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Economic analysis of groundnut farmers participating in Rythu Bharosa Kendras (RBKs) in Guntur district of Andhra Pradesh

Shaik Nayeem Heera and K Nirmal Ravi Kumar

Abstract
This study measured the Technical Efficiency (TE) and Economic Efficiency (EE) of groundnut farmers participating in Rythu Bharosa Kendras (RBKs) in Guntur district of Andhra Pradesh using Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) from 40 groundnut farmers. According to DEA and SFA results, the mean TE of farmers was found to be 96.8 and 85.45 per cent respectively. The mean EE obtained from DEA and SFA were found to be 73.5 and 70.25 respectively. As a result, DEA explains more variability in terms of both TE and EE compared to SFA. The results indicate that majority of groundnut farmers were found with lesser technical inefficiencies and more economic inefficiencies. Economic inefficiency was due to using high costs on inputs like seed, lime and gypsum and machine charges to produce optimum level of output. Garrett ranking was used to find the constraints faced by farmers in accessing inputs from RBKs. They were mandatory linking of e-crop booking (I) and inadequate amount of capital resources with small farmers (II). It was suggested that government should take measures to avoid technical problems related to e-crop bookings by fixing servers (I) and supply of input subsidies at needed times (II).

Keywords: Rythu Bharosa Kendras, Groundnut, Technical and Economic Efficiency, Data Envelopment Analysis, Stochastic Frontier Analysis, Garrett ranking

1. Introduction
Agriculture is the main source of livelihood for most of the population in India. Farmers face many problems in the process of timely availability, high cost and supply of low quality of inputs which leads to losses to farmers. Farmers fail to exploit fully the potential of a technology leads to allocative errors while using agricultural inputs leading to decrease in their TE as well as EE (Varasani *et al.* 2016) [7]. So, to help farmers with these issues, a strong integrated platform is needed to assist them right from input delivery to selling of the produce. Thus, keeping this in the view, Government of Andhra Pradesh introduced Rythu Bharosa Kendras (RBKs) on 30th May 2020 which act as one stop solution to address all the farmers' needs, which provides agriculture and allied sector advisory services at every panchayat level and improve the services of government for farmers in qualitative and quantitative terms. Government has launched the RBKs to bring more transparency and to provide quality of services to the farm sector (Reddy, 2020) [6].
India is the largest producer of major oilseeds in the world. Among the oilseeds, world production of Groundnut reached a record of about 210 lakh tonnes. India ranks first in the world, in terms of area with 49.14 lakh hectares, second in the production with 82.54 lakh tonnes with a productivity of 1679 Kg/ha (Indiastat, 2021) [3]. Andhra Pradesh ranks fourth in terms of groundnut production with 7.74 lakh tonnes in an area of 8.7 Lakh hectares with the lowest productivity of 891 Kg/ha during 2020-21. In Andhra Pradesh, Guntur district stands at sixth position in area and production with 0.03 lakh hectares and 0.11 lakh tonnes respectively and ranks second in terms of productivity with 3638 Kg/ha (ANGRAU Groundnut Outlook Report, January-December 2021).
Production of groundnut farmers is influenced by good management practices coupled with timely availability of inputs which influence the TE of farmers. The TE of farmers in Andhra Pradesh is quite low due to timely unavailability of right quantity of inputs at right time and unreasonably high prices (Rao *et al*. 2003) [5]. In this context, Government of Andhra Pradesh has introduced RBKs to help farmers right from delivery of inputs at right quantity, right time and at reasonable prices to selling of the produce which shows a potential impact on TE and

EE of farmers. As Guntur district is one of the major producers of Groundnut, with the advent of RBKs, there is a change in the input delivery mechanism which influence the TE and EE of farmers. As RBKs are recently introduced and there were no prior studies related to RBKs, therefore, an attempt was made to study the TE and EE of groundnut farmers participating in RBKs in Guntur district of Andhra Pradesh.

