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# Economic Analysis Of Technical Efficiency Of Paddy Crop Cultivation In Andhra Pradesh

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**Abstract**

Paddy is the widely consumed staple food for a large part of the world human population, especially in Asia. Rice is one of the three major crops in the world among the maize and wheat. Paddy is grown in an area of 47.60 Million hectares with a production and productivity of 1367 Lakh Million tonnes and 2390 kg hectare in 2023-2024 in India. In Andhra Pradesh, paddy is grown in an area of 58.75 Million hectare with production of 128.95Million tonnes and productivity of 2385 kgs per hectare respectively. The efficiency in production is a can be increased by using good technology along with better management of resources, available at the farmer s disposal. To increase the productivity the resources/ inputs have to be efficiently used which otherwise leads to inefficiency/ inability to produce maximum possible output even if the given level of inputs is made available. The present study was taken up with an objective to calculate the farm level technical efficiency and yield gap of paddy production in Andhra Pradesh. The rice farmers however face several problems besides water scarcity, stagnating yield, declining profit, less land, and labour for rice cultivation, crop failures due to adverse weather and growing environmental concerns. In an agrarian country like India, intensified efforts to improve both crop and water productivity and the farmers income is a vital need of the hour. Besides inefficiency in resource use, the yield also stagnated in many parts of rice growing regions in India. There is little scope to increase in the area. Hence increase in production and productivity with an improvement in efficiency of production through farm technology is necessary to meet the growing demand. On the other hand, despite the widespread use of efficiency measures in Indian rice farms, only a handful of these studies have examined the same across size groups and agro-ecological regions (zones) at the same time. Furthermore, there is little agreement among the studies available on the age-old topic about efficiency disparities between small and large farms. Previously, it was thought that due of the increased cost of hired labour, output per hectare on large farms was lower when using traditional labour-intensive equipment. Nonetheless, the gradual adoption of technology has opened up new productivity potential for vast farms.
As a result of their greater capital position, as well as institutional, extension, and financing advantages, large farmers can use labour-saving equipment to replace manpower, making them more efficient than small farms. Now among farms of equal size and other production characteristics, many factors explain variances in efficiency. When ecological (environmental) considerations are included in, the discussion will become much more intense. This is a pressing issue at the moment, as environmental concerns are at the heart of long-term growth. As a result, the current study is an attempt to look into an economic analysis of the technical efficiency of paddy production in the Kurnool District of Andhra Pradesh.

Since the mid-sixties, India agriculture has seen significant growth in the post-independence period. The use of new HYV seeds, irrigational avenues, use of modern inputs like fertiliser, herbicides and insecticides, tractors, pump sets, and other machineries in crop production are the most significant of these improvements. Another redeeming characteristic of the Indian agricultural system is the evolution of organisational and institutional systems for production, input compositions, and distribution of the whole package of inputs available. Furthermore, it is also true that the advances in agricultural productivity over the last two decades were mostly due to better utilisation of available infrastructure and an increase in yield per acre, which enabled India reach food grain self-sufficiency. The reasons attributed to these events are believed to be technological breakthroughs along with farmer perceptions about the use of modern inputs, available extension, and their impact on the productivity network. These changes in crop production and method, however, are not universal across crops, farms, and areas in the country. It has not only widened regional differences, but it has also resulted in an uneven distribution of rewards among different size groups of farmers across areas. This disparity in growth is mostly attributable to the fact that the areas under diverse agricultural crops have responded to technological and economic changes in these regions in different ways. As a result, the difficulties affecting a country cropping system are numerous, attracting the attention of experts and policymakers. The technological challenges and efficiency metrics of farms included in the country cropping system are among the main issues debated in the current era of agriculture development. The farmers only option is to increase crop production through adoption of improved technology and efficient use of available resources, as rising population and income increase demand for crop products. Because there is no room for expanding land frontiers due to the trend of diverting agricultural land to non-agricultural uses, the only option available to farmers is to increase crop production through adoption of improved technology and efficient use of available resources. Agricultural output, on the other hand, is heavily influenced by agro-climatic conditions as well as technology at the regional level, with varying amounts of input utilisation having an impact on farm productivity. A yield gap can occur when resources are used inefficiently or ineffectively. As a result, examining differences in potential and actual yields at the farm level for a given technology and resource endowment of farmers across regions is critical in order to gain a better understanding of the productivity gap at a time when major changes in macro-policy are taking place in the context of India economic liberalisation. The present study on an economic analysis of technical efficiency of paddy cultivation in Kurnool district of Andhra Pradesh is an attempt on this direction. The examine the resource use pattern of paddy cultivating farmers of varying size groups and to evaluate the farm level technical efficiencies in the production of paddy in Kurnool District in Andhra Pradesh.

