IOSR Journal Of Humanities And Social Science (IOSR-JHSS)
Volume 19, Issue 2, Ver. I (Feb. 2014), PP 11-21
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Inter-Size Crop Level Agricultural Production Function With Reference To Groundnut Crop: A Case Study in Nellore District Of Andhra Pradesh

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Abstract:*Crop-wise production function analysis will clearly indicate many points which are not evident in aggregate and size-wise models. But crop-wise analysis is a farm of aggregate model as the output of a crop coming from different size enterprises has been put together. Land is an important factor for production and its effect on technology must be fully emphasized. It is only an inter-size analysis of production function for a particular crop, which can do away the limitations of an aggregate crop model. Inter-size crop models would also indicate the relative superiority of different crops for different size-group of farms that it is helpful for crop-cum-size level planning. The study aims to analyse the Inter-size crop level Agricultural Production Function for staple crop-groundnut 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 in three revenue mandals of Nellore district. 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: *Inter-size Crop level Agricultural Production Function, Ordinary Least Squares Method, RegressionCo-efficients, Human Labour, HYV Seeds.*

I. Introduction

Production is a process, where by some goods and services called inputs and transformed into other goods and services called outputs. Many types of activities are involved in the production including changes in farms, location and the time of use of products. Each of these changes involves the use of inputs to produce the desired outputs. The farms outputs of products depends upon the quantities of inputs used in production. This relation between input and output can be characterized by a production function. A production function provides information concerning the quantity of output that may be expected when particular inputs are combined in a specific manner. The chemical, physical and biological properties determine the kind and amount of output which will be received from particular combination of inputs.

Crop-wise production function analysis will clearly indicate many points which are not evident in aggregate and size-wise models. But crop-wise analysis is a farm of aggregate model as the output of a crop coming from different size enterprises has been put together. Land is an important factor for production and its effect on technology must be fully emphasized. It is only an inter-size analysis of production function for a particular crop, which can do away the limitations of an aggregate crop model. Inter-size crop models would also indicate the relative superiority of different crops for different size-group of farms that it is helpful for crop-cum-size level planning.

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 Inter-size crop level agricultural production function. Hence the empirical and scientific investigational study of Inter-size crop level 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 Inter-size crop level production function for staple crop-groundnut basing on entire sample of farms of three mandals, namely, Kaligiri, Muttukur and Pellakur of Nellore district of Andhra Pradesh.

II. Review of Literature

HanumanthaRao[1] has used production function to analyse agricultural data. His contribution lies in the adoption of disaggregated approach. He runs regression separately for farmers in different size-groups and also for three natural regions of the Hyderabad State. He used Cobb-Douglas Function and relates production with inputs of land and labour. Firstly, he finds positive production elasticity for labour. Second and important

one is the production elasticity of labour is higher for large farms with holdings above 5 to 10 acres and it is contradicted in the case of small farmers. Further, he finds the production elasticity of labour to be higher than that of land in two relatively less fertile regions and a reverse situation in the track of Marathwada.

Mathur and Balishter[2] studied the impact of HYV's of crops on farm labour use. An attempt has been made to know the extent of labour utilization across different size of farms under various types of HYV's in a sub-region of Agra district of Utter Pradesh. It is pointed out that average labour use per hectare in high-yielding varieties is higher than that of other type of varieties. It is also observed that the family employment has increased by 8 percent in 1967-68 over 1966-67 due to switching over to high-yielding varieties.

Venkatesam, Naidu and Venkateswarlu[3] discussed the resource use efficiency on maize farms in Karimnagar district of Andhra Pradesh. They adopted Cobb-Douglas Production Function to study the resource use efficiency of sample farms. The authors identified in the case of maize production, contribution of family labour and total cost of cultivation decreases with the increase in farm size. Small farmers used more manures and less fertilizers, whereas medium and large farmers used more fertilizers and less manures. It is also observed that the average yield of hybrid maize was more on small farms and decreased as the farm size increased. Cost of production was the lowest in small farms.