2. Materials and Methods

For this study, Guntur district was purposively selected as it is the one of the major producers of Groundnut in Andhra Pradesh. One mandal was selected randomly. From that mandal, two villages were selected and from each village, one RBK was selected. Primary data was collected from 40 farmers *i.e.*, 20 farmers from each RBK were selected using pre structured schedules. Secondary data was collected from published articles, ANGRAU Groundnut Outlook Report, Indiastat *etc.*

2.1 Data Envelopment Analysis (DEA)

DEA is a linear programming method employed to estimate the different types of efficiencies like (technical, allocative and economic efficiencies) of the sampled data. Assume there are n homogenous Decision-Making Units (DMUs), in order to produce number of outputs (r=1, 2, 3,…k), number of inputs utilized are (s=1, 2, 3,… m) by each DMU_i (i=1, 2,3,…n). The input and output vectors of i^{th} DMU are represented as x_i and y_i, respectively. The data for all DMUs is denoted by the input matrix $(X)_{m\times n}$ and output matrix $(Y)_{k\times n}$. The input minimization process to measure TE for each DMU can be expressed as

$min\theta, \lambda\phi$

Subject to $-y_i+Y_\lambda\leq 0$

$\phi x_j+X_\lambda\geq 0$

$N_1\lambda=1$

$\lambda\geq 0$

Where, N = no. of Decision-Making Units.

k = inputs, m = outputs.

x_i and y_i = input and output vectors respectively for i^{th} DMU.

λ = N x 1 vector of weights, of i^{th} DMU.

ϕ = TE score, $0 \leq\phi\leq 1$.

Min, λ, xi* wi' xi*

Subject to $-y_i + Y_\lambda \geq 0$,

$xi^* - X_\lambda \geq 0$

$N1'\lambda = 1$

$\lambda \geq 0$,

Where

w_i is vector of input price of firm and x_i* is the cost-minimizing vector of input bundles of i^{th} farm, given the input price w_i and the output levels y_i.

The EE for firm 'i' will be then solved by the following computation:

EE = wi'x* / wi' xi

Allocative efficiency (AE) = EE / TE

Estimation of TE

Dependent variable: Y= Yield (kg/ha)

Independent variables: X_1=Seed rate (kg/ha), X_2= Farm Yard Manure (kg/ha), X_3= Fertilizers (kg/ha), X_4= Gypsum & Lime (kg/ha), X_5= Complex fertilizers (kg/ha), X_6= Plant protection chemicals (kg/ha), X_7= Machine labour (hr/ha), X_8= Total labour (man days).

Estimation of EE

Dependent variable: Y= Total Production costs (Rs)

Independent variables: X_1= Cost of Seed (Rs), X_2= Cost of Farm Yard Manure (Rs), X_3= Cost of Fertilizers (Rs), X_4= Cost of Gypsum & Lime (Rs), X_5= Cost of Complex fertilizers (Rs), X_6= Cost of Plant protection chemicals (Rs), X_7= Cost of Machine labour (charges in Rs), X_8= Cost of Total labour (wages in Rs)

2.2 Stochastic Frontier Analysis (SFA)

SFA is a parametric approach which applies random production, cost or profit functions to measure efficiency (Varasani *et al.* 2016) [7]. Variables used for both DEA and SFA are same for TE and EE.

Estimation of TE

The stochastic frontier approach was used.

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(X_{1i}) + \beta_2 \ln(X_{2i}) + \beta_3 \ln(X_{3i}) + \beta_4 \ln(X_{4i}) + \beta_5 \ln(X_{5i}) + \beta_6 \ln(X_{6i}) + \beta_7 \ln(X_{7i}) + \beta_8 \ln(X_{8i}) + V_i - U_i$$

Estimation of EE

The following formula was used.

$$\ln(Y_i) = a_0 + a_1 \ln(X_{1i}) + a_2 \ln(X_{2i}) + a_3 \ln(X_{3i}) + a_4 \ln(X_{4i}) + a_5 \ln(X_{5i}) + a_6 \ln(X_{6i}) + a_7 \ln(X_{7i}) + a_8 \ln(X_{8i}) + V_i + U_i$$

ln = The natural logarithm; a_i and β_i = Coefficients; V_i is assumed to be independently and identically distributed random errors, having N (0, σ2 v) distribution.

2.3 Garrett Ranking

Garrett ranking was used in ranking the constraints faced by farmers in accessing inputs from RBKs. The formula for percent position, as suggested by Garrett is:

Per cent position = $100(R_{ij}-0.5)/ N_j$

Where,

R_{ij} = Rank given for the i^{th} item by the j^{th} individual

N_j = Number of items ranked by the j^{th} individual

The per cent position of each rank was converted to scores by referring to tables given by Garret and Woodworth (1969). Then for each factor, the scores of individual respondents will be summed up and divided by the total number of respondents. The mean scores for all the factors will be ranked.

