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A Study on Technological Parameters in Size-Wise Agricultural Production Function in Nellore District: Andhra Pradesh

Dr. E. Lokanadha Reddy[1], Dr. D. Radhakrishna Reddy[2]
[1]*Department of Economics, Sri Venkateswara College of Engg. & Tech., Chittoor District – 517 127, A.P, India.*
[2]*Department of Economics, Sri Venkateswara College of Engg. & Tech., Chittoor District – 517 127, A.P, India.*

Abstract: *Farm-size is of an extreme interest in agriculture. This has been much debated over what may be appropriate size of the farm because the size of the operating unit, as in the case of manufacturing industries, decisively affects the income from agriculture. Even where there is no cost advantage or disadvantage for farms of various sizes, small farms will have, under usual price relationship, lower incomes and savings than large farms. Thus, the size of farms is a vital element in determining the earning capacity of the farmer as well as the efficiency of a farming unit. Hence the present study aims to analyse the Size-wise Agricultural Production Function based on entire sample of Farms in Three Revenue Mandals of Nellore District, Andhra Pradesh. Data was collected for the explanatory and explained variables with the help of survey method through personal interviews of the farmers selected through mixed sampling. Regression co-efficients are estimated to study the relationship between gross output and various factors of production. The sum of the elasticities and their statistical significance was also studied to decide the returns to scale.*

Key Words: *Size-wise Agricultural Production Function, Ordinary Least Squares Method, Regression Co-efficients, Human Labour, HYV Seeds.*

I. Introduction

Farm-size is of an extreme interest in agriculture. This has been much debated over what may be appropriate size of the farm because the size of the operating unit, as in the case of manufacturing industries, decisively affects the income from agriculture. In case of manufacturing industry, we have optimum size of the unit, a size which is in existing conditions of technique and organizing ability has the lowest average cost of production per unit. Similarly in agriculture, too, we have a size, which under given conditions, would yield the best results to the farmer. The advantages of large and small farms have been debated for atleast a century. There are economists and farmers who advocate large-scale farming for efficient operations, a satisfactory income to the farm family and food to the consumer at reasonable rate. But, on the other hand, some persons strongly advocate small-scale farming on the ground of social justice. Poverty in agriculture, in most of the third world countries is as much a problem of farm size as of other single factor. The great majority of farm families in these developing countries with low income line on undersized and adequate units. Since the amount of income is dependent on the size of the farm, preponderance in small and tiny holdings is mainly responsible for peasantry in these countries. Even where there is no cost advantage or disadvantage for farms of various sizes, small farms will have, under usual price relationship, lower incomes and savings than large farms. Thus, size of farms is a vital element in determining the earning capacity of the farmer as well as the efficiency of a farming unit. The size of the farm is usually measured on the basis of acreage. This is the only measure consistently used by the agricultural census of many countries of the world. India is a land of small units of cultivation. A predominantly large proportion of the cultivated holdings has steadily continued. Today about 82 percent of the holdings are being operated in small units covering about 39 percent of the total operated land. It is obvious at a glance that small units of cultivation reflect a serious imbalance on the land-man ratio. In contrast to large holdings which suffer from lack of labour and inputs, the small units suffer from holdings also have less of motivation than the other farmers. The new approach in agricultural production serves to emphasize the importance of small units of cultivation and to understand the problems connected with these.

Many evaluative studies were made an impact on new technology in transforming Indian Agriculture. The extreme diversities in resource endowments and relative factor scarcities have led the economists to make a diverse assessment about the impact of the new technology on the small and large farms. The northern states which are endowed with a developed infrastructural and irrigational facilities, surpass the other states in sharing the benefits. However in those states too, there is disagreement among agricultural economist regarding the equity problem between small and large farms. Some have expressed the view that the inverse relationship which was existing under traditional labour-intensive technology which still holds under new technology. Contrast to this, the second group of economists have observed that the inverse relationship, though still exists,

is slowly disappearing. There is yet another group which argues that the new technology has resulted in disappearance to positive relationship.

There are number of studies on the agricultural sector in Nellore district. Among these studies, the research on agricultural production is very limited. The empirical investigations are needed to study the size-wise agricultural production function. Hence, the empirical and scientific investigational study of size-wise agricultural production function in the rural economy of Nellore district is an important phenomena. In the present study, an attempt has been made to study the size-wise production function basing on entire sample of farms of three mandals, namely, Kaligiri, Muttukur and Pellakur of Nellore district of Andhra Pradesh.

II. Review of Literature

Rajvir Singh and Patel[1] made an attempt to examine the relationship between output and farm-size in Meerut district of Utter Pradesh. The authors was 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. One possible explanation for these trends is that, as farm technology undergoes a change; large farmers take together interest in using land more intensively with modern inputs at proper time in the week of higher probability offered by the New Technology.

