FARM DYNAMICS, RETURNS TO SCALE AND ALLOCATIVE EFFICIENCY IN AGRICULTURE

Article Particulars: Received: 24.03.2018 Accepted: 19.04.2018 Published: 28.04.2018

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Abstract
In recent years the agricultural sector of India has been undergoing rapid changes in view of widespread adoption of new technology, commercialization of agriculture and the growth of capitalist relations in agricultural production. However, variation in efficiency of agricultural production is observed because of credit entitlement issues which are important for new technology adoption. Also, it can be postulated the existence of different forms of agrarian organization which may have its impact on farm efficiency. The present study focuses on efficiency aspects of major types of agricultural organization in the changed context.
Keywords: *Agriculture, Returns to Scale, efficiency and Farm*

Introduction

Agriculture is one of the major sectors of Indian economy. Besides meeting the demand for food and income growth, it is the sector in which the majority of people earn their livelihood. In recent years the agricultural sector of India has been undergoing rapid changes because of widespread adoption of new technology, commercialization of agriculture and the growth of capitalist relations in agricultural production. The new technology adoption is instrumental for higher productivity of agriculture. The new technology consists of bio-chemical and mechanical aspects. The bio-chemical inputs are divisible and can be used equally by all types of farms. The mechanical aspects, though, are instrumental in speeding up agricultural operations, they are not divisible as per requirement.

The new technology adoption require money to buy essential bio-chemical inputs like High Yielding Varieties of seeds, fertilizers and Pesticides which are costlier and are supplied by the industrial sector. Thus, its application requires credit to buy the high cost inputs. For agricultural credit, credit entitlement depends upon the area the farmer own. This is because, the farmer can pledge his land and in return can get credit from financial institutions. In India different forms of organization exist in agriculture. Some farms are own farms, some are lease holdings of various forms. Thus, credit entitlement of different forms of organization may vary. That is, a owner cultivated farm can get credit from financial institutions but a tenant holding cannot get the same as most of the tenant contracts are oral. Credit has been the major constraint of Indian agriculture. Thus, it can be postulated that availability of credit may affect new technology adoption. Variations in technology adoption can lead to differential impact in efficiency of agricultural production. The present study focuses on efficiency aspects of major types of agricultural organizations.

The efficiency of resource use under different types of tenure is the subject of discussion. Many empirical studies have been conducted to examine the efficiency aspects of different organisatonal structure of agricultural production in the Indian Context. Some of them are SN.S Cheung (1969) V.S.Vyas, A.Chakravarthy and Ashok Rudra (1973), H.Dwivedy and Ashok Rudra

(1973), C.H.H.Rao (1971), P.K.Bardhan and T. Srinivasam (1971) C.Bell (1977), M.Chattopadhyaya (1979), D.M.G.Newberry (1974) and M.Chattopadyay and Atanu Sengupta (2001). Their conclusions on the efficiency aspects are mixed. The agrarian condition is different altogether now which needs re-examination of the efficiency aspects. The present study is an attempt to assess variations in the efficiency of different forms of agrarian organization.

Objectives

The objectives of the study are:

1. to measure the variations in efficiency among the different organizational forms and
2. to analyse the factors determining the variations in efficiency.

Hypothesis

The hypothesis to be tested is:

1. Agricultural Production is ruled by constant returns and
2. As the consequence of variations in technology adoption differences in efficiency of production prevail among them.

Data and Methodology

The proposed study is based on cross section primary data collected by multistage random sampling technique. The data base of this study pertains to paddy cultivation during the major cropping season (2016) in Thoothukudi District. At the first stage the rice producing blocks are identified. Of the rice producing blocks a sample of rice producing villages are selected so that the sample selected represent paddy cultivation. The ultimate sample unit is a farm household.

Limitations of the Data

The data base of this study pertains to paddy cultivation during the major cropping season. It cannot, however, explain seasonal fluctuations. Further, barring a few, majority of the cultivators do not have any records of the transactions. Hence, data supplied by them will depend entirely on their memory. Any lapse in their memory may influence the conclusion. However, enough care has been taken to obtain correct data.

