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NOTES

RETURNS TO SCALE, FARM SIZE AND PRODUCTIVITY IN MEERUT DISTRICT*

The Studies in the Economics of Farm Management conducted in six typical regions of India provided a wealth of data to draw many conclusions for the economists and policy makers. One of the important conclusions drawn from these studies was that the output per acre declines as the size of farm increases (1, 2, 7, 8, 10).† The conclusions of these studies were based on the data collected prior to the introduction of high-yielding varieties programme except for the studies conducted in 1966-67 which was also too early to examine the impact of this programme on the farm size and productivity relationship (8). The present study is, therefore, an attempt to examine the validity of the hypothesis of inverse relationship between farm size and productivity and also to examine returns to scale in the context of recent technological developments taking place in the country-side.

METHODOLOGY

As the present study was intended to examine the size and productivity relationship in the context of new technology, the selection of area became an important aspect for this study. The major criterion in the selection adopted was that the area should have been covered by the high-yielding varieties programme and other programmes and schemes which are used to increase the agricultural production. Keeping in view the above criterion, Meerut district of Uttar Pradesh provided a suitable background for the investigation as it is one of the most advanced districts of the State and has the top rank in the agricultural development.

The data on the area under Mexican varieties of wheat of all the development blocks of the district, where the holdings were consolidated prior to 1968, were collected from the District Agriculture Office, Meerut. These blocks were, then, arranged in descending order according to the percentage area under Mexican varieties of wheat. Two development blocks, having first and second place, were chosen for the purpose of this study. From each of the block two villages were selected based on the same criterion of percentage area under Mexican wheat varieties.

All the farmers of these four villages were arranged in the ascending order of their operational area. The top farms occupying one-third of the total area of all the farms were classified as small farms; the next one-third were categorised as medium farms and the remaining farms as large farms. Thus, the small farms comprised of the holdings less than 3 hectares, medium farms 3 to less than 5.5 hectares and the large farms with holdings of 5.5 hectares

* This paper is a part of the unpublished Ph.D. thesis of the senior author approved by the P. G. Council of Indian Agricultural Research Institute, New Delhi.

† Figures in brackets refer to publications cited at the end of this paper.

and above. The data pertaining to the agricultural year 1969-70 were collected by survey method with the help of a specially structured schedule from 120 farms, representing small, medium and large, selected randomly on the basis of probability proportional to the number of farms in each size class.

RETURNS TO SCALE

By returns to scale, we mean the behaviour of the change of total returns when all the factors of production are changed simultaneously in the same proportion. However, it is not possible for an entrepreneur to have control over all the resources, therefore, in empirical studies only economic returns to scale is, generally, worked out including only those factors which are under the control of the entrepreneurs and contribute significantly towards the returns.

To examine the nature of returns to scale on the selected farms, Cobb-Douglas type of equations was fitted. The variables which did not turn out to be significant even at 20 per cent level of significance, were dropped from the equations. Out of two variables which had high inter-correlation,[1] only one which had higher correlation with the returns, was retained in the equation. The equations fitted to the per farm data with the variables[2] retained finally were as follows :

Mawana Block :

$$Y=73.4925 \quad X_1^{0.1770^{*}}_{(0.1247)} \; X_3^{0.5866^{***}}_{(0.1334)} \; X_4^{0.0831^{*}}_{(0.0502)} \; X_5^{0.2633^{***}}_{(0.0924)}$$

$$N=60 \qquad R^2=0.9210$$

Sarurpur Block :

$$Y=14.3422 \quad X_1^{0.1413^{*}}_{(0.1068)} \; X_2^{0.3287^{**}}_{(0.1418)} \; X_5^{0.6715^{***}}_{(0.1375)} \; X_6^{0.1077^{*}}_{(0.0720)}$$

$$N=60 \qquad R^2=0.8952$$

Two Blocks Combined :

$$Y=59.2463 \quad X_1^{0.3770^{***}}_{(0.1005)} \; X_2^{0.3759^{***}}_{(0.1040)} \; X_5^{0.4830^{***}}_{(0.0859)}$$

$$N=120 \qquad R^2=0.8704$$

Figures in parentheses are standard errors of the regression coefficients.
*** Significant at 1 per cent level.
** Significant at 5 per cent level.
* Significant at 20 per cent level.

where,

Y = Gross returns on the farm in rupees.

X_1 = Area under the farm in standard hectares.

X_2 = Plough units in days.

1. The simple correlation between the independent variables is presented in Appendix 1.
2. For definition of the variables see Appendix 2.

X_3 = Irrigation in hectare-centimeters.