**Methodology**

The study is empirical in nature and based on survey method. Both the primary and secondary data are used for this study. The primary data have been collected from the respondents with the help of pre-tested interview schedule. The respondents have been contacted in person over a period of twelve months to elicit information about the paddy production and other information. In recent years, the Stochastic Frontier Production Function (Aigner) has been the most prevalent approach for estimating technological efficiency. The stochastic frontier has been represented using a two-component composite error term. A symmetric component allows for random fluctuation in the frontier across businesses, capturing the effects of measurement error, statistical noise and random shocks outside the farms control. Firm-specific impacts like as slackness in output owing to labour shirking, which is under the control of the businesses and influences their degree of technical efficiency, are captured by a one-sided component. The empirical model utilised for analysis in this study is divided into two parts. The first stage involves estimating farm-specific technical efficiency ratings using a stochastic production function of the following equation:

$$\ln (Y_i) = X_i \alpha + V_i - U_i \text{ -------------------- } (1)$$

Where Y is the dependent variable (output) and $X_i$ are the independent variables viz., area under crop, seed, family labour, hired labour, machine hours, chemical fertilizer and pesticide cost. In this model, the dependent variable is bounded by the stochastic variable, $V_i - U_i$. The random error is $V_i$ can be positive or negative and so the stochastic outputs vary about the deterministic part of the frontier model. The variables specified for estimation of Technical Efficiency for the individual farms and crops based on Cobb Douglas function:

y = Output of Crops (Paddy / in Quintal / Acre)
$X_1$ = seed rate in kg/acre
$X_2$ = Area under crop (in acres)
$X_3$ = Family labour (male + female) man-days/acre.
$X_4$ = Hired labour used in man-days/acre
X5 = Cost on machine hours used in Rs. / acre
$X_6$ = Quantity of chemical fertilizer used in kg/acre
$X_7$ = Cost on pesticide components (in Rs./acre)

**Determinants of Technical Efficiency of Paddy in Kurnool District of Andhra Pradesh**

As crop output is conditioned by the factors like rainfall, incidence of disease pest, soil fertility and other socio-economic factors, a simple linear regression technique of the following type was used to identify the factors that influence the technical efficiency of the selected farmer households. The technical efficiency scores generated by the frontier are regressed on the independent variables as follows;

**TEij = α + α1 (X1) + α2 (X2) + α3 (X3)+ α4 (X4) + ei…………………(2)**

Where,

TEij = level of technical efficiency estimated through MLE
X1 = Farm size
X2 = Age
X3 = Educational status
X4 = Family Size
α1………α4 = regression co-efficients
ei = error term and α = constant.

**Sampling Design**

The sampling for the analysis is based on multi-stage simple random sampling method. A multi-stage stratified random sampling frame will be used for the collection of the primary data. Kurnool District in Andhra Pradesh has been purposively selected for the study. The primary data were collected through interview schedule method. The study will be of revenue division-wise at the first stage (Adoni, Kurnool and Pattikonda). There are 9 mandals in Adoni division, 8 mandals in Kadapa division and 9 mandals in Pattikonda division. Owing to the time constraints, of the 26 mandals in the district. One mandal is selected from each of the three revenue division in the district. Total sample mandals are Three. In the next stage of sampling, each from one mandal two villages has been selected in sample study area. In each village 25 sample paddy farmers are selected. The total sample size is 150. Details of the number of sample paddy farmers in each village are presented in the following Table-1.Table-1