Based on the data derived from different resources, Hanumantha Rao[2] reached the following observations, "Despite better access to resources, output per acre among large farms under the traditional labour intensive technology was cost of (hired) labour was higher for them for small family farms. Also, managerial and supervisory diseconomies of large-size under labour-intensive methods accounted for lower labour input per acre among large farms. Technological changes created new production possibilities for large farms which could now increasingly substitute capital for labour by adopting biological as well as mechanical techniques and produce at a faster rate than small farms. The latest evidence shows that the inverse relationship between farm size and output per acre found under traditional technology no longer holds true with the adoption of new technology".

Bhatia and Datta[3] made an attempt to analyse, whether the use of different energy inputs help in promoting employment. The study was conducted in the Amritsar District for the year 1984-85 and cultivators were divided into four groups namely marginal, small, medium and large sized farm groups. The study revealed that the number of family labour engaged in agriculture bears direct relationship with size of operational holding. However, employment (man equivalent days/acre) bears inverse relationship. The functional relationship revealed that in the case of marginal and small farms, human employment can be supplemented by the more use of mechanical energy, whereas in the case of medium farms the use of human-labour can be increased some extent within the increased use of chemical energy but in the case of large farms, the use of human-labour was rational and can be increased with more use of chemical as well as mechanical energy.

A.R. Reddy and C.Sen[4] study was undertaken in the Sone Canal command area of the state of Bihar. A sample of 270 farmers comprising 207 marginal (< 1 hectare), 31 small (1-2 hectares), 22 semi-medium (2-4 hectares) and 10 medium (4-10 hectares) farms were selected through stratified random sampling method. Technical inefficiency of the individual farms was estimated through stochastic frontier production function analysis. This study reveals that the technical inefficiency in rice production decreased with increase in farm size. The average technical inefficiency was highest in marginal farms (27.28%) followed by small farms (22.05%). Minimum average and technical inefficiency was observed in medium group. Technical inefficiency in the production of rice is negatively related with farm size.

Jain[5] made an attempt to examine the interaction between farms size, technology and rural institutions to discover their influence on income distribution. The study reveals that in case of traditional crops or where irrigation and HYV seeds have not been used, little differences in per acre yield existed among various farm size groups. But under jointly managed capital intensive irrigation technology, the per acre yield of the rich and middle farmers was much higher when compared to the poor farmers. Family, it was also observed under individual managed labour intensive irrigation technology the per acre yield of the poor farmers was much higher than that of the rich and middle farmers. The study, therefore, suggested that the technology suited for the poor is promoted, income differences can be minimized.

Pritam Singh[6] made an attempt to examine the economic efficiency of different farm-size groups. He tested the significance of various indicators of economic efficiency within the size groups and farm types. He concluded that there is a direct relationship between farm-size and economic efficiency on tractorised farms only. Moreover, the level of economic efficiency is higher on tractor-operated farms, on bullock-operated farms especially medium and large farms.

Debnarayan Sarker and Sudpita De[7] study attempted to examine the extent of efficiency under different types of nature and different farm sizes in two types of villages – Technologically Advanced villages and Technologically Backward villages. This study considering all farm sizes in both the type of villages together, it can be said that except the lowest farm size where all farms are efficient, the proportion of efficient

farm increase with the increase of farm size. This analysis shows that the use of high technological inputs in Agriculture is not so important in improving the efficiency level of the farms. This might suggest that only high use of technical inputs like irrigation, HYV seeds, chemical fertilizer per unit of land does not necessarily bring about maximum possible output for a given set of inputs, nor does it only make 'best practice' relationship between inputs and outputs.

Srinivasa Gowda, Basavaraj Bankar, Basvaraj and Hugar[8] studied the productivity differences between small and large farms by analyzing the parameters of their respective production functions. The study revealed that the productivity differences between small and large farms were largely attributable to the existing technology. The author found that the level of output use had a relative significant influence on productivity difference. Large farms were found to have a technological advantage over small farms under irrigated conditions, while the reverse was true under un-irrigated conditions. The study concluded that an improvement in technology appropriate for them but also an increase in their access to the modern agricultural inputs.

III. Objective of the Study

The following is the objective of the study:

To study the Technological Parameters in Size-wise Agricultural Production Function based on entire sample of farms in three revenue mandals of Nellore District, Andhra Pradesh.

IV. Data and Methodology

The following methodology is adopted to study the above objective. The present study extends over Nellore district of Andhra Pradesh. A multistage random sampling design was used. We purposefully selected three mandals, Namely Kaligiri, Muttukur and Pellakur of Nellore District at the first stage and later with help of random sampling ten to twelve villages were selected from each Mandal. After the selection of villages a complete list of agricultural families was prepared. As it is generally believed that the technology was size-based, the list of farmers was further divided into three categories of farms defined as under;

0.00	acres	-	2.50	acres	-	small farms
2.51	acres	-	5.00	acres	-	medium farms
5.01	acres and above				-	large farms

From the sub-divided list of farmers 15-20 farmers were selected from each village for preparing a sample of 420 farmers taking for Kaligiri, Muttukur and Pellakur mandals. Data was collected for the explanatory and explained variables with the help of survey method through personal interviews of the farmers selected through mixed sampling for this study relating to the agricultural year 2004-2005.