Data Analysis

Regression analysis was used to identify the nature of relationship between variables considered. Cobb-Douglas type of production function has been used to determine the nature of returns to scale and allocative efficiency.

Allocative Efficiency

Efficiency as a measure of producer's performance is often useful for policy purposes. Agricultural efficiency has two aspects, namely economic and productive. Economic efficiency can be of two forms, technical and allocative (price). Technical efficiency refers to the proper choice of production function, and allocative efficiency refers to the proper choice of input combination. A farm is guided by the principle of economic considerations of earning a profit by allocating its resources between various inputs. This constitutes resource use efficiency (allocative efficiency). It refers to an optimum input combination which implies that the entrepreneur's goal is profit maximization. In short, all operations pertaining to agricultural production are governed by economic motives.

Previous studies have reported that there exist variations in resource use among farms of different types. The poor but efficient hypothesis of Theodore Schultz postulates that peasant farmers are poor, not because they utilize their resources inefficiently, but because of restrictions in kinds and quantities of resources they command. If this postulate is accepted, variations in resource use efficiency with respect to size and tenure can be expected. Also, once it is theoretically established that allocative efficiency is a proxy of profitability, the next question which has to be taken care of is, to what extent can resources be used profitably? A measurement of allocative efficiency can provide the answer. Efficiency of the use of resources can be defined as equality of marginal factor product and acquisition cost or market price. This contention has been supported by E.O.Heady who states, "an optimum or maximum cannot be determined or defined except in terms of marginalities". In algebraic form the condition of efficiency can be written as

$MVP_x = P_x$ or $MVP_x / P_x = 1$

Wise and Yotopoulas suggest that comparison of marginal revenue with marginal cost (price) of factors for the average farm leads to an evaluation of the degree of efficiency (profit maximization) that is prevalent on the average. A more important conceptual criticism is that these tests consider deviation of average from a single point of input-output space which has been defined as representing perfect economic rationality. Instead, a condition which is both necessary and sufficient has been that farms lie on the same point that variance from the rational behavior defined a priori zero. However, criticism of the approach can be reduced by testing efficiency not only for an average farm but also for a set of average farms each representing a different stratum of farm population based on (i) farm size, (ii) farm tenure and thereby reduce the problem arising out of aggregation. It would also partly meet Ashok Rudra's objection to the use of geometric average in the study of allocative efficiency. This, of course, falls short of studying each and every farm separately. It is therefore, rational that grouping of farms into more homogeneous categories would suffice for some generalization which on an average would be quite valid as stated by Ashok Rudra. Therefore, in this study the allocative efficiency is examined by grouping the farms on the basis of (i) farm size and (ii) farm tenure.

To determine allocative efficiency either production function technique or linear programming technique can be used. Here, the important question is what form of production function is suitable to take care of the neo-classical profit maximization principle in a situation of perfect competition. In India most of the studies on agricultural production have used Cobb-Douglas form of production function. It provides a compromise between (i) adequate fit of the data, (ii) Computational feasibility and (iii) sufficient degrees of freedom unused to allow for statistical testing. Further, Cobb-Douglas production function is a single equation model that assumes a unilateral causal relationship between inputs employed and the output produced. Therefore, Cobb-Douglas function yields best estimates of the parameters of relationship between input and output.

Another important reason for the selection of Cobb- Doulas form of production function is the fact that in the study area tiny and small operating farms coexist with large holdings, a fact which suggests that constant returns to scale could prevail. Further, the divisible characteristics of new technology inputs can entail constant returns.

The next question which demands more elaboration has been its acceptability to a set of cross- section data. The objective of fitting Cobb-Doulas function to a set of cross section data for a group of farms is to obtain accurate estimates of marginal contributions of each input to output. Such estimates make it possible to evaluate the performance of sample farms and compare the productivity of different farm groups.