Distribution of Sample Paddy Farmers in Kurnool District of Andhra Pradesh

| Revenue Division | Selected Mandal | Selected Villages | Total Sample Size |
|---|---|---|---|
| Adoni | Mantralayam | Kachapuram | 25 |
| | | Rachumarri | 25 |
| Kurnnol | Orvakal | Brahmanapalle | 25 |
| | | Meedivemula | 25 |
| Pattikonda | Devanakonda | Karivemula | 25 |
| | | Potlapadu | 25 |
| Total sample size | | | 150 |

Source: 1) Government of Andhra Pradesh, District Hand Book, Kurnool, 2023.
2) Government of Andhra Pradesh, Mandal Hand Books, Kurnool, 2023.

**Analysis of the Data**

The results of the study are presented in two parts are (I) Estimated Cost and Returns of paddy Cultivation and (II) Technical Efficiency of Paddy Production in Kurnool district of Andhra Pradesh.

**Estimated Cost and Returns of Paddy Cultivation in Kurnool district of Andhra Pradesh**

The anticipated cost and revenue details of paddy production based on farm level data received from the sample farmers of Kurnool district. The per acre cost and revenue particulars of the selected sample paddy cultivating farmers of Kurnool district of Andhra Pradesh were shown in Table-2.

Table- 2
Estimated the Cost and Revenue of Paddy Cultivation in
Kurnool District of Andhra Pradesh

| Cost / Revenue | Farm Size (Acres.) | | | | Total |
|---|---|---|---|---|---|
| | Below 2.5 Acre | 2.5-5.0 Acre | 5.0-7.5 Acre | Above 7.5 Acre | |
| Average Area under Crop in Acres | 1.32 | 3.14 | 5.92 | 10.24 | 6.92 |
| Cost of Seed | 825 (5.04) | 685 (5.65) | 725 (6.51) | 655 (6.34) | 426 (5.20) |
| Cost of Family Labour | 7685 (46.97) | 4665 (38.49) | 3685 (33.13) | 2815 (27.26) | 2581 (31.52) |
| Cost of Hired Labour | 2915 (17.81) | 2345 (19.35) | 2645 (23.78) | 2855 (27.65) | 2165 (26.44) |
| Cost of Machine hours | 1885 (11.52) | 1525 (12.58) | 1625 (14.61) | 1505 (14.57) | 1285 (15.69) |
| Cost of Chemical Fertilizer | 1565 (9.56) | 1642 (13.55) | 1282 (11.52) | 1440 (13.94) | 1162 (14.19) |
| Cost of Pesticide | 1485 (9.07) | 1255 (10.35) | 1160 (10.49) | 1055 (10.21) | 568 (6.93) |
| TVC | 16360 (100) | 12117 (100) | 11122 (100) | 10325 (100) | 8187 (100) |
| TC | 13710 | 12415 | 13749 | 13658 | 12615 |
| TR | 18675 | 15615 | 15848 | 14845 | 13541 |
| Net Revenue (TR-TC) | 4965 | 3200 | 2099 | 1187 | 926 |
| Revenue over Total Variable Cost (TR-TVC) | 2315 | 3498 | 4726 | 4520 | 5354 |
| Total | 48 | 43 | 34 | 25 | 150 |