Bal[4] studied the factor share in farm income and farm income inequality in Punjab. It was observed that the size of the farm accounted for the major part of the farm income inequality. It was further showed that large farms had better access to the yield increasing input as a result of which the skewness in income distribution is more than that of skewness in farm size distribution. He told that speedy implementation of land reform measures can go a long way in reducing the existing disparities in farm incomes and farm income distribution.

Sharma and Sharma[5] study concerns with micro evidence from an agriculturally developed region, where new agricultural technology had permeated quite thoroughly, showed the existence of inverse farm size-productivity relationship in the production of wheat and paddy. The results showed that the small farms used higher amount of human labour and fertilizer as compared to higher farm size categories. The regression results also confirmed the inverse relationship between the farm-size and inputs use. In broad terms, the results of the study do not support the view that the inverse farm size-productivity relationship has disappeared with the spread of new agricultural technology.

Singh and Pandey[6] studied the resource use efficiency in a dry farming area of Banda district of Utter Pradesh. The study concluded that the farmers are handicapped with inadequacy of growth promoting inputs such as manure, fertilizer and irrigation facilities and are using the conventional input, labour in excessive quality due to non-availability of other non-farmer employment opportunities. The author observed that the new technology of high yielding variety was still in its infancy owing to the un assured irrigation facilities. Therefore, policy for the growth of this dry farming area of crop thriving under low rain-fed conditions and adequate provision for credit and non-farm employment is made for raising the farm productivity and for uplifting the standard of living of the people in the region.

Rathore[7] studied the contribution of various factors such as neutral technology non-neutral technology and other inputs to the overall productivity differences and / or the overall efficiency differences between small and large farms of Himachal Pradesh and Maharashtra. The study reveals that while applying neutral technology the farm productivity will be less on small farms on the other hand applying non-neutral technology, small farms have an advantage over the large ones. After the neutral and non-neutral technology components, the study finds that present technology is also in favour of large farms.

Ninan[8] studied the pattern and intensity of labour use in the tapioca and paddy cultivation. The study shows that there is a positive association between per acre labour input and tapioca/paddy yield per acre. It was found that per acre family labour input is inversely related to size of holding both in the case of tapioca and paddy. Average productivity for tapioca was found to be higher than that of paddy in all size groups.

III. Objectives of Study

The following is the objective of the study:

To study the Inter-size crop level Agricultural Production Function for staple crop-groundnut 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 Pellakurmandals. 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[5], HanumanthaRao[1], Rajkrishna[13], Singh[19] and Eswara Prasad[20] 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[21], DebnarayanSarker and Sudptia De[22] 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[21] 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.

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 Inter-size crop level analysis.

4.2. Inter-size crop level production function

To study the Inter-size crop level production function based on entire sample of farms, the following production function was fitted for groundnut crop of different size groups

$$Y_i = a_{i0} X_{i1}^{a_{i1}} X_{i2}^{a_{i2}} X_{i3}^{a_{i3}} X_{i4}^{a_{i4}} X_{i5}^{a_{i5}} X_{i6}^{a_{i6}} X_{i7}^{a_{i7}} \quad \rightarrow (1)$$

Where,

i = G represents groundnut
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.

V. Results and Discussions

Groundnut is the one of the most important crop in the Nellore district. This crop has largely been affected by technological innovations in agriculture. In order to analyse the nature and significance of technology in the different size of holdings in the groundnut crop, it is necessary to analyse the parameters of different factors.

To study the Inter-size crop level production function for Groundnut crop of different size groups 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 and other related statistics for groundnut crop production function for all the size groups of the farms are given in table 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.

5.1. Kaligiri Mandal

Table 1 shows values of R^2 for different categories of farms for groundnut crop. F-test was carried out and it is found to be significant at 5 percent probability level. The included variables explained 87 percent of variation in groundnut output of small farms, 90 percent in medium farms and 94 percent in large farms of Kaligiri mandal. The estimated equation shows true relationship between output and inputs. Thus, all the functions fulfill the goodness of fit.