3. Results and Discussion

a. Data Envelopment Analysis (DEA)

From the table-1, it can be observed that, to produce an output of 4220 kg/ha on an average, farmer used 340 kg/ha of seed, 1783.3 kg/ha of Farm Yard Manure, 189 kg/ha of fertilizers, 187 kg/ha of Lime & Gypsum, 220 kg/ha of complex fertilizers, 7.6 l/ha of plant protection chemicals, 52 machine hours/ha and 74 man days/ha were used on an average.

Table 1: Summary statistics of inputs and output

Variables	Minimum	Maximum	Mean	Standard Deviation
Output				
Yield (kg/ha)	2700	6300	4220	963.3
Inputs				
Seed (kg/ha)	250	540	339.9	62.81
FYM (kg/ha)	0	5000	1783.3	1492.3
Fertilizers (kg/ha)	0	375	188.7	91.6
Lime & Gypsum (kg/ha)	0	500	186.8	128.6
Complex fertilisers (kg/ha)	0	500	220.4	123.3
Plant protection chemicals(l/ha)	1.7	28	7.6	4.5
Machine hours/ha	30	82.5	52.3	13.5
Man days/ha	60	107	74.4	11.2

From table 2, we can summarize that the mean TE of groundnut farmers is 96.8 per cent. This means the farmers can reduce their inputs by 3.2 per cent to produce same level of output. 45 per cent of the farmers are fully technically efficient and they are not using any excessive amount of fertilizers. 40 per cent of the farmers are highly technically efficient and they are using only 0.1-0.01 per cent of excessive amount of fertilizers. Rest of the farmers are optimally technically efficient. No farmers are technically inefficient. The mean AE of groundnut farmers is 75.8 per cent indicates that farmers should allocate their inputs in a more efficient way at a given cost and can reduce their cost of inputs by 24.2 per cent to meet the same output. Majority of farmers (62.5 per cent) are utilising high priced inputs to produce same level of output. Hence, they have to allocate resources properly to reduce input costs to produce same level of output. The mean EE of groundnut farmers is 73.5 per cent implying that the farmers should reduce overall cost of cultivation by 26.5 per cent on an average to produce same level of output. Majority of farmers (47.5 per cent) employed more costs to produce same level of outputs which leads to increase in cost of cultivation.

Table 2: Frequency distribution of TE, AE and EE of groundnut farmers participating in RBKs in Guntur district of Andhra Pradesh

DEA Score	TE		AE		EE	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	18	45	2	5	2	5
0.9-0.99	16	40	3	7.5	3	7.5
0.8-0.89	6	15	3	7.5	3	7.5
0.7-0.79	0	0	25	62.5	19	47.5
<0.69	0	0	7	17.5	13	32.5
Sum	40	100	40	100	40	100
Maximum	1		1		1	
Minimum	0.885		0.460		0.443	
Mean	0.968		0.758		0.735	

b. Stochastic Frontier Analysis (SFA)

From table-3, it is summarized that, the estimated values of the coefficients of seed (0.640), FYM (0.074) were positive and highly significant at 1per cent and 5 per cent level of significance respectively. FYM (-0.025) was negative but highly significant. It implies that seed and FYM were important contributors to technical efficiency of groundnut cultivation. When seed use was increased by 1 per cent, holding other inputs constant, output would increase by 0.64 per cent. When FYM use was increased by 1 per cent, holding other inputs constant, output would increase by 0.074 per cent. When Fertilizer use was increased by 1 per cent, holding other inputs constant, output would decrease by 0.025 per cent. At the same time, the negative but significant coefficient of fertilizers (-0.025) indicated the over-use of the resource. Sigma-squared is significant which indicates the appropriateness of the model and it satisfies distributional assumptions of the error term. Gamma value was 0.904 means 90.4 per cent of variations in groundnut output was attributed to variations in technical efficiencies of farmers. Log likelihood value was 42.9 which indicates the goodness of fit, that is higher the value, better the model. It lies between -α to +α.