The production function has been estimated by applying ordinary least square technique. It is used in its unrestricted form to facilitate returns to scale. The function fitted is of the following form.

$Y = A \cdot X_1^{b1} \cdot X_2^{b2} \cdot X_3^{b3} \cdot X_4^{b4}$

'Y' is output, X_1, X_2, X_3, X_4 are farm size, bio-chemical inputs, labour and capital respectively and b_1, b_2 ….. b_4 are elasticities of production. In order to introduce linearity the variables are expressed in logarithm form and then its coefficients are obtained. The estimated coefficients are presented together with their standard errors to indicate the level of significance and goodness of fit. R^2 value was calculated to neutralize the effect of increase in the variables. The equation in logaritham form is given below.

$\text{Log } y = \log A + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4$

The estimated coefficients are elasticities of production of inputs which in turn have been used to calculate their marginal value product at their geometric mean for an average farm. The marginal productivity of factors is derived by multiplying elasticity parameters of the particular input by the average product of that factor. The possibility of increasing production by making adjustment of inputs has been examined on the criterion whether farms use their resources efficiently. It has been judged on neo-classical criterion that each factor of production is paid according to its marginal product. A significant difference between the marginal value product and the market price of individual input would indicate that farmers are using, on an average, their factors of production inefficiently.

In a set of cross section data, there often exists a high correlation between some of the explanatory variables leading to the problem of multicollinearity. It has been suggested that inter-correlation or multicollinearity is not necessarily a problem unless it is highly relative to the overall degree of multiple correlation among all variables simultaneously. In the present study multiple correlation coefficients has been greater than any of the zero order correlations. Therefore, we have fitted the function with all the variables.

Returns to Scale and Allocative Efficiency

Returns to scale refers to the relation between a proportional change in input to a production process and resulting proportional change in output. The estimated regression coefficients are depicted in the Table 1.

Table 1: Coefficients of Farm Production Function and Returns to Scale

Regression Equation	Farm classification Size Classification (acres) Tenurial Classification	N	Constant log	Regression Coefficients				R^2	Sum of Regression Coefficients	Deviation From Unity	Returns to scale Indicated by 't' Test	'F' Value
				Land	Bio-Chemical Input	Labour	Capital					
1.	All Farms	249	5.8114	0.5047* (0.0879)	0.2626* (0.0511)	0.1689* (0.0574)	0.1197* (0.0484)	0.94 (0.94)	1.0559	0.0559	Constant	935.03
2.	Upto 2	133	5.5990	0.4829* (0.0939	0.3395* (0.0596)	0.0235 (0.0679)	0.0274 (0.0557)	0.88 (0.88)	0.8733	-0.1267	Constant	242.82
3.	2-4	73	8.1131	0.9084* (0.3047)	0.0777 (0.1094)	-0.0312 (0.1489)	0.0961 (0.1191)	0.45 (0.99)	1.0510	0.0510	Constant	13.79
4.	Above 4	43	6.4454	0.8139* (0.2976)	0.0952 (0.1438)	0.0876 (0.1564)	0.2198** (0.1372)	0.73 (0.99)	1.2165	0.2165	Constant	25.50
5.	Own Farms	86	8.6513	0.8656* (02286)	0.0785 (0.1166)	0.0866 (0.1302)	-0.0428 (0.1204)	0.91 (0.90)	0.9879	-0.012	Constant	197.43
6	Tenant Holdings	59	5.9510	0.4276* (0.1228)	01025* (0.0742)	0.2657* (0.0812)	0.2388* (0.756)	0.96 (0.97)	1.0346	0.0346	Constant	400.80
7.	Tenant Farms	45	6.0666	0.6161* (0.2125)	0.3080* (0.1261)	0.0316 (0.1033)	0.1045** (0.0793)	0.96 (0.95)	1.0602	0.0602	Constant	22745
8.	Own Holdings	59	6.1873*	0.6356* (0.1649)	0.2931* (0.1047)	0.0259 (0.1249)	0.1155*** (0.0689)	0.97 (0.97)	1.0701	0.0701	Constant	482.99