Table 1: Estimated Parameters and other Related Statistics of Production Equationin Kaligiri Mandal

Inputs	Description of Inputs	Small	Medium	Large
a_0	Intercept	3.1939	8.4327	1.4335
X_1	Bullock-labour	0.008 (0.0062)	-0.0004 (0.0034)	0.0042 (0.0045)
X_2	Expenditure on Tractor	0.001 (0.0026)	-0.0013 (0.0023)	-0.0019 (0.0055)
X_3	Human-labour	0.1242 (0.0723)	-0.1448 (0.1811)	0.7526* (0.3436)
X_4	HYV Seeds	0.224* (0.0688)	0.0018 (0.0412)	-0.255 (0.2693)
X_5	Chemical Fertilizers	0.1466* (0.0750)	0.1279 (0.1015)	0.001 (0.1566)
X_6	Manures	0.1164* (0.0525)	0.296* (0.0678)	0.23 (0.145)
X_7	Pesticide and other Plant Protection Expenditure	0.3103* (0.0892)	-0.0068 (0.1454)	0.3842* (0.1710)
-	R^2	0.87161	0.89858	0.94501
-	F	92.13376*	6.32887*	14.72956*
	SUM	0.9305	0.2724	1.1152

*Significant at 5% Probability level.

Figures in the Parentheses are Standard Errors.

5.1.1. Small Farms

From the table 1, it is found that the regression co-efficients of all input variables are positive. The regression co-efficients of HYV seeds, chemical fertilizer, manures and pesticides and other plant protection methods are statistically significant at 5 percent of probability level. Keeping all other variables are constant at their respective geometric mean level, an increase of one rupee in bullock-labour, the amount of output including by-products of groundnut in small farms of Kaligiri mandal would tend to increase by Rs. 0.008 and with the increase of one rupee in expenditure on tractor, the amount of gross output including by-products of groundnut would tend to increase by Rs. 0.001. Similarly every one rupee increase in each of the variables expenditure on tractor, human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods it would be increased by Rs. 0.001, Rs. 0.12, Rs. 0.22, Rs. 0.15, Rs. 0.12 and Rs. 0.31 respectively. Therefore in Kaligiri mandal, small farmers are utilizing modern agricultural technology in growing groundnut. Hence, it may be concluded that the effect of technological factors – HYV seeds, chemical fertilizers and pesticides and other plant protection methods on groundnut output in Kaligiri mandal in case of small farms are statistically significant. Therefore, small farmers are adopting the modern technology in groundnut production.

5.1.2. Medium Farms

The regression co-efficients of bullock-labour, expenditure on tractor, human-labour and pesticides and other plant protection methods are observed to be negative whereas the regression co-efficients of HYV seeds, chemical fertilizers and manures are positive. The regression co-efficient of manures is statistically significant at 5 percent probability level. 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 including by-products of groundnut in medium farms of Kaligiri mandal would tend to increase by Rs. 0.002, and with the increase of one rupee in chemical fertilizers, the amount of gross output including by-products of groundnut would tend to increase by Rs. 0.13. Similarly in the case of manures it would be Rs. 0.29. But it is a significant increase. It is observed that for every one rupee increase in each of the variables – bullock-labour, expenditure on tractor, human-labour and pesticides and other plant protection methods would tend to decrease the groundnut output by Rs. 0.0004, Rs. 0.0013, Rs. 0.145 and Rs. 0.007 respectively. The technological effect was not observed in medium farms of groundnut crop.