4.1. Specification of variables

A great deal of caution is essential in the selection, classification and aggregation of input variables used in the production process for studying resources productivity. Different researchers have classified and aggregated farm inputs in different ways suitable for their studies. Various ways of classifying and aggregating input variables in production function studies together with a brief description of variables used as explanatory variables in the present study are giving below.

4.1.1. Bullock-Labour

Preparation of farm is an important agricultural work and bullock-power have been taken as an explanatory variable by a number of writers. Chaudhari[9], Reddy and Sen[10], Hopper[11] and Radhakrishna[12] have used it in terms of plough unit days consisting of one pair of animal-labour day and one human-labour day comprising one plough unit. While Rajkrishna[13], Badal and Singh[14] specified this variable in terms of bullock-labour days, Robellow and Desai[15] included a labour with a pair of bullocks. Here, we also include one human-labour to a pair of bullocks and specify them in value terms. This done with the help of accounting prices.

4.1.2. Human-Labour

Human-labour too, has been used as an explanatory variable in the estimation of production functions either in physical units of time or in value of terms. Shan[16] and Goyal[17] used all human labour while, Hopper[11] and Mathur[18] used all human-labour except those associated with plough unit in value terms. Sharma and Sharma[19], Hanumantha Rao[2], Rajkrishna[13], Singh[20] and Eswara Prasad[21] have used all human-labour in terms of man-days. We also include human-labour as an explanatory variable but from it exclude those labourers who are engaged in traditional irrigation work and are associated with bullock units. Variable is specified in terms of rupees.

4.1.3. Seeds

A few writers have used seeds as explanatory variable in their functions. Prasad[22], Debnarayan Sarker and Sudptia De[7] used seeds as a separate explanatory variable in his study terms of expenditure on seeds. We also include seeds in our functions, the prices of seeds are determined at the prevailing market price of the seeds at the seeding time.

4.1.4. Irrigation

Assured and effective irrigation which has been one of the most important factors in the production function studies. Rajkrishna[13], Timothy and Krishna Moorthy[23] has specified this variable in terms of expenses on irrigation. We also specify it in the same term. Expenses on irrigation include permanent of wages to labourers used in traditional system of irrigation, water charges paid to the Government for the use of state tube-wells, hire-price of the water received from private tube-wells and pumping sets. Expenses also include accounting prices for the water received from farmers own pumping sets and tube-wells.

4.1.5. Fertilizer

Fertilizer is one of the most important components in Agricultural Production. Parikh[24] and Shan[16] Mythili and Shanmugam[25] have used chemical fertilizers as separate variable, while Basak and Choudhary[26] has included manure along with chemical fertilizers as an explanatory variable. Yadav and Gangwar[27] considered various categories of chemical fertilizers as independent explanatory variables. In the present study, though category-wise chemical fertilizer is not taken, chemical fertilizers and pesticides and natural fertilizers are specified as separate variables, and taken in value terms. While expenses on chemical fertilizer are the actual expenses, help of accounting price has been taken to determine the expenses on traditional fertilizers, like seen manure, compost burnt of waste goods and cow-dewing.

4.1.6. Plant Protection

Plant protection measures are included as explanatory variable. Prasad[22] and Badal and Singh[14] taken them in terms of expenditure on their use. In our study also this variable is specified in terms of actual expenditure.

V. Model Specification

Like specification of variables, specification of an equation showing functional relationship between inputs and output is an important aspect of production function studies. Many of the economists used the generalized Cobb-Douglas Production Function to study the relation between the inputs and output in production analysis. The following production function has been specified for size-wise analysis.

To study the Size-wise production function based on entire sample of farms, the following production function was considered.

$$Y_i = a_{i0} X_{i1}^{a_{i1}} X_{i2}^{a_{i2}} X_{i3}^{a_{i3}} X_{i4}^{a_{i4}} X_{i5}^{a_{i5}} X_{i6}^{a_{i6}} X_{i7}^{a_{i7}}$$

Where,

i = S, M and L represents Small, Medium and Large
Y = Gross output including by-products (in Rs.)
a_0 = Intercept
X_1 = Bullock Labour (in Rs.)
X_2 = Expenditure on Tractor (in Rs.)
X_3 = Human Labour (in Rs.)
X_4 = HYV Seeds (in Rs.)
X_5 = Chemical Fertilizers (in Rs.)
X_6 = Manures (in Rs.)
X_7 = Pesticides and other Plant Protection Expenditure (in Rs.)
and $a_1, a_2, a_3, a_4, a_5, a_6$ and a_7 are the elasticities.

