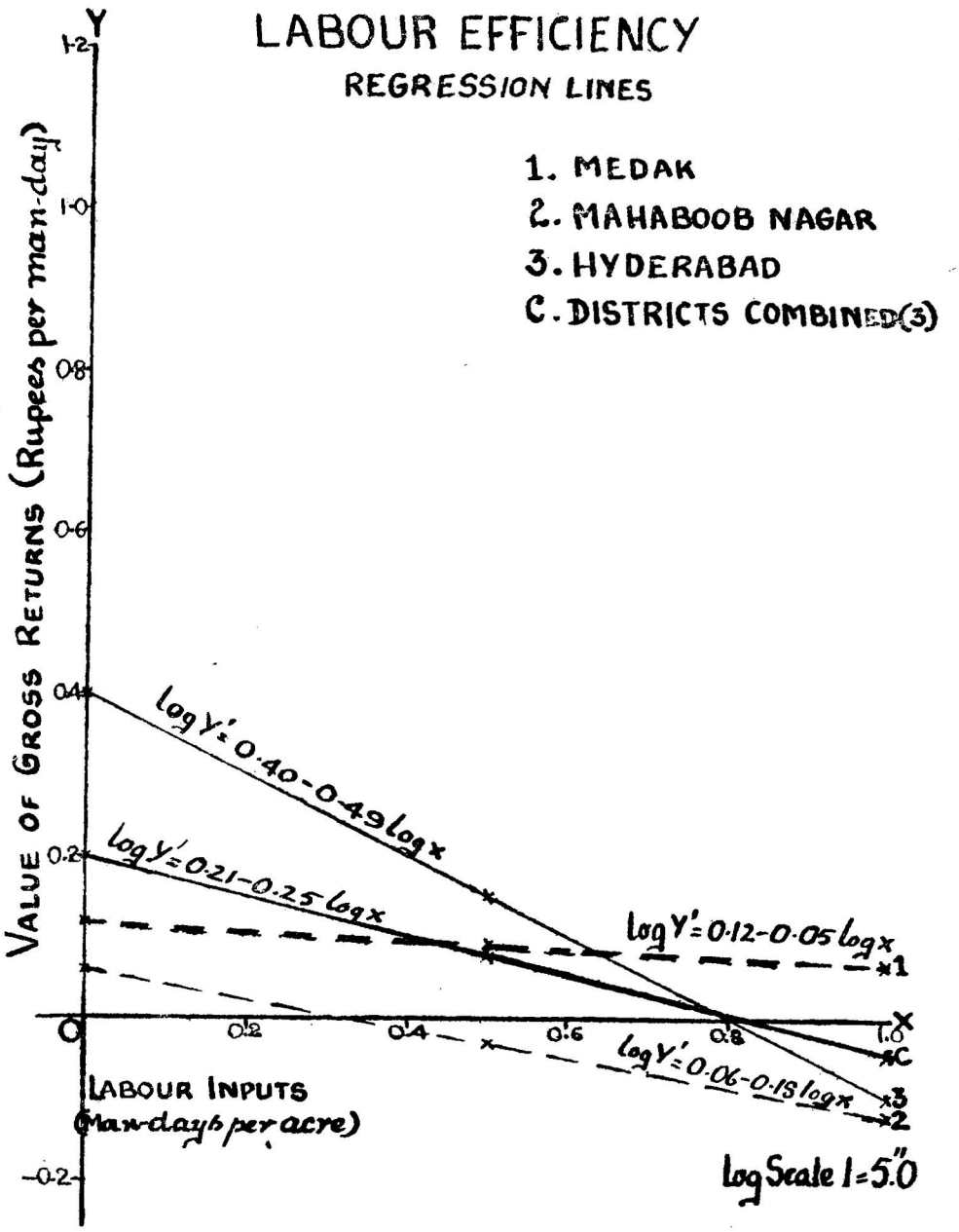
The following table shows the logarithmic relationship between labour inputs (man-days) per acre and gross returns (value of products and services from the farm) per acre obtained from a random sample of farms in the three selected districts of Telengana for our preliminary investigations. If y stands for gross returns per acre and x for labour input per acre, the regression equations are given below :-