Table 3: Maximum likelihood estimates of the stochastic frontier production function in the study area

Variables	Coefficient	Standard error	t-ratio
Constant	0.429	1.7172	0.2497
Seed (kg/ha)	0.640**	0.1578	4.0533
Fertilizer (kg/ha)	-0.0254*	0.0111	-2.3047
FYM (kg/ha)	0.0741*	0.0344	2.1530
Lime &Gypsum (kg/ha)	0.0259	0.0157	1.6456
Complex fertilizers (kg/ha)	0.0590	0.0258	2.2889
Plant protection chemicals(l/ha)	0.004	0.0799	0.0559
Human labour (man days)	0.147	0.1092	1.3531
Machine hours(hr/ha)	0.685	0.2817	2.4297
Sigma-squared	0.035**	0.0072	4.9316
Gamma	0.904**	0.0421	21.472
Log likelihood = 42.9			

Note: ** and * indicates 1% and 5% level of significance respectively

From table 4, it is summarized that the mean TE of all farmers was 85.45 per cent, implying that on an average, the sample farmers tend to realize around 85 per cent of the technical potential in terms of groundnut yield. Hence, on an average, approximately 15 per cent of technical yield potential was not realized. That means farmers are using 15 per cent of excessive inputs that can be reduced to produce the same level of output. Therefore, it may be possible to improve the yield of groundnut crop by 15 per cent. Majority of the farmers 50 per cent operated at TE levels between 76 to 90 per cent. Only about 5 per cent of the groundnut farmers were found below 76 per cent of the TE level. About 37.5 per cent of sample farmers were operating closer to frontier with the TE of above 91 per cent as they are using inputs efficiently. Hence, a majority the sample groundnut farmers were found to be with lesser technical inefficiencies which could be mainly attributed to their efficient use of the resources.

Table 4: Distribution of sample farmers under different levels of TE

TE (Per cent)	No. of farmers	Per cent total
61-65	0	0
66-70	2	5
71-75	3	7.5
76-80	5	12.5
81-85	7	17.5
86-90	8	20
>91	15	37.5
Total farmers	40	100
Mean efficiency (Per cent)	85.45	

Note: ** and * indicates 1% and 5% level of significance respectively.

Table 5: Maximum likelihood estimates of the stochastic frontier cost function in the study area

Variables (Rs.)	Coefficient	Standard error	t-ratio
Constant	0.879**	1.100	8.03
Cost of Seed	0.157**	0.0168	9.35
Cost of Fertilizer	0.003	0.0043	-0.08
Cost of FYM	-0.004	0.015	-0.425
Cost of Lime &Gypsum	0.008**	0.002	3.44
Cost of Complex fertilizers	0.004	0.0799	0.0559
Cost of Plant Protection Chemicals	-0.004	0.0374	-0.11
Machine charges	0.037**	0.0103	3.69
Wages	0.014	0.0494	0.29
Sigma-squared	0.006**	0.0016	4.29
Gamma	0.710**	0.0457	15.5
Log likelihood = 42.9			

From table-5, it is concluded that cost of seed, lime and gypsum, machine charges significant at 1 per cent level of significance which shows significant influence on the costs of groundnut production. If 1 per cent increase in seed cost, could increase the total cost of cultivation by 0.15 per cent. If 1 per cent increase in cost of lime and gypsum could increase the total cost of cultivation by 0.008 per cent. If 1 per cent increase in machine charges, could increase the total cost of cultivation by 0.037 per cent. Sigma-square is significant which indicates the appropriateness of the model and it satisfies distributional assumptions of the error term. Gamma value was 0.710 which means 71 per cent of variations in cost of cultivation of groundnut farmers were accounted for the variations in EE of farmers. Log likelihood value was 47.2 which indicates the goodness of fit, that is higher the value, better the model. It lies between -α to +α.

From table-6, it is concluded that, the mean EE of all farmers was 70.25 per cent, implying that on an average, the sample farmers tend to realize around 70 per cent of the economic potential in terms of groundnut yield. Hence, on an average, approximately 30 per cent of economic potential was not realized. Therefore, it is possible to improve the yield of groundnut crop by 30 per cent. It was also observed that a majority of the farmers 62.5 per cent operated at EE levels between 61 to 75 per cent which means they are using more costs on inputs to produce same level of output. At the same time, only about 12.5 per cent of the groundnut farmers were found above 91 per cent of the EE level which means they are using optimum costs to produce efficient level of output. About 25 per cent of the sample farmers were operating closer to frontier with the EE between 76 to 90 per cent. Thereby, as a whole, a majority the sample groundnut farmers were found to be with more economic inefficiencies.