5.1.3. Large Farms

The regression co-efficients of expenditure on tractor and HYV seeds are observed to be negative.It means a negative relationship may be observed by these variables on output. The regression co-efficients of bullock-labour, human-labour, chemical fertilizers, manures and pesticides and other plant protection methods are positive. Therefore, these variables established a positive relationship with groundnut output. The regression co-efficients of human-labour and pesticides and other plant protection methods are statistically significant at 5 percent probability level. 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 of groundnut in large farms of Kaligiri mandal would tend to decline by Rs. 0.002. Similarly in the case of HYV seeds it would be Rs. 0.25. 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 including by-products of groundnut in large farms of Kaligiri mandal would tend to increase by Rs. 0.004. Similarly an increase of one rupee in human-labour, the amount of gross output of groundnut would tend to increase by Rs. 0.75. In the case of chemical fertilizers, manures and pesticides and other plant protection methods it would be Rs. 0.001, Rs. 0.23 and Rs. 0.38 respectively. A significant technological effect was noticed by the variable pesticides and other plant protection methods only. Hence, the influence of technological parameters on groundnut production was absent.

5.2. Muttukur Mandal

Table 2 shows values of R^2 for different categories of farms for groundnut crop. F-test was carried out and it is found to be significant at 5 percent probability level. The included variables explained 97 percent of variation in output of small farms, 79 percent of medium farms and 98 percent of large farms of Muttukur mandal. The estimated equation shows true relationship between output and inputs. Thus, all the functions fulfill the goodness of fit.

Table 2: Estimated Parameters and other Related Statistics of Production Equationin Muttukur Mandal

Inputs	Description of Inputs	Small	Medium	Large
a_0	Intercept	2.2269	3.9475	3.45575
X_1	Bullock-labour	-0.0217 (0.0473)	0.0291 (0.0968)	0.7730* (0.1286)
X_2	Expenditure on Tractor	-0.0072 (0.0075)	0.0061 (0.0112)	0.0534* (0.0127)
X_3	Human-labour	0.4511* (0.0721)	0.5536* (0.1846)	0.0059 (0.0268)
X_4	HYV Seeds	0.495* (0.1183)	0.1503 (0.1784)	-0.0225 (0.0309)
X_5	Chemical Fertilizers	0.0498 (0.0926)	-0.0140 (0.0749)	0.1316 (0.1137)
X_6	Manures	-0.0408 (0.0936)	0.0379 (0.0871)	0.0816 (0.0775)
X_7	Pesticide and other Plant Protection Expenditure	0.0574 (0.0472)	0.0358 (0.0594)	0.0469 (0.0368)
-	R^2	0.97364	0.79221	0.98459
-	F	332.4454*	14.16124*	246.3687*
	SUM	0.9836	0.7988	1.0699

*Significant at 5% Probability level.

Figures in the Parentheses are Standard Errors.

5.2.1. Small Farms

From table 2, it is observed that the regression co-efficients of bullock-labour, expenditure on tractor and manures are negative whereas the regression co-efficients of human-labour, HYV seeds, chemical fertilizers and pesticides and other plant protection methods are positive. It means a positive technological factors effect was noticed on groundnut output in case of small farms in Muttukur mandal. The regression co-efficients of human-labour and HYV seeds are statistically significant at 5 percent of probability level. Keeping all other variables constant at their respective geometric mean level, with the increase of one rupee in human-labour, the amount of gross output of groundnut would tend to increase by Rs. 0.45. Similarly in the case of HYV seeds, chemical fertilizers and pesticides and other plant protection methods it would be Rs. 0.50, Rs. 0.05 and Rs. 0.06 respectively. Keeping all other variables are constant at their respective geometric mean level, with the increase of one rupee in bullock-labour, the amount of gross output of groundnut in small farms of Muttukur mandal would tend to decline by Rs. 0.02. Similarly in the case of expenditure on tractor and manures it would be Rs. 0.007 and Rs. 0.04 respectively. Therefore, one can say that the farmers of Muttukur mandal are utilizing modern agricultural technology in growing groundnut. It is also observed that all the explanatory variables explained by 97.36 percent of variation in groundnut production in small farms. This variation is significant.