VI. Results and Discussions

6.1. Size-wise Production Function Analysis

To study the Size-wise production function based on entire sample of farms, we considered the production function

$$Y_i = a_{i0} X_{i1}^{a_{i1}} X_{i2}^{a_{i2}} X_{i3}^{a_{i3}} X_{i4}^{a_{i4}} X_{i5}^{a_{i5}} X_{i6}^{a_{i6}} X_{i7}^{a_{i7}}$$

The equation is estimated by the method of ordinary least squares and the estimated parameters with the other related statistics are presented in the tables 1, 2 and 3. By using the Klein[28] and Heady-Dillon[29]

test of multi co-llinearity was carried out to examine the presence of multi co-llinearity and results were indicate the absence of multi co-llinearity between the variables.

6.1.1. Kaligiri Mandal

Table 1 shows the values of R^2 for different categories of farms in the Kaligiri mandal. F-test was carried out and it was found significant at 5 percent probability level in the Kaligiri mandal under study. The included variables explained 98 percent of variation in output of the small farms, 79 percent in medium farms and 99 percent in large farms of Kaligiri mandal. The estimated equation shows the true relationship between output and inputs. Thus all the functions fulfill the goodness of fit.

Table 1: Estimated Parameters and other Related Statistics of Functions Related to Different Size Group of Farms in Kaligiri Mandal

Inputs	Description of Inputs	Kaligiri Mandal		
		Small	Medium	Large
a_0	Intercept	3.0077	2.8064	2.5387
X_1	Bullock-labour	0.0014 (0.0030)	0.0002 (0.0088)	-0.0023 (0.0024)
X_2	Expenditure on Tractor	0.0063* (0.0027)	0.0034 (0.0048)	0.0001 (0.0042)
X_3	Human-labour	0.4586* (0.1820)	0.0996 (0.1299)	0.2543* (0.0760)
X_4	HYV Seeds	0.0126 (0.0674)	-0.0096 (0.0653)	0.0302 (0.0495)
X_5	Chemical Fertilizers	0.1601 (0.1672)	0.3137* (0.1537)	0.2002* (0.0768)
X_6	Manures	-0.0120 (0.1141)	0.3105* (0.1049)	0.1392 (0.0791)
X_7	Pesticide and other Plant Protection Expenditure	0.3161* (0.1229)	0.2722* (0.1136)	0.4043* (0.0658)
-	R^2	0.97802	0.79212	0.97762
-	F	101.7113*	25.5844*	268.3700*
	SUM	0.9431	0.900	1.0260

*Significant at 5% Probability level.

Figures in the Parentheses are Standard Errors.

Small Farms:

From table 1, it is observed negative relation between manures with the gross output. Hence, keeping all other variables constant at their respective geometric mean level, with the increase in manures by one rupee, the amount of gross output would tend to decline by Rs. 0.01. Further, it is noticed positive relationship between the variables – bullock-labour, expenditure on tractor, human-labour, HYV seeds, chemical fertilizers and pesticides and other plant protection methods – and the amount of gross output. Out of these six variables the co-efficients of expenditure on tractor, human-labour and pesticides and other plant protection methods are found to be significant at 5 percent probability level. A close look at the table reveals the fact that with the increase of one rupee in human-labour, the amount of gross output including by-products would tend to increase by Rs. 0.046; In the same way keeping all other variables constant at their respective geometric mean level, with the increase of one rupee in chemical fertilizers, the amount of gross output including by-products would tend to increase by Rs. 0.16. Similarly, in the case of expenditure on tractor, HYV seeds and pesticides and other plant protection methods it would be Rs. 0.01, Rs. 0.01 and Rs. 0.32 respectively.

Medium Farms:

We find negative relationship between HYV seeds and gross output including by-products. The regression co-efficient indicates that with the increase in HYV seeds by one rupee, the amount of gross output including by-products would tend to decline by Rs. 0.01, keeping all other input variables constant at their respective geometric mean level. Further, it is observed a positive relationship between the independent variables – bullock-labour, expenditure on tractor, human-labour, chemical fertilizers, manures, pesticides and other plant protection methods – and the gross output including by-products. The regression co-efficients indicates that, with the increase in bullock-labour by one rupee, the amount of gross output including its by-products would tend to increase by Rs. 0.003. Similarly in the case of human-labour, chemical fertilizers,

manures and pesticides and other plant protection methods it would be Rs. 0.01, Rs. 0.31 and Rs. 0.27 respectively. It is also found that chemical fertilizers, manures and pesticides and other plant protection methods are significant at 5 percent probability level.

Large Farms:

It is observed negative relationship between bullock-labour and gross output including by-products. The regression co-efficient indicates that with the increase in bullock-labour by one rupee, the amount of gross output including by products would tend to decline by Rs. 0.002, keeping all other input variables constant at their respective geometric mean level. It is noticed that a positive relationship between the variables – human-labour, HYV seeds, chemical fertilizers, manures, pesticides and other plant protection methods and gross output including by-products. The regression co-efficients indicates that with the increase in human-labour by one rupee, the amount of gross output would tend to increase by Rs. 0.25, keeping all other input variables constant at their respective geometric mean level. In the same way, keeping all other variables constant at their respective geometric mean level, with the increase of one rupee in HYV seeds, the amount of gross output would tend to increase by Rs. 0.04. Similarly, in the case of chemical fertilizers, manures, and pesticides and other plant protection methods it would be Rs. 0.20, Rs. 0.14 and Rs. 0.40 respectively. The regression co-efficient indicates that with the increase in bullock-labour by one rupee, the amount of gross output would not change. Further, it is observed that the human-labour, chemical fertilizers and pesticides and other plant protection methods are significant at 5 percent probability level.