Table 6: Distribution of sample farmers under different levels of EE

EE (Per cent)	No. of farmers	Per cent total
61-65	8	20
66-70	7	17.5
71-75	10	25
76-80	5	12.5
81-85	2	5
86-90	3	7.5
>91	5	12.5
Total farmers	40	100
Mean efficiency (Per cent)	70.25	

Table 7: Comparison of TE results obtained from both SFA and DEA

TE (Per cent)	DEA		SFA	
	Frequency	Per cent	Frequency	Per cent
61-65	0	0	0	0
66-70	0	0	2	5
71-75	0	0	3	7.5
76-80	0	0	5	12.5
81-85	0	0	7	17.5
86-90	4	10	8	20
>91	36	90	15	37.5
Total farmers	40	100	40	100
Mean efficiency (Per cent)	96.8		85.45	

Table 8: Comparison of EE results obtained from both SFA and DEA

EE (Per cent)	DEA		SFA	
	Frequency	Per cent	Frequency	Per cent
61-65	0	0	8	20
66-70	0	0	7	17.5
71-75	15	37.5	10	25
76-80	13	32.5	5	12.5
81-85	3	7.5	2	5
86-90	4	10	3	7.5
>91	5	12.5	5	12.5
Total farmers	40	100	40	100
Mean efficiency (Per cent)	73.5		70.25	

From table-7, it is concluded that the comparative results of DEA and SFA showed that mean TE score obtained from the DEA was higher than SFA result. Highest score obtained from DEA model with a score of 0.968 and SFA (0.8545).

DEA is explaining more variability in terms of TE than SFA. From table-8, it is concluded that the comparative results of DEA and SFA showed that mean EE score obtained from the DEA was higher than SFA result. Highest score obtained from DEA model with a score of 73.5 compared to SFA (70.25). DEA is explaining more variability in terms of EE than SFA.

C. Garrett Ranking Technique

From table-9, it specifies the problems faced by farmers in accessing inputs from RBKs ranked according to their Garrett mean score. It was found that respondents faced problems regarding Mandatory linking of e-crop booking (77.5), Inadequate amount of capital resources with small farmers (63.4), Inadequate amount of fertilizers for distribution (51.15), Server issues in the synching of the data (49.5), Land constraint in procuring of fertilizers (41), Farmers have poor awareness about services provided by RBKs (40.45).

Table 9: Ranking constraints in accessing inputs from RBKs by the farmers

S. No	Constraints	Total mean	Rank
1	Mandatory linking of e-crop booking.	77.5	I
2	Inadequate amount of capital resources with small farmers.	63.4	II
3	Inadequate amount of fertilizers for distribution.	51.15	III
4	Server issues in the synching of the data.	49.5	IV
5	Land constraint in procuring of fertilizers.	41	V
6	Farmers have poor awareness about services provided by RBKs.	40.45	VI

4. Conclusion and Suggestions

The results of the present study concluded that the mean TE and EE obtained from the DEA was better than the result obtained from SFA, as DEA efficiency scores have greater variability than the SFA measures. The results were similar with Örük and Baran (2021) [4] studied on Measurement of technical efficiency in Cotton production in Batman province, Turkey: A comparison of DEA and SFA. Their results showed that DEA, TE was 0.99 and SFA, TE was 0.84. The findings of this study concluded that there is little technical inefficiency among selected sample Groundnut farmers. Majority of farmers has not properly allocated their inputs and realised increase in their cost of cultivation leads to economic inefficiencies. It is also concluded that mandatory linking of e-crop booking (77.5), inadequate amount of capital resources with small farmers (63.4), inadequate amount of fertilizers for distribution (51.15), server issues in the synching of the data (49.5), land constraint in procuring of fertilizers (41), farmers have poor awareness about services provided by RBKs (40.45) were the major constraints faced by the farmers in the study area.

To improve TE and EE, overuse of fertilizers should be reduced by technically inefficient farmers. Farmers should make adjustments in the use of inputs to improve AE. Economically inefficient farmers should spend less costs on purchase inputs to produce same level of output can reduce the economic inefficiency. To overcome problems faced by farmers while availing services from RBKs, Government should take measures to avoid technical problems related to e-crop bookings by fixing servers and bugs in the software to overcome non-synching of the farmer's details. Farmers should buy fertilizers at RBKs as prices are low compared to open market. Supply of YSR Rythu Bharosa, input subsidies, crop insurance to farmers at right time. Supply of inputs to RBKs in terms of adequacy and right time from RBK hubs. Improve the competency of technical staff at RBKs by providing trainings on method demonstrations, crop cutting experiments *etc.* Government interventions for spreading the awareness among the farmers regarding the services of RBKs through RBK you tube channel. ANGRAU's role in development of RBKs. (For example, uploading videos recorded by scientists or experts on integrated crop management practices in RBK you tube channel, so that farmers can learn and employ those practices in their respective fields so that they can reduce the over usage of inputs in turn leading to increase in their TE).

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