5.2.2. Medium Farms

The regression co-efficients of bullock-labour, expenditure on tractor, human-labour, HYV seeds, manures and pesticides and other plant protection methods are positive whereas the regression co-efficient of chemical fertilizers is negative. All variables shows a positive effect on groundnut production except chemical

fertilizers. The regression co-efficient of human-labour is statistically significant at 5 percent probability level. 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 of groundnut would tend to decline by Rs. 0.01. This decrease in output is a negligible decrease. 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 including by-products of groundnut in medium farms of Muttukur mandal would tend to increase by Rs. 0.03. In the same way, an increase of one rupee in expenditure on tractor, the amount of gross output of groundnut in medium farms would tend to increase by Rs. 0.006. Similarly in the case of human-labour, HYV seeds, manures and pesticides and other plant protection methods it would be Rs. 0.55, Rs. 0.15, Rs. 0.04 and Rs. 0.03 respectively. From the above analysis, the absence of technological effect was noticed in medium farms of Muttukur mandal.

5.2.3. Large Farms

The regression co-efficients of HYV seeds is observed to be negative whereas the regression co-efficients of bullock-labour, expenditure on tractor, human-labour, chemical fertilizers, manures and pesticides and other plant protection methods are positive. The regression co-efficient of bullock-labour and expenditure on tractor are statistically significant at 5 percent probability level. 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 of groundnut in large farms would tend to increase by Rs. 0.77. Similarly in the case of expenditure on tractor, human-labour, chemical fertilizers, manures and pesticides and other plant protection methods it would be Rs. 0.05, Rs. 0.006, Rs. 0.13, Rs. 0.08 and Rs. 0.05 respectively. Except the HYV seeds all other technological variables shows a positive effect on production. An insignificant positive technological effect was noticed on groundnut output in large farms of Muttukur mandal.

5.3. Pellakur Mandal

Table 3 shows values of R^2 for different categories of farms for groundnut crop. F-test was carried out and it is found to be significant at 5 percent probability level. The included variables explained 99 percent of variation in groundnut output of small farms, 96 percent of medium farms and 54 percent of large farms of Pellakur mandal. The estimated equation shows true relationship between output and inputs. Thus, all the functions fulfill the goodness of fit.

Table 3: Estimated Parameters and other Related Statistics of

Production Equation in Pellakur Mandal

Inputs	Description of Inputs	Small	Medium	Large
a_0	Intercept	2.3221	2.7083	4.7322
X_1	Bullock-labour	-0.027 (0.0096)	0.0026 (0.0171)	-0.136 (1.7485)
X_2	Expenditure on Tractor	-0.0003 (0.0017)	0.4414* (0.1824)	0.6965 (0.8188)
X_3	Human-labour	0.0579* (0.0269)	0.096 (0.2007)	0.0067 (0.2444)
X_4	HYV Seeds	0.3752* (0.0738)	0.04811 (0.0263)	-0.059 (0.2576)
X_5	Chemical Fertilizers	0.3505* (0.0496)	-0.0039 (0.1284)	0.1546 (1.5449)
X_6	Manures	0.2015* (0.0367)	0.1247* (0.0623)	0.1259 (0.8893
X_7	Pesticide and other Plant Protection Expenditure	0.0819 (0.0424)	0.3334* (0.0653)	-0.011 (0.2025)
-	R^2	0.98751	0.95616	0.53569
-	F	790.5601*	109.0578*	3.46121*
	SUM	1.0397	1.0423	0.7777

*Significant at 5% Probability level.

Figures in the Parentheses are Standard Errors.