The regression co-efficient of human-labour is found to be significant in small and large farms. Further, the regression co-efficients of human-labour is found to be more in the case of small farms (0.4586) followed by large farms (0.2543) and medium farms (0.0996). The regression co-efficient of chemical fertilizers is observed to be significant in the case of medium and large farms. This co-efficient is found to be more in the case of medium farms (0.3137) followed by large farms (0.2002) and small farms (0.1601). The regression co-efficients of pesticides and other plant protection methods is found to be significant in small, medium and large farms. The regression co-efficient of HYV seeds is seen to be negative in medium farms and positive in small and large farms. The regression co-efficient of manures is found to be negative in the case of small farms and positive in the case of medium and large farms. Therefore, the absence of significant effect of technology on crop output was observed in Kaligiri mandal.

6.1.2. Muttukur Mandal

Table 2 shows the values of R^2 for different categories of farms in the Muttukur mandal. F-test was carried out and it was found significant at 5 percent probability level for the Muttukur mandal under study. The included variables explained 98 percent of variation in output of the small farms, 76 percent in medium farms and 90 percent in large farms of Muttukur mandal. The estimated equation shows the true relationship between output and inputs. Thus all the functions fulfill the goodness of fit.

Table 2: Estimated Parameters and other Related Statistics of Functions Related to Different Size Group of Farms

Inputs	Description of Inputs	Muttukur Mandal		
		Small	Medium	Large
a_0	Intercept	2.0436	0.5862	2.8280
X_1	Bullock-labour	-0.0081 (0.0278)	-0.0217 (0.0855)	0.1028 (0.0814)
X_2	Expenditure on Tractor	-0.0825 (0.0665)	0.1840 (0.2543)	0.2389 (0.2097)
X_3	Human-labour	0.4178* (0.0988)	0.7781* (0.2458)	0.2323 (0.2161)
X_4	HYV Seeds	0.1002* (0.0443)	0.1432 (0.1554)	0.0168 (0.1248)
X_5	Chemical Fertilizers	0.3579* (0.0955)	0.0434 (0.1976)	0.0822 (0.1642)
X_6	Manures	0.0879 (0.0972)	0.1303 (0.2127)	0.0489 (0.1592)
X_7	Pesticide and other Plant Protection Expenditure	0.1642* (0.0736)	-0.0010 (0.1296)	0.2994* (0.1504)
-	R^2	0.97870	0.76336	0.90193
-	F	164.1306*	12.903*	82.7750*
	SUM	1.0374	1.2562	1.0213

*Significant at 5% Probability level.

Figures in the Parentheses are Standard Errors.

Small Farms:

From the table 2, a negative relationship was noticed between the variables – bullock-labour, expenditure on tractor – and gross output including by-products. Keeping all other variables constant at their respective geometric mean level, with the increase of one rupee in bullock-labour, the amount of gross output would tend to decline by Rs. 0.01. Similarly, in the case of expenditure on tractor it would be Rs. 0.08. Further, a positive relationship was observed between each of the variables – human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods and gross output including by products. Out of these five, four variables, human-labour, HYV seeds, chemical fertilizers and pesticides and other plant protection methods are found to be significant at 5 percent probability level. A close look at the table reveals the fact that with the increase of one rupee in human-labour, the amount of gross output would tend to increase by Rs. 0.42, keeping all other input variables constant at their respective geometric mean level. Similarly, in the case of HYV seeds chemical fertilizers, manures and pesticides and other plant protection methods it would be Rs. 0.36, Rs. 0.09 and Rs. 0.16 respectively.

Medium Farms:

It is observed a negative relationship between the variables – bullock-labour and pesticides and other plant protection methods – and gross output including by-products. Keeping all other variables constant at their respective geometric mean level, an increase of one rupee in each variable the amount of gross output would tend to decline by Rs. 0.02 and Rs. 0.001. It is noticed positive relationship between the variables – expenditure on tractor, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods each – and gross output. The regression co-efficient indicates that with the increase in expenditure on tractor by one rupee, the amount of gross output would tend to increase by Rs. 0.18, keeping all other input variables constant at their respective geometric mean level. In the same way keeping all other variables constant at their respective geometric mean level, an increase of one rupee in human-labour, the amount of gross output including by-products would tend to increase by Rs. 0.77. Similarly, in the case of HYV seeds, chemical fertilizers and manures it would be Rs. 0.14, Rs. 0.04 and Rs. 0.13 respectively. Only one regression co-efficient that is the co-efficient of human-labour is found to be significant at 5 percent probability level.