District	No. of Farms	Regression Equation	Correlation coefficient between Log y and Log x
1. Medak	77	$\log y = 0.1228 + 0.9496 \log x$	0.9325
2. Mahboobnagar ..	65	$\log y = 0.0640 + 0.8186 \log x$	0.8367
3. Hyderabad ..	54	$\log y = 0.4028 + 0.5147 \log x$	0.5667
For the three Districts combined	196	$\log y = 0.2127 + 0.7498 \log x$	0.7760

The table above clearly shows that there is a high positive correlation between labour input (man-days) and gross returns. Since the data were in logarithmic form we can speak of proportionate response in output as a result of proportionate change in factor input. For instance, a one per cent increase in labour input increases, on the average, the returns by 0·75% in respect of the three districts combined. Compared to this average rate of return, the contribution of labour is greater on farms in Medak and Mahboobnagar districts, while it is less in the case of Hyderabad district. The contrast in labour productivity is brought out by the differences in the slopes of the regression lines (*vide Diagram*). When there are no differences in the rates of response, the regression curves should be almost parallel, but in the diagram the curves rise with different slopes indicating regional differences. In other words, differences in additional returns exist between districts.



Note: Acre refers to corrected acre.


LABOUR EFFICIENCY
REGRESSION LINES
1. MEDAK
2. MAHABOOB NAGAR
3. HYDERABAD
C. DISTRICTS COMBINED(3)
Y
X
VALUE OF GROSS RETURNS (Rupees per man-day)
LABOUR INPUTS (Man-days per acre)
1·2
1·0
0·8
0·6
0·4
0·2
0
-0·2
0·2
0·4
0·6
0·8
1·0
log Y' = 0·40 - 0·49 log x
log Y' = 0·21 - 0·25 log x
log Y' = 0·12 - 0·05 log x
log Y' = 0·06 - 0·18 log x
×1
×C
×3
×2
Log Scale 1 = 5"0

So far we have concentrated on finding out what happens to production per acre when labour input per acre is increased and we have found that the former increases with the latter, though less than proportionately. But if we look at output per man-day, it appears that this is declining as labour per acre increases. If we describe output per man-day as "efficiency of labour" then this efficiency is falling as seen from the derived coefficient (b—1) obtained from the relation:

$$\text{Log } y = \log a + b \log x \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Putting $y/x = y$ equation (1) becomes

$$\begin{aligned} \text{Log } y &= \log y - \log x \\ &= \log a + b \log x - \log x \\ &= \log a + (b-1) \log x \quad \ldots\ldots\ldots\ldots\ldots\ldots (2) \end{aligned}$$

The following table shows the above logarithmic relationships in respect of the three districts studied, the change in output per acre and the change in output per man-day as labour per acre increases.

District	Regression co-efficient of	
	Gross returns per acre on labour per acre (b)	Gross returns per man-day (labour efficiency) on labour per acre (b—1)
1. Medak	0.95	— 0.05
2. Mahaboobnagar	0.82	— 0.18
3. Hyderabad	0.51	— 0.49
For the three districts combined	0.75	— 0.25

It is seen from the above table that labour efficiency is comparatively low in Hyderabad district and is below the average efficiency of labour worked in the three districts combined. The regression lines in respect of gross returns per acre and labour efficiency take opposite directions with different slopes (*vide Diagram*)

So far we have assumed output per acre to depend only on one factor, labour input per acre, ignoring altogether the other inputs though land had been indirectly taken into account. To come closer to reality, we may now directly include size of land (corrected for fertility) and capital per acre as two other important variables having a bearing on output and work out multiple regression equation with one dependent and three independent variables.[2]

2 As examples of this type of study may be cited: E. O. Heady, "Production Functions from a Random Sample of Farms", *Journal of Farm Economics*, Vol. 28, 1946, pp. 989-1004, and—"Resource Returns and Productivity Coefficients in Selected Farming Areas," Vol. 35, 1953, pp. 243-57).