X_4 = Manures and fertilizers in rupees.

X_5 = Human labour in days.

X_6 = Machinery and implements in rupees.

N = Number of observations.

R^2 = Coefficient of multiple determination.

The regression coefficients of Cobb-Douglas type of equations indicate the elasticities of production of an input and the sum of these elasticities indicates the nature of returns to scale. The returns to scale are decreasing, constant or increasing as the sum of regression coefficients is less than, equal to or greater than unity. The sum of elasticities, the 't' value and the nature of returns to scale for the two selected blocks separately and combined is presented in Table I.

TABLE I—RETURNS TO SCALE ON FARMS IN MAWANA AND SARURPUR BLOCKS OF MEERUT DISTRICT (1969-70)

Items	Mawana block	Sarurpur block	Two blocks combined
Degrees of freedom	55	53	116
Sum of elasticities	1.1100	1.2487	1.2359
Difference between sum of elasticities and unity	0.1100	0.2487	0.2359
Standard error of difference	0.0508	0.0657	0.0466
't' value	2.167**	3.786***	5.066***
Returns to scale indicated by 't' test	Increasing	Increasing	Increasing

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

It can be observed from the table that the sum of elasticities was positive and significantly greater than unity in both the blocks separately and combined, indicating thereby increasing returns to scale in the area under study. This finding controverts the results of earlier investigations based on the Farm Management Studies data indicating constant returns to scale in Indian agriculture (2, 4, 6, 7, 8).

OUTPUT AND FARM SIZE

Majority of the workers in this field have concluded an inverse relationship between output per hectare and farm size (1, 2, 7, 8, 10). An attempt is made here to examine this relationship in an area where new technology has been well adopted. To remove the heterogeneity in the soil of the different

farms the land was standardised on the basis of consolidation assessed value fixed by the revenue department of the State at the time of consolidation of holdings. These values were assigned for the plots in annas and the same was used as an index of fertility.[3]

To examine the relationship between output and farm size a function of the form $Y=aX^b$ may be fitted where Y may be taken as output per standard hectare or total output of the farm. In this paper per farm data are used as dependent variable and the area of the farm as an independent variable in the present study. In this case regression coefficient of land would be positive but less than unity if output per standard hectare declines with the size of farm; positive and equal to unity if output per standard hectare remains same with the size of farm; and positive and greater than unity if output per standard hectare increases with the size of farm.

The fitted equations for Mawana and Sarurpur blocks and for both the blocks combined are given below:

Mawana Block :

$$\text{Log } Y = 3.6714 + 1.0592^{***} \text{ Log } X_1 \quad (0.0629)$$
$$N = 60 \qquad R^2 = 0.08299$$

Sarurpur Block :

$$\text{Log } Y = 3.5610 + 1.0962^{***} \text{ Log } X_1 \quad (0.0692)$$
$$N = 60 \qquad R^2 = 0.8096$$

Two Blocks Combined :

$$\text{Log } Y = 3.6125 + 1.0811^{***} \text{ Log } X_1 \quad (0.0662)$$
$$N = 120 \qquad R^2 = 0.08153$$

*** Significant at 1 per cent level.

where

Y = Gross returns on the farm in rupees.

X = Size of the farm in standard hectare.

R^2 = Coefficient of multiple determination.

N = Number of observations.

It may be observed from the above equations that the regression coefficient of land is positive and significant in all the three equations indicating thereby that the total output of the farm increases significantly with an increase in the size of farm. To examine the relationship between per standard hectare

3. Area in standard hectares = $\frac{\text{Area in hectares} \times \text{Assessed value in annas}}{16}$.

output and size of farm, the difference of the regression coefficient from unity was tested with the help of 't' test. It was observed that in Mawana block the difference of regression coefficient from unity was not significant even at 30 per cent level of significance indicating that the per standard hectare output did not increase significantly with the farm size. In Sarurpur block the difference was significant at 20 per cent level and for both the blocks combined at 30 per cent level which may again not be considered as the appropriate level of significance to conclude a positive relationship between output per standard hectare and farm size. However, it may be concluded that in the context of new technology there is no indication of decrease in output per hectare with an increase in farm size and, therefore, the hypothesis of inverse relationship is rejected in the area under study.

CONCLUSIONS

Increasing returns to scale was observed to be operating on the selected farms of Meerut district. The per hectare productivity and farm size relationship indicated that the hypothesis of inverse relationship does not hold true under the new agricultural technology in the area under study.