Source: Field Data

From the Table-2 shows that, the average farm size for the land groups (Below 2.5 acres, 2.5-5.0 acres, 5.0-7.5 acres and above 7.5 acres) was calculated to be 1.32, 3.14, 5.92 and 10.24 acres and the average farm size was calculated to be 6.92 acres when all sizes of farms were included in the study area. The area under paddy, the cost of seed, the cost of family labour, the cost of hired labour, the cost of machine hours used, the cost of chemical fertiliser, and the cost of pesticide were all essential factors in determining paddy production economics in the area. The cost of seeds accounted for 5.20 per cent of the overall cost, demonstrating that modern HYVs seeds were used in crop production. The family labour costs should account for 31.52 per cent of the overall cost for the average paddy producing farmer in the area, followed by paid labour (26.44 per cent). To put it another way, paddy cultivating is a labour intensive occupation that heavily relies on human labour. It is possible that the higher amount of family labour is attributable to their excessive reliance on farm operations or a lack of available or affordable hired labour in the area. The cost of machine hours utilised for cultivation accounted for 15.69 per cent of the overall cost, demonstrating that modern agricultural equipment were used in crop production. Other key factor inputs that have a direct impact on crop output are chemical fertiliser and pesticide cost. In other words, the expenditure on chemical fertiliser 13.26 per cent overall cost, on chemical fertiliser were used in crop production; in terms of pesticide use on the crops expenditure on chemical fertiliser 6.93 per cent overall cost, on chemical fertiliser were used in crop production. To summarise, an average paddy cultivating farmer in the area spent 5.20 per cent, 31.52 per cent, 26.44 per cent, 15.69 per cent, 14.19 per cent, and 6.93 per cent on seed, family labour, hired labour, machine hours, chemical fertiliser, and pest management, respectively and received a net revenue of only Rs.926/- per acre in the study area.

**Technical Efficiency in Paddy Production in Kurnool District of Andhra Pradesh**

The input and output characteristics of chosen farmer families of varied sizes in the in Kurnool District prior to the discussion on technical efficiency of farm groups are presented in Table-3.

Table-3
Average Levels of Input Use and Output per Acre by Farm Size Groups
in Kurnool district of Andhra Pradesh

| Cost / Revenue | Farm Size (Acres.) | | | | Total |
|---|---|---|---|---|---|
| | Below 2.5 Acre | 2.5-5.0 Acre | 5.0-7.5 Acre | Above 7.5 Acre | |
| Area under crop (in acres) | 1.32 | 3.14 | 5.92 | 10.24 | 6.92 |
| Seed(Kgs) | 48 | 36 | 32 | 35 | 31 |
| Family Labour (Man days) | 78 | 82 | 55 | 56 | 62 |
| Hired Labour (Man days) | 32 | 36 | 34 | 35 | 32 |
| Machine hours | 15 | 22 | 15 | 16 | 14 |
| Chemical Fertilizer(Kgs) | 195 | 204 | 208 | 204 | 182 |
| Pesticide (Rs..) | 1165 | 1015 | 952 | 985 | 892 |
| Production (quintals) | 24 | 23 | 25 | 24 | 21 |
| Total | 48 | 43 | 34 | 25 | 150 |

Source: Field Data

From the Table-3 observed that, the average size of paddy farms in Kurnool district the is 1.32 acres, 3.14 acres, 5.92 acres, and 10.24 acres for farms of below 2.5 acres, 2.5-5.0 acres, 5.0-7.5 acres and above 7.5 acres and the average size of a farm growing paddy in Kurnool district was calculated to be 6.92 acres in the study area. The family labour appeared to be an important component of agricultural productivity, particularly for small and medium sized farms, the percentage of family labour used by each category of farms was calculated separately. The family labour appeared to be a key source of agricultural production for all sizes of farms in Kurnool district, with each farm using 78 days, 82 days, 55 days, 56 days and an average paddy cultivating farmer were used 62 man-days per acre in family labour and the hired labour appeared to be a key source of agricultural production for all sizes of farms in Kurnool district, with each farm using 32 days, 36 days, 34 days, 35 days and an average paddy cultivating farmer in Kurnool district were used 32 man-days per acre in hired labour in the study area. The machine hours are all sizes of farms are using 15 hours, 22 hours, 15 hours, 16 hours and an average paddy cultivating farmer in Kurnool district were used 14 hours per acre in the study area. In the quantity of plant nutrients in the form of NPK compounded fertiliser applied per acre was observed to rise with farm size, the average farmer in Kurnool District utilised 182 kg of NPK compounded fertiliser (per acre) on paddy. The pesticides expenditure on the form paddy, per acre was observed to rise with farm size, the average farmer in Kurnool District Rs.892/- (per acre) on paddy. Finally the production of paddy is 21 quintals in Kurnool district of Andhra Pradesh. The Cobb-Douglas Production Function was used to estimate the output elasticities with respect to the primary inputs in paddy production using the Ordinary Least Square (OLS) technique. The output elasticities for paddy based on OLS estimates of the Cobb-Douglas production function is presented in Table-4.