5.3.1. Small Farms

From table 3, it is observed that the regression co-efficients of bullock-labour and expenditure on tractor are negative whereas the regression co-efficients of human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods are positive. The regression co-efficients of human-labour, HYV seeds, chemical fertilizers and manures are statistically significant at 5 percent probability level. 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 of groundnut would tend to decline by Rs. 0.03. Keeping all other variables constant at their respective geometric mean level, with the increase of one rupee, in human-labour, the amount of gross output including by-products of groundnut in small farms of Pellakur mandal would tend to increase by Rs. 0.06. In the same way, with the increase of one rupee in HYV seeds, the amount of gross output would tend to increase by Rs. 0.38. Similarly in the case of chemical fertilizers, manures and pesticides and other plant protection methods it would be Rs. 0.35, Rs. 0.20 and Rs. 0.08 respectively. The two major technological factors, HYV seeds and chemical fertilizers shows a significant positive effect on groundnut production.

5.3.2. Medium Farms

The regression co-efficients of chemical fertilizers is observed to be negative whereas the regression co-efficient of bullock-labour, expenditure on tractor, human-labour, HYV seeds, manures and pesticides and other plant protection methods are positive. The regression co-efficient of expenditure on tractor, manures and pesticides and other plant protection methods are statistically significant at 5 percent probability level. Keeping all other variables are constant at their respective geometric mean level, with the increase of one rupee in bullock-labour, the amount of gross output including by-products of groundnut in medium farms of Pellakur mandal would tend to increase by Rs. 0.002. In the same way, an increase of one rupee in expenditure on tractor, the amount of gross output of groundnut it would tend to increase by Rs. 0.44. Similarly, in the case of human-labour, HYV seeds, manures and pesticides and other plant protection methods it would be Rs. 0.1, Rs. 0.05, Rs. 0.13 and Rs. 0.33 respectively. 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 of groundnut would tend to decline by Rs. 0.004. It is observed that the two technological factors,namely, expenditure on tractor and pesticides and other plant protection methods effect is positive and significant on groundnut output.

5.3.3. Large Farms

The regression co-efficients of bullock-labour, HYV seeds and pesticides and other plant protection methods are negative whereas the regression co-efficients of expenditure on tractor, human-labour, chemical fertilizers and manures are positive, Keeping all other variables are constant at their respective geometric mean level, with the increase of one rupee in bullock-labour, the amount of gross output including by-products of groundnut in large farms of Pellakur mandal would tend to decline by Rs. 0.14. Similarly in the case of HYV seeds and pesticides and other plant protection methods it would be Rs. 0.06 and Rs. 0.01 respectively. 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 of groundnut in large farms would tend to increase by Rs. 0.69. In the same way an increase of one rupee in human-labour, the amount of groundnut output would tend to increase by Rs. 0.007. Similarly, in the case of chemical fertilizers and manures it would be Rs. 0.15 and Rs. 0.12 respectively. The seeds and pesticides effect is negative on groundnut production. Finally one can say that there is no technological effect on groundnut production in case of large farms in Pellakur mandal.

5.4. Returns to Scale

The sum of the value of regression co-efficients or the elasticities of output with respect to different factors are given in table 4.

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: Sum of the Regression Co-efficients

Size of Farms	Sum of the Co-efficients		
	Kaligiri	**Muttukur**	**Pellakur**
Small	0.9305	0.9836	1.0397
Medium	0.2724*	0.7988*	1.0423*
Large	1.1152	1.0699	0.7777

*Significant at 5% Probability level different from unity.

From table 4, we found that the sum of the elasticities are not significantly different from unity at 5 percent probability level in the case of small and large farms of Kaligiri mandal and this indicates the constant

returns to scale in small and large farms whereas the sum of the elasticites was significantly different from unity in the case of medium farms and this indicates the decreasing returns to scale in medium farms. In Muttukur mandal the sum of the elasticities of small and large farms are not significantly different from unity and this indicates the constant returns to scale in small and large farms whereas the sum of the elasticities was significantly different from unity in the case of medium farms and this indicates the decreasing returns to scale in medium farms. In Pellakur mandal also the sum of the elasticities of small and large farms are not significantly different from unity. The constant returns are prevailing in small and medium farms whereas the sum of the elasticites was significantly different from unity in the case of medium farms and hence decreasing return to scale in medium farms is noticed.