Large Farms:

A positive relationship between the variables each – bullock-labour, expenditure on tractor, human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods – and gross output was noticed. The regression co-efficient of bullock-labour indicates that with the increase in bullock-labour by one rupee, the amount of gross output would tend to increase by Rs. 0.10, keeping all other input variables constant at their respective geometric mean level. Similarly, in the case of expenditure on tractor, human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods it would be Rs. 0.24, Rs. 0.23, Rs. 0.02, Rs. 0.08, Rs. 0.05 and Rs. 0.30 respectively. Further it is noticed that the effect of variable pesticides and other plant protection methods is significant at 5 percent probability level.

The regression co-efficient of human-labour is found to be significant in the case of small and medium farms; The value of regression co-efficient is found to be more (0.7781) in the case of medium farms followed by small farms (0.4178) and large farms (0.2323). The regression co-efficient of HYV seeds is observed to be significant in the small farms only, and this co-efficient is found to be more in the case of medium farms (0.1432) followed by small farms (0.1002) and large farms (0.0168). The regression co-efficient of chemical fertilizers is observed to be significant in the case of small farms only, and this co-efficient is found to be more in small farms (0.3579) followed by large farms (0.0822) and medium farms (0.0434). The effect of pesticides and plant protection expenditure is also found to be positive and significant in the case of small and large farms where as it is negative in case of medium farms.

6.1.3. Pellakur Mandal

Table 3 shows the values of R^2 for different categories of farms in the Pellakur mandal. F-test was carried out and it was found significant at 5 percent probability level for the Pellakur mandal under study. The included variables explained 99 percent of variation in output of the small farms, 91 percent in medium farms and 97 percent in large farms of Pellakur mandal. The estimated equation shows the true relationship between output and inputs. Thus all the functions fulfill the goodness of fit.

Table 3: Estimated Parameters and other Related Statistics of Functions Related to Different Size Group of Farms

Inputs	Description of Inputs	Pellakur Mandal		
		Small	Medium	Large
a_0	Intercept	3.2001	3.0130	2.5026
X_1	Bullock-labour	0.0246 (0.0145)	-0.0360 (0.0239)	0.0067 (0.0272)
X_2	Expenditure on Tractor	0.1915* (0.0734)	-0.0510 (0.0556)	0.1493 (0.1171)
X_3	Human-labour	0.3130* (0.0981)	0.1279 (0.0954)	0.0970 (0.0893)
X_4	HYV Seeds	-0.0360 (0.1490)	0.2099* (0.0673)	0.0101 (0.0465)
X_5	Chemical Fertilizers	-0.0469 (0.1278)	0.7538* (0.0982)	0.3610* (0.1539)
X_6	Manures	0.4229* (0.1178)	0.0898 (0.0860)	0.2560* (0.1251)
X_7	Pesticide and other Plant Protection Expenditure	0.0830 (0.1258)	-0.1540* (0.0352)	0.1680 (0.1046
-	R^2	0.98948	0.90560	0.96631
-	F	94.0210*	49.3367*	340.0436*
	SUM	0.9516	0.9404	1.0481

*Significant at 5% Probability level.
Figures in the Parentheses are Standard Errors.

Small Farms:

From table 3, it observed a negative relationship between the variables – HYV seeds and chemical fertilizers each – and gross output including by-products. Keeping all other variables are constant at their respective geometric mean level, with the increase of one in HYV seeds and chemical fertilizers the amount of gross output including by-products would tend to decline by Rs. 0.04 each. Further, it is noticed a positive relationship between the variables each – bullock-labour, expenditure on tractor, human-labour, manures and pesticides and other plant protection methods – and gross output including by-products. Out of these five variables three variables, expenditure on tractor, human-labour and manures are significant at 5 percent probability level. A close look at the table reveals the fact that with the increase of one rupee in bullock-labour, the amount of gross output including by-products would tend to increase by Rs. 0.03, keeping all other input variables constant at their respective geometric mean level. Similarly, an increase of one rupee in expenditure on tractor, human-labour, manures and pesticides and plant protection, the amount of gross output would tend to increase by Rs. 0.19, Rs. 0.31, Rs. 0.42 and Rs. 0.08 respectively.