Table-4
OLS estimates of the production Function for paddy in
in Kurnool district of Andhra Pradesh

| Variables | Unstandardized Co-efficient | | Standardized Co-efficient | t-value | Sig |
|---|---|---|---|---|---|
| | B | Std.Error | Beta | | |
| Intercept | 6.318 | 1.011 | 0.275 | 6.252 | 0.000 |
| Area under crop | $8.422^{**}$ | 4.334 | 0.611 | 1.956 | 0.055 |

| | | | | | |
|---|---|---|---|---|---|
| Seed | 7.015* | 1.521 | 0.276 | 4.821 | 0.000 |
| Family Labour | 2.621* | 0.836 | 0.182 | 3.154 | 0.003 |
| Hired Labour | 1.114* | 0.361 | 0.124 | 3.101 | 0.002 |
| Machine hours | 1.051 | 0.656 | 0.058 | 1.616 | 0.109 |
| Chemical Fertilizer | 5.012* | 0.811 | 0.294 | 6.081 | 0.000 |
| Cost on Pesticide | 0.674 | 0.736 | 0.051 | 0.924 | 0.368 |
| $R^2$ | 0.898 | | | | |
| F | 253.041 | | | | |
| N | 150 | | | | |

Source: Field Data

From the Table-4 observed that, the estimated regression co-efficient of the variables pertaining to the data on these variables explained a significant proportion of variability in paddy yield as measured by the $R^2$ of 0.898 for Kurnool district of Andhra Pradesh. The output elasticities assessed for area under crop, seed, family labour, hired labour, and chemical fertiliser used were 8.422, 7.015, 2.621, 1.114 and 5.012 respectively, and statistically significant at the 1 per cent and 5 per cent levels. By fitting a Stochastic Frontier Production Function to chosen farms participating in paddy output from the Kurnool District in Andhra Pradesh, the Technical Efficiency of paddy production was evaluated. The estimated parameters of the Stochastic Frontier Production Function for paddy Cultivation in Kurnool district are presented in Table-5.

Table-5

Stochastic Frontier Production Function of Paddy Cultivation in Kurnool District of Andhra Pradesh

| Variables | Co-efficient | t-value | Sig |
|---|---|---|---|
| Intercept | 5.378 | 2.392 | 0.021 |
| Area under crop | 0.564** | 2.534 | 0.018 |
| Seed | 0.128*** | 1.786 | 0.094 |
| Family Labour | 0.102* | 2.674 | 0.012 |
| Hired Labour | 0.485** | 2.342 | 0.025 |
| Machine hours | 0.008 | 0.184 | 0.864 |
| Chemical Fertilizer | 0.926* | 9.824 | 0.000 |
| Cost on Pesticide | 0.054 | 0.825 | 0.425 |
| σ2 | 0.098 | | |
| σu2 | 0.079 | | |
| σv2 | 0.025 | | |
| y | 0.784 | | |
| Log likelihood | 13.351 | | |
| **N** | 150 | | |

Source: Field Data

From the Table-5 shows that, the stochastic frontier production function, observed that, the estimating technical efficiency, stochastic production function approach was used.. A high value of γ (0.784) in all the farms indicates the presence of significant inefficiencies in the production of paddy crop. It shows about 78 per cent of differences between the observed and maximum production frontier outputs were due to the factors which were under farmer control. The stochastic frontier analysis has further shown that 78 per cent of observed inefficiency was due to farmer inefficiency in decision-making and only 22 per cent of it was due to random factors outside their control in the case of all farms. Further, the estimates of stochastic frontier have shown that in the case of all farms, the estimated value of the coefficient of seeds, fertilizers, family labour, hired labour, machine hours was positive and highly significant, indicating fertilizers to be productive input for successive production of paddy crop. Statistically significant and positive values of the estimated coefficients indicated that farmers could increase per hectare yield by applying more units of these inputs in the study area. The average level of technical efficiency of paddy in Kurnool district is presented in Table-6.