VI.Conclusions

6.1. Kaligiri Mandal

In the case of small farms, the positive regression co-efficients of bullock-labour, expenditure on tractor, human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods reveals that for every one rupee increase in each of these factors will increase the groundnut production by Rs. 0.008, Rs. 0.001, Rs. 0.12, Rs. 0.22, Rs. 0.15, Rs. 0.12 and Rs. 0.31 respectively. A constant returns to scale was noticed in small farms of groundnut in Kaligiri mandal. It is also observed that to get more yield of groundnut in small farms, the pattern of resource use in small farms needs some modification, particularly, application of human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods should be increased.

In the case of medium farms, the positive regression co-efficient of HYV seeds indicates that for every one rupee raise in HYV seeds, the amount of gross output of groundnut would tend to increase by Rs. 0.002. Similarly in the case of chemical fertilizers and manures it would be Rs. 0.13 and Rs. 0.29 respectively. The negative co-efficients of expenditure on tractor, human-labour, and pesticides and other plant protection methods reveals the decrease in output for increase of one rupee of each factor by Rs. 0.001, Rs. 0.14 and Rs. 0.007 respectively. A decreasing returns to scale in medium farms of groundnut in Kaligiri mandal was noticed. It is also observed that, to obtain more yield of groundnut in medium farms, the application of chemical fertilizers and pesticides and other plant protection methods may be increased whereas application of human-labour, pesticides and other plant protection methods may be decreased.

In the case of large farms, the positive regression co-efficient of bullock-labour indicates that, with the increase of one rupee in bullock-labour, the amount of gross output of groundnut in large farms of Kaligiri mandal would tend to increase by Rs. 0.004. Similarly, in the case of human-labour, chemical fertilizers, manures and pesticides and other plant protection methods it would be Rs. 0.75, Rs. 0.001, Rs. 0.23 and Rs. 0.38 respectively. The negative regression co-efficient of expenditure on tractor indicates that with the increase of one rupee in expenditure on tractor, the amount of gross output would tend to decline by Rs. 0.002. Similarly in the case of HYV seeds it would be Rs. 0.25. It is noticed that there is constant returns to scale of large farms of groundnut in Kaligiri mandal. In order to obtain more yield of groundnut in large farms, the application of human-labour, chemical fertilizers, manures and pesticides and other plant protection methods may be increased whereas the use of HYV seeds should be decreased. It is also found that the large size farmers are utilizing modern agricultural technology to obtain more yield in the case of groundnut.

6.2. Muttukur Mandal

In the case of small farms, the negative regression co-efficient of bullock-labour indicates that, for one rupee increase in bullock-labour will decrease the gross output of groundnut by Rs. 0.02 in small farms of Muttukur mandal. Similarly in the case of expenditure on tractor and manures it would be Rs. 0.007 and Rs. 0.04 respectively. The positive regression co-efficient of human-labour indicates that, the gross output of groundnut will increase Rs. 0.45, by raising one rupee of human-labour. Similarly in the case of HYV seeds, chemical fertilizers and pesticides and other plant protection methods it would be Rs. 0.49, Rs. 0.05 and Rs. 0.06 respectively. The constant returns to scale in small farms of groundnut in Muttukur mandal was observed. Hence, one can say that in Muttukur mandal bullock-labour and manures are over utilized by small farmers, further small farmers are utilizing human-labour, HYV seeds, chemical fertilizers and pesticides and other plant protection methods to obtain more yield.

In the case of medium farms, the positive regression co-efficient of bullock-labour expresses that for one rupee increase in bullock-labour, the amount of gross groundnut output in medium farms of Muttukur mandal by Rs. 0.03. Similarly, in the case of expenditure on tractor, human-labour, HYV seeds, manures and pesticides and other plant protection methods it would increase, Rs. 0.006, Rs. 0.55, Rs. 0.15, Rs. 0.38 and Rs. 0.03 respectively for one rupee increase in each variable. The negative regression co-efficient of chemical fertilizers indicates that an increase of one rupee in chemical fertilizers, the amount of gross output would tend to decline by Rs. 0.001. Therefore medium size farmers are not utilizing adequate modern agricultural

technology. It is noticed a decreasing returns to scale in medium farms of groundnut in Muttukur mandal. To obtain more yield of groundnut in medium farms, application of human-labour, HYV seeds, manures and pesticides and other plant protection methods should be increased.