Medium Farms:

A negative relationship is observed between the variables each – bullock-labour, expenditure on tractor and pesticides and other plant protection methods – and gross output including by-products. Keeping all other variables are constant at their respective geometric mean level, with the increase of one rupee in the amount of gross output including by-products would tend to decline by Rs. 0.04. Similarly, in the case of expenditure on tractor and pesticides and other plant protection methods it would be Rs. 0.05 and Rs. 0.15 respectively. Out of these three variables the effect of pesticides and other plant protection methods is significant at 5 percent probability level. A negative and significant co-efficient of the variable pesticides and plant protection on expenditure reveals that there is some possibility to raise the output by increasing the variable, if the use of this variable is insufficient. Further, it is observed a positive relationship between the variables each – human-labour, HYV seeds, chemical fertilizers and manures – and gross output including by-products. Out of these four variables HYV seeds and chemical fertilizers are significant at 5 percent probability level. A close look at the table reveals the fact that with the increase of one rupee in human-labour, the amount of gross output including by-products would tend to increase by Rs. 0.13, keeping all other input variables are constant at their respective geometric meal level, with the increase of one rupee in HYV seeds, the amount of gross output including by-products would tend to increase by Rs. 0.21. Similarly, in the case of chemical fertilizers and manures it would be Rs. 0.75 and Rs. 0.09 respectively.

Large Farms:

A positive relationship was noticed between the variables each – bullock-labour, expenditure in tractor, human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods –

and gross output including by-products. The regression co-efficient indicates that the increase in bullock-labour by one rupee, the amount of gross output including by-products would tend to increase by Rs. 0.01, keeping all other input variables constant at their respective geometric mean level. In the same way keeping all other variables constant at their respective geometric mean level, with the increase of one rupee in expenditure on tractor, the amount of gross output including by-products would tend to increase by Rs. 0.15. Similarly in the case of human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods it would be Rs. 0.10, Rs. 0.01, Rs. 0.36, Rs. 0.26 and Rs. 0.16 respectively. Further we observed that the chemical fertilizers, manures are significant at 5 percent probability level.

The regression co-efficient of human-labour is found to be significant in small farms. Further the regression co-efficients of human-labour is found to be more in the case of small farms (0.3130) followed by medium farms (0.1279) and large farms (0.0970). In view of these observations, one can say that in Pellakur Mandal the effect of human-labour on gross output including by-products is found to be having inverse relationship with the farms size. The regression co-efficient of manures is found to be significant in small and large farms. Further the regression co-efficient of manures is found to be more in the case of small farms (0.4224) followed by large farms (0.2560) and medium farms (0.0898). The regression co-efficients of HYV seeds and chemical fertilizers are seen to be negative in small farms whereas it is positive and significant in medium and large, while in the case of pesticides and other plant protection methods is seen to be negative and significant in medium farms and positive in small and large farms. Therefore in total, we have observed the absence of significant effect of technology in Pellakur mandal.

6.2. Returns to Scale

The sum of the regression co-efficients or the elasticities of output with respect to different factors for different size group of farms will decide the returns to scale. The sum of the co-efficients are given in the table 2. To test whether there were constant returns to scale or not, t-test was applied to test the significance of the difference;

$$\sum_{i=1}^{7} a_i - 1$$

Table 4: Some of the regression co-efficients

Size of Farms	Sum of the Co-efficients		
	Kaligiri	Muttukur	Pellakur
Small	0.9431	1.0374	0.9516
Medium	0.9900	1.2562*	0.9404*
Large	1.0260	1.0213	1.0481

*Significant at 5% Probability level different from unity.

From table 4, it is observed that the sum of the co-efficients are not significantly different from unity in the case of small, medium and large farms of Kaligiri mandal and it indicates the constant returns to scale. In Muttukur mandal the sum of co-efficients of small and large farms are not significantly different from unity and it indicates the constant returns to scale in small and large farms whereas the sum of the co-efficients is significantly different from unity and it indicates the increasing returns to scale in medium farms. In Pellakur mandal, the sum of the co-efficients are not significantly different from unity in the case of small, medium and large farms and it indicates the constant returns to scale.

VII. Conclusions

7.1. Kaligiri Mandal

In the case of small farms, the regression co-efficients of all the seven variables except manures are positive. The regression co-efficient of expenditure on tractor, human-labour and pesticides and other plant protection methods are significant at 5 percent probability level. The regression co-efficient of human-labour is highest and it is followed by pesticides and other plant protection methods, chemical fertilizers, HYV seeds, expenditure on tractor, bullock-labour and manures. An increase of one rupee in each of input factors – bullock-labour, expenditure on tractor, human-labour, HYV seeds, chemical fertilizers and pesticides and other plant protection methods will increase gross output by Rs. 0.00, Rs. 0.006, Rs. 0.46, Rs. 0.01, Rs. 0.16 and Rs. 0.31 respectively. Similarly the output tend to decline by raising a rupee in manures. It is observed that the sum of the regression co-efficients was not significantly different from unity and it indicates the constant returns to scale in small farms.

In the case of medium farms, the regression co-efficients of the seven variables except HYV seeds are positive. The regression co-efficients of chemical fertilizers, manures and pesticides and other plant protection

methods are significant at 5 percent probability level. An increase of one rupee in each of the input factors – bullock-labour, expenditure on tractor, human-labour, chemical fertilizers, manures and pesticides and other plant protection methods will increase the gross output by Rs. 0.002, Rs. 0.003, Rs. 0.10, Rs. 0.31, Rs. 0.31 and Rs. 0.27 respectively. The regression co-efficient of HYV seeds is negative and it indicates, with the increase of one rupee in HYV seeds, the amount of gross output would tend to decline by Rs. 0.01. It is observed that the sum of the regression co-efficients was not significantly different from unity and the sum indicates a constant returns to scale in medium farms.