Table-6
Technical Efficiency by Farm Size Groups for Paddy Cultivation in Kurnool District of Andhra Pradesh

| Levels of Technical efficiency (Per cent) | Farm size Group | | | | Total |
|---|---|---|---|---|---|
| | <2.5 | 2.5-5.0 | 5.0-7.5 | Above 7.5 | |
| < 60 | 4(8.33) | 4(9.31) | 2(5.88) | 1(4) | 11(7.33) |
| 60-70 | 6(12.5) | 6(13.95) | 5(14.71) | 3(12) | 20(13.33) |
| 70-80 | 11(22.91) | 10(23.25) | 14(41.17) | 10(40) | 45(30) |
| 80-90 | 18(37.5) | 15(34.88) | 8(25.52) | 8(32) | 49(32.66) |
| >90 | 9(18.75) | 8(18.61) | 5(14.71) | 3(12) | 25(16.66) |
| Mean TE | 0.81 | 0.85 | 0.92 | 0.88 | 0.865 |
| N | 48 | 43 | 34 | 25 | 150 |

Source: Field Data

Table-6 shows that the average level of technical efficiency for the Kurnool district farms was estimated to be 0.865 per cent, indicating that paddy output can be increased by 10 per cent by following better crop management practises without having to increase the level of input application. It was also discovered that 7.33 per cent of the farmers in the area had efficiency levels of less than 60 per cent, while 13.33 per cent had efficiency levels of 60-70 per cent, 32.66 per cent had efficiency levels of 80-90 per cent, and 16.66 per cent had efficiency levels of >90 per cent. The mean technical efficiency for farms of less than 2.5 acres, 2.5-5.0 acres, 5.0-7.5 acres, and more than 7.5 acres was calculated to be 0.81, 0.85, 0.92 and 0.88 respectively, with farmers in the 5.0-7.5 acres paddy cultivation group being more efficient than the other groups in the study area.

**Conclusion and Suggestions**

The findings of the study have policy implications since they not only provide empirical efficiency indicators that can be used to plan farm production, but they also assist us identify the potential for crop production improvement across diverse farming systems based on efficiency. The study findings also provide insight into long-term productivity improvement approaches that do not require more resources. Given that education has a considerable impact on technical efficiency, efforts should be made to popularise both formal and informal education among farmers in the area. According to the report, farmers should be paid a minimum support price for their produce in order to ensure their survival. There are steps that can be taken to protect the soil health. The farmers will be able to actively engage in the soil fertility enhancement movement with the use of soil health cards. The farmers will benefit from the timely availability of loans at a reasonable interest rate. Through links with
technology, markets, society, and the Government, steps can be done to improve farmers abilities as agricultural entrepreneurs. For the sustainable use of ground water and pollution prevention, a water literacy movement might be created and regulated. The steps could be done to ensure that all farmers are covered by crop insurance. The efforts can be made to ensure that agricultural products are sold at a profit. The officials from the agriculture department may provide farmers with training and advice on how to apply recommended fertiliser and pesticide doses. The high-tech machinery may be utilised in greater numbers to minimise the cost of paddy harvesting in the study area. The subsidies for fertiliser and pesticide should be provided to farmers. The Government should take tough measures against those who pollute the water and air. The usage of appropriate scientific information to capture highest potential resource use efficiency with less cost, innovative methods to reduce the wastage and dissemination of all farm relevant knowledge material should be encouraged to make the technical efficiency more and more.

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