Source: Field Survey

Figures in the parentheses below the R^2 are $\bar{R}^2$ Values

***Sigificant at 5 per cent level; ** Siginificant at 10 per cent level; *Siginficant at 1 per cent level.

It can be observed from the table 1.1 that the sum of elasticities is positive and greater than one for most of the equations. However, the sum of regression coefficients for their deviation from unity by't' test indicates constant returns to scale in all the regression equations. This finding is consistent with some of the earlier studies which report constant returns to scale. Also, extension of this analysis to different categories of farms grouped size-wise and tenure-wise indicates that agricultural production in the study area is ruled by constant returns. The explanation for the constant returns can be offered in terms of divisible characteristics of bio-chemical inputs. Further, the most interesting aspect of capital is its divisibility which is facilitated by hiring of capital. It means that, farms do not maintain own capital, instead they hire from capital service providers. Moreover, the existence of tiny and small farms along with larger farms in the study area gives credence to the conclusion.

The prevalence of constant returns to scale is also important in the context of the much discussed inverse relationship between farm size and productivity. If the agricultural production function has not been of constant returns there could be an inverse relationship between farm size and productivity. With returns to scale being constant, inverse relationship has given way for a positive relationship between farm size and productivity.

Allocative Efficiency

From the estimated production function it is possible to evaluate efficiency of the use of resources which can be defined as equality of marginal factor product and acquisition cost. To determine the possibility to increase efficiency through re-allocation of resources, it is important to take note of the quantum of variation between marginal value product and price. Marginal value product indicates expected increase in total output resulting from the use of one additional unit of a particular input. If the marginal value product of any input exceeds its price, then increased use of it will add more to production. The reverse is true if marginal value product is less than price. Equality of marginal value product and price would mean that no gain in production can be achieved through either more or less use of the input. In order to evaluate allocative efficiency of farmers, marginal value products of various inputs with their respective acquisition costs are compared. The marginal value product of input factors and their ratios of factor costs are given in the tables 2 and 3 respectively.

Table 2 Marginal Value Product of Inputs

Regression Equation	Farm Classification Size (acre) / Tenure	Marginal Value Product of Input Factors			
		Land	Bio-Chemical Input	Labour	Capital
1.	All Farms	6010	1.264	45.20	1.261
2.	Upto 2	5862	1473	5938	0.298
3.	2-4	10188	0.395	-8.37	0.975
4.	Above 4	10102	0.574	27.92	2.234
5.	Own Farms	9313	0.358	18.87	0.425
6.	Tenant Holdings	5545	0.502	76.70	2.676
7.	Tenant Farms	6890	1.668	8.73	1.023
8.	Own Holdings	8452	1.368	7.32	1.314

Source: Field Survey

Table 3 Ratio of Marginal Value Product to Factor Cost

Regression Equation	Farm Classification Size (acre) / Tenure	Ratios of Marginal Return to Factor Cost			
		Land	Bio-Chemical Input	Labour	Capital
1.	All Farms	1.67	1.264	0.753	1.261
2.	Upto 2	1.63	1.473	0.989	0.298
3.	2-4	2.83	0.395	-o.139	0.975
4.	Above 4	2.81	0.574	0.465	2.234
5.	Own Farms	2.586	0.358	0.315	0.425
6.	Tenant Holdings	1.540	0.502	1.278	2.676
7.	Tenant Farms	1.913	1.668	0.146	1.023
8.	Own Holdings	2.347	1.368	0.122	1.314

Source: Field Survey

The ratio of marginal return to land cost has been quite high for all estimated regression equations. It is significantly greater than unity. The higher marginal productivity of land states its continued importance in agriculture. Thus, it would pay if land is used more intensively.