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APPENDIX 1

SIMPLE CORRELATION MATRICS ON FARMS IN MAWANA AND SARURPUR BLOCKS OF MEERUT DISTRICT (1969-70)

Gross returns	Area (standard hectare)	Plough unit (days)	Irrigation (hectare-centi-metres)	Manures and fertilizers (Rs.)	Human labour (days)	Machinery and implements (Rs.)
Y	X_1	X_2	X_3	X_4	X_5	X_6
Mawana Block						
Y 1.0000	0.8254	0.7310	0.9735	0.2753	0.8114	0.7556
X_1	1.0000	0.7518	0.7852	0.2254	0.6863	0.7658
X_2		1.0000	0.8218	0.2499	0.5805	0.5463
X_3			1.0000	0.6584	0.7140	0.7773
X_4				1.0000	0.2769	0.1176
X_5					1.0000	0.5255

(Contd.)

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APPENDIX 1 (*Concld.*)

Gross returns	Area (standard hectare)	Plough unit (days)	Irrigation (hectare-centi-metres)	Manures and fer-tilizers (Rs.)	Human labour (days)	Machi-nery and imple-ments (Rs.)
Y	X_1	X_2	X_3	X_4	X_5	X_6
Sarurpur Block						
Y 1.0000	0.8601	0.7370	0.8933	0.7416	0.8231	0.8107
X_1	1.0000	0.7798	0.8997	0.7550	0.6387	0.6236
X_2		1.0000	0.8418	0.7395	0.6236	0.6528
X_3			1.0000	0.8314	0.7925	0.8143
X_4				1.0000	0.7599	0.6516
X_5					1.0000	0.7008
Two Blocks Combined						
Y 1.0000	0.8324	0.7322	0.9254	0.5432	0.8157	0.7936
X_1	1.0000	0.7678	0.8347	0.5726	0.6795	0.6832
X_2		1.0000	0.8322	0.6873	0.6027	0.5938
X_3			1.0000	0.7789	0.7622	0.7925
X_4				1.0000	0.4738	0.5426
X_5					1.0000	0.6358

APPENDIX 2

Definition of the Variables

Gross returns (Y) : Value of the output in rupees of the crops grown on the farm including main product as well as by-product. The prevailing prices at the time of harvest were used for this purpose.

Area (X_1): The total operational holding in standard hectare was used as the area of the farm. The standardisation was done on the basis of the assessed value of the land fixed by the revenue department of the U.P. State at the time of consolidation of holdings. This assessed value of land was used as an index of fertility to remove the difference in the fertility between the farms.

$$\text{Area in standard hectare} = \frac{\text{Area in hectare} \times \text{assessed value in annas}}{16}$$

Plough unit (X_2) : One pair of bullocks and one human labour for 8 hours of work was used as plough unit in days. This was used to remove the multi-collinearity between bullock labour and human labour.

Irrigation (X_3): This included annual quantity of water used on the farm in terms of hectare-centimetres. The depth of one irrigation by canal was assumed to be 7.5 centimetres while by tube-wells 6.25 centimetres. However, the cost of irrigation could not be used in the equation because the charges of canal irrigation were fixed according to crops and not according to frequency of irrigation. Moreover, the farmers under study were using both canal and tube-well irrigation on the same plots.

Manures and fertilizers (X_4) : This included total cost of manures and fertilizers used on a farm in rupees. The value of farm produced manures was imputed at the prevailing prices in the villages and the value of commercial fertilizers was used as the actual cost paid by the farmer.

Human labour (X_5) : This included all human labour used on the farm for crop production except those associated with the bullock labour. The woman labour and child labour were converted into man equivalent on the basis of the pervailing wage rate.

Machinery and implements (X_6) : The annual depreciation and interest in rupees on the machinery and implements used in the farm were included in this variable.

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THE ANALYSIS OF DEMAND FOR FOODGRAINS

This paper is an attempt to provide a more complete understanding of the demand relations of foodgrains in India. During the past years efforts have been made to increase foodgrain production by introducing new technology in the farm sector and as a result, foodgrain production has increased considerably. But increase in population and income has exerted upward pressure on prices of these commodities. Population expansion provides for symmetrical expansion of the demand for food items while increase in income results into asymmetrical growth of demand for foodgrains. Knowledge of explicit relationship amongst quantity, prices and income is very essential for better planning of production, trade and distribution. The objective of this study is to provide an empirical estimate of demand functions for wheat, rice, total cereals, gram, pulses and total foodgrains on aggregate basis for the whole country.

This paper is divided into four parts. The first part presents a brief discussion on demand curve and statistical analysis. The second part deals with the model used in this study. The third part deals with the empirical results. The last part contains the implications and conclusion of the study.