In the case of large farms, the regression co-efficients of all the seven variables except bullock-labour are positive. The regression co-efficients of human-labour, chemical fertilizers and pesticides and other plant protection methods are significant at 5 percent probability level. It is noticed that for every one rupee increase in each of input factors – human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods will raise the production by Rs. 0.25, Rs. 0.03, Rs. 0.20, Rs. 0.14 and Rs. 0.40 respectively. It is observed that the sum of the regression co-efficients was not significantly different from unity and this indicates constant returns to scale in the case of large farms.

7.2. Muttukur Mandal

In the case of small farms, the regression co-efficients of bullock-labour and expenditure on tractor are negative. These two factors established a negative relationship with output. The negative values reveals that an increase of one rupee in bullock-labour and expenditure on tractor, the amount of gross output would tend to be decline by Rs. 0.01 and Rs. 0.08 respectively. The regression co-efficients of human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods are positive. It is noticed that a rupee increase in each of the factors – human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods would increase the gross output by Rs. 0.42, Rs. 0.10, Rs. 0.36, Rs. 0.09 and Rs. 0.16 respectively. The effect of input factors human-labour, HYV seeds, chemical fertilizers and pesticides and other plant protection methods on crop output is statistically significant. It is observed that the sum of the regression co-efficients was not significantly different from unity in small farms and the sum indicates the constant returns to scale.

In the case of medium farms, the regression co-efficient of bullock-labour is negative and it indicates that, with the increase of one rupee in bullock-labour the amount of gross output would tend to decline by Rs. 0.02. The regression co-efficients of expenditure on tractor, human-labour, HYV seeds, chemical fertilizers, manures are positive and with the increase of one rupee in each of these factors would tend to increase the gross production by Rs. 0.18, Rs. 0.78, Rs. 0.14, Rs. 0.04 and Rs. 0.13 respectively. The regression co-efficient of human-labour is statistically significant at 5 percent probability level. It is observed that the sum of the regression co-efficients was greater than unity and this indicates the increasing return to scale in medium farms.

In the case of large farms, the regression co-efficients of all the input factors are positive. The regression co-efficient of pesticides and other plant protection methods is significant at 5 percent probability level. With the increase of one rupee in each of bullock-labour, expenditure on tractor, human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods would tend to increase the gross output by Rs. 0.10, Rs. 0.24, Rs. 0.23, Rs. 0.02, Rs. 0.08, Rs. 0.05 and Rs. 0.30 respectively. It is observed that the sum of the regression co-efficients was not significantly different from unity and it indicates the constant returns to scale in the case of large farms.

7.3. Pellakur Mandal

In the case of small farms, the regression co-efficients of HYV seeds and chemical fertilizers are negative. These two variables effect is negative on output. An increase of one rupee in these two technical variables will decrease the production by Rs. 0.04 and Rs. 0.05 respectively. The regression co-efficients of bullock-labour, expenditure on tractor, human-labour, manures and pesticides and other plant protection methods are positive. Every one rupee increase in each of the above factors would raise the crop production by Rs. 0.02, Rs. 0.19, Rs. 0.31, Rs. 0.42 and Rs. 0.08 respectively. The regression co-efficients of expenditure on tractor, human-labour and manures are statistically significant. It is observed that the sum of the regression co-efficients was not significantly different from unity and it indicates the constant returns to scale in the case of small farms.

In the case of medium farms, the regression co-efficients of bullock-labour, expenditure on tractor and pesticides and other plant protection methods are negative. Therefore, the production was negatively affected by these three variables in Pellakur. These variables expresses that for every one unit increase in each of these factors would raise the production by Rs. 0.04, Rs. 0.05 and Rs. 0.15 respectively. The regression co-efficient of human-labour, HYV seeds, chemical fertilizers and manures are positive. It means the crop production was positively influenced by these variables. A rupee increases in each of the above factors, the output would increased by Rs. 0.13, Rs. 0.21, Rs. 0.75 and Rs. 0.09 respectively. It is noticed that the sum of the regression

co-efficients was not significantly different from unity in medium farms and it indicates the constant returns to scale in medium farms.

In the case of large farms, the regression co-efficients of all the input variables are positive. The co-efficients of chemical fertilizers and manures are significant at 5 percent probability level. An increase of one rupee in bullock-labour, expenditure on tractor, human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods would tend to increase the gross crop output by Rs. 0.07, Rs. 0.15, Rs. 0.09, Rs. 0.01, Rs. 0.36, Rs. 0.26 and Rs. 0.17 respectively. The sum of the regression co-efficients was not significantly different from unity and a constant returns to scale in the case of large farms was noticed.

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