In the case of large farms, the positive regression co-efficient of bullock-labour indicates that the groundnut output will increase Rs. 0.77, by raising one rupee on the input factor bullock-labour in Muttukur mandal. Similarly in the case of expenditure on tractor, human-labour, chemical fertilizers, manures and pesticides and other plant protection methods also the output will increase Rs. 0.05, Rs. 0.006, Rs. 0.13, Rs. 0.08 and Rs. 0.05 respectively. The negative regression co-efficient of HYV seeds reveals that the output will decrease Rs. 0.02 by raising one rupee in HYV seeds variable. The constant returns to scale, in large farms of groundnut of Muttukur mandal was noticed. To obtain more yield of groundnut in large farms of Muttukur mandal, the application of bullock-labour, chemical fertilizers, manures and pesticides and other plant protection methods should be increased. Hence the large size farmers are not utilizing the modern agricultural technology.

6.3. Pellakur Mandal

In the case of small farms, the positive regression co-efficients of human-labour indicates a positive relationship with the output. An increase of one rupee in human-labour, the amount of gross output of groundnut in small farms of Pellakur mandal would tend to increase by Rs. 0.06. Similarly in the case of HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods would be increased by Rs. 0.37, Rs. 0.35, Rs. 0.20 and Rs. 0.08 respectively, due to one rupee raise in each of the above variables. The two negative co-efficients of bullock-labour and expenditure on tractor reveals that a rupee increase in each of these variable, the groundnut output will decreased by Rs. 0.03 and Rs. 0.003 respectively. The constant returns to scale in small farms of groundnut was noticed. Therefore in order to obtain more yield of groundnut in small farms application of human-labour, HYV seeds, chemical fertilizers, manures and pesticides and other plant protection methods should be increased whereas application of bullock labour may be decreased. Further, one can say that small farmers of Pellakur mandal are utilizing modern agricultural technology at significant level in growing the groundnut.

In the case of medium farms, the positive regression co-efficients of input factors reveals the positive relationship with the groundnut production. Every one rupee increase in each of the input factors bullock-labour, expenditure on tractor, human-labour, HYV seeds, manures and pesticides and other plant protection methods would increase the output by Rs. 0.003, Rs. 0.44, Rs. 0.01, Rs. 0.05, Rs. 0.12 and Rs. 0.33 respectively. An increase of one rupee in chemical fertilizers, the amount of gross output of groundnut in medium farms would tend to decrease by Rs. 0.004. It is observed constant returns to scale in medium farms of groundnut. It is also observed to obtain more yield of groundnut in medium farms of Pellakur mandal, the application of expenditure on tractor, human-labour, HYV seeds, manures and pesticides and other plant protection methods should be increased, also the application of chemical fertilizers should be decreased.

In the case of large farms, the positive regression co-efficient of expenditure on tractor indicates that an increase of one rupee in expenditure on tractor, the amount of gross output of groundnut in large farms of Pellakur mandal would tend to increase by Rs. 0.69. Similarly in the case of human-labour, chemical fertilizers and manures it would be Rs. 0.007, Rs. 0.16 and Rs. 0.13 respectively. An increase of one rupee in HYV seeds, the amount of gross output of groundnut in large farms would tend to decline by Rs. 0.06 because the co-efficient of HYV seeds is negative. It is observed that decreasing returns to scale in large farms of groundnut. To obtain more yield of groundnut in large farms of Pellakur mandal, application of chemical fertilizers and manures may be increased whereas application of HYV seeds should be decreased.

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