The contribution of bio-chemical inputs has been mixed. The ratio of marginal return to its cost has been greater than one for equations 1,2,3,7 and 8. It is quite low for the rest of the equations. For the tenant farms marginal return is quite high. The ratio of marginal return to cost in respect of human labour is less than one for all regression equations. It means labour use is uneconomical in agriculture. The possible cause for this proposition is the availability of labour only at a higher cost during the peak season. The operation of diminishing returns suggests the need to optimize labour use by suitable alternative measures or relocating them gainfully. This finding corroborates with the much held view of diminishing returns to labour in Indian agriculture. The ratio of marginal returns to the cost of capital is also mixed. It is greater than unity for equations 1,4,6,7 and 8. Its significance is quite reasonable for equations 4 and 6. Since marginal productivity of capital is more than unity in many cases it will pay to use capital more intensively and also its prudent use may help to replace unproductive labour.

Conclusions

From the above analysis the following conclusions can be drawn.

1. The agricultural production in the study area is ruled by constant returns to scale.
2. The ratio of marginal value product of land to its cost is significantly high. This implies that production can be significantly increased by increasing the area of land under cultivation.
3. The ratio of marginal value product of capital to its cost suggests inefficient use of capital. Hence, production can be increased by the efficient use of capital.
4. The scope for increase in farm income through reallocation of available resources exists with reference to land and capital alone.
5. The ratio of marginal value product of bio-chemical inputs to its cost is mixed. Tenant farms, own holdings and small farms can use them more intensively.
6. The ratio of marginal value product of labour to wage is significantly less than unity. However, the ratio is not zero.
7. The tenant farms, tenant holdings and own holdings can increase the area of land under cultivation, quantum of bio-chemical inputs and the amount of capital.

References

1. Ashok Rudra, ‘More on Returns to Scale in Indian Agriculture’ Economic and Political Weekly, Vol.3, No.43, Oct.26, 1968, pp. A33-A38.
2. Bardhan, P.K. and Srinivasam, T.,(1971), ‘Crop Sharing Tenancy in Agriculture: A Theoretical and Empirical Analysis’, American Economic Review, Vol.61, No.1, and March.
3. Bell, C., (1977), ‘An Alternative Theory of Sharecropping: Some Tests Using Evidences from Northern India’, Journal of Development Studies, Vol.13, No.4, July.
4. Chattopadhyay, M., (1979), ‘Farm Size and Productivity: A new Look at the Old Debate’, Economic and Political Weekly, Vol.32, No.52, Dec.
5. Chattopadhyaya, M., Atanu Sengupta, (2001), ‘Tenancy Inefficiency: A Study Based on west Bengal Agriculture’, Economic and Political Weekly, Vol.34, No.5-6, Feb.
6. Cheung, S.N.S. (1969), Theory of Share Tenancy, The University of Chicago Press, Chicago.
7. Dwivedy, H., and Ashok Rudra (1973) ‘Economic Effects of Tenancy: Some Negative results’, Economic and Political Weekly, Vol.8, No.29, July.
8. Heady, E.O., Economic of Agricultural Production and Resource use, (Prentice Hall, New Delhi), 1968, p.42.
9. Newberry, D.M.G., (1974), ‘Crop Sharing Tenancy in Agriculture: Comment’, American Economic Review, Vol.64, Dec.
10. Rao, C.H.H. (1971), ‘Uncertainty, Entrepreneurship and Sharecropping in India’, Journal of Political Economy, Vol.79, No.3, May-June.
11. The term ‘poor but efficient hypothesis’ can be attributed to T.W. Schultz. The ability of a farmer to command credit depends upon the area he owns.
12. Vyas, V.S., et.al (1973) Significance of the New Strategy of Agricultural Development for Small Farmers, Agro Economic research Centre for Gujarath, Vallabhvidyanagar.
13. Wise, J., P.A. Yotopoulos, ‘The Empirical Content of Economic Rationality: A Test for Less Developed Economy’, Journal of Political Economy, Vol.77, No1, Nov-Dec, 1969, p.980.