These are of the type : $y = a\ x_1^b\ x_2^c\ x_3^d$; which in logarithms takes the form : $\log y = \log a + b \log x_1 + c \log x_2 + d \log x_3$ where x_1, x_2, x_3, are land (corrected for fertility), labour (man-days) per acre and capital (average annual charge on fixed assets) per acre respectively and y is output (gross returns) per acre as before.

(2) *Three Types of Farms*

These relationships have been established for each type of farm, *viz*, wet, dry and mixed, and the results are presented in the following table :

Type of Farm	No. of Farms	Multiple regression equations
1. Wet	18	$\log y = 1.4533 - 0.3738 \log x_1 + 0.1414 \log x_2 + 0.0844 \log x_3$
2. Dry	72	$\log y = 1.8951 - 0.5793 \log x_1 + 0.0399 \log x_2 + 0.0713 \log x_3$
3. Mixed	106	$\log y = 1.5528 - 0.4656 \log x_1 + 0.2591 \log x_2 + 0.1342 \log x_3$
For the three types combined	196	$\log y = 1.6529 - 0.4960 \log x_1 + 0.1505 \log x_2 + 0.0983 \log x_3$

All the multiple correlation coefficients obtained were found to be significantly high. The coefficient of determination (R^2) explains the percentage of the variance by the terms included. For instance, in the case of the three types combined 75.14% of the variance was explained by the variables included, while in the case of wet, dry and mixed farms separately, the variance accounted for was 71.08%, 71.39% and 76.04% respectively.

There was found to be a positive correlation between output on the one hand and labour and capital taken individually on the other (except in the case of capital in respect of wet farms), indicating that their separate contribution to output with other inputs constant, was positive : it increased with every increase of labour or capital per acre. The rate of increase, however, is less than proportionate in each case, revealing the tendency to diminishing factor returns. Comparatively, mixed farms (*i.e.*, combinations of wet, dry or garden) fare better on the average showing a relatively higher rate of returns on account of labour and capital. On the other hand, all the farms had a negative correlation with land, implying thereby that an increase in land size without a rise in labour and capital per acre, reduces output in fact.

It is a characteristic of the Cobb-Douglas type of production function we have studied, that the sum of the regression coefficient reflects upon diminishing, constant or increasing returns to scale, according to whether this sum is less than one, or equal to, or greater than one. In the present study for each type of farm taken separately as well as for all types combined the sum of the regression coefficients is less than one, exhibiting that there are diminishing returns to scale. Output in fact tends to decline as all inputs are raised by one per cent. This result as may be seen from the equations, is due to the diminishing productivity of land

which more than offsets the tendency towards increasing contribution of labour and capital. It may also be that in Telengana farms the managerial factor which has been assumed to be constant through all ranges of farm sizes in this study, serves as a bottleneck and results in diminishing returns to scale of an extreme nature. This implies that a larger output may be obtained when the size of farm is small rather than large. For, when the farm size is increased, management factor, being constant, tends to spread out too thinly. And, its effects are felt more on land factor (because of physical and spatial increase in land use) than on other factors explaining, thus, the negative coefficient of land as well as scale obtained. This situation is found to exist both on the aggregate of farms and in all the three types studied.

CONCLUSION

The study has revealed that definite relationships between input factors and output do exist and can be traced in our farms. It shows that diminishing returns to inputs of different orders of magnitude are encountered in the Telengana region of Andhra Pradesh in each of the districts studied and for each type of farms. It seems as though an increase in acres without simultaneous increases in labour per acre and capital per acre, leads to decreasing production per acre in the districts studied. On the other hand, the contribution of labour and capital is positive. Output per acre increases as labour or capital per acre is applied in greater quantities but the increase in output is less than proportionate to increases in these input factors.

Relatively, the district of Medak and the type of mixed farms had better relationships on the average, in regard to additional returns as seen from the productive contribution of the three factors studied individually. It also appears that both region-wise and type-wise variations which are usually assumed to be prevalent in farming, are in fact a relativity. The dry land farms occupied an intermediate position with a more even contribution among the different factor-inputs.