Research article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Evaluation of Technical Efficiency in respect of production of Oilseeds in India – DEA approach

G.R.Kanmani*[1] and V. Prakash[2]

Department of Statistics, Presidency College, Chepauk, Chennai -05, Tamil Nadu, India.
Email:Kkanmani96@Yahoo.Com
Head-Department of Statistics, Presidency College, Chepauk, Chennai -05,Tamil Nadu, India.
Email:Venu.Prakas@Gmail.Com

ABSTRACT

This study estimates the Technical efficiency of total production of Oil seeds among few states in India during the year 2015-2016. To evaluate the Technical efficiency CRS and VRS models are attempted. The analysis of the study reflects that two states are efficient under CRS, and six states are efficient under VRS model. DEA provides input and an output target for the inefficient DMU'S to improve its efficiency.

KEYWORDS-Data Envelopment Analysis(DEA),Technical efficiency(TE),Constant returns to scale(CRS),Variable returns to scale(VRS).

***Corresponding author**

G.R.Kanmani

Department of Statistics,

Presidency College,

Chepauk, Chennai -05, Tamil Nadu, India.

Email:kkanmani96@yahoo.com

I INTRODUCTION

Oilseeds are raised mostly under rainfed conditions and important for the livelihood of small and marginal farmers in arid and semiarid areas of the country. The production of the oilseeds in 2015-2016 is 25.30 million tonnes. The yield of oilseeds in 2015-16 is 968 kg per hectare (as per 4th advance estimates). During 2014-15 and 2015-16 major oilseeds producing states experienced late monsoon at the time of sowing,insufficient rain during crop growing phase, untimely rain, yellow mosaic virus in soybean.There are totally Nine oil seeds which includes Groundnut, Castorseed, Sesamum, Nigerseed, Rapeseed and mustard, Linseed, Safflower, Sunflower, Soyabean.

The author of this study is interested in evaluating the efficiency among the states in India which all produces the oilseeds. So the author has considered 21 states with one input and two outputs. Each state is considered as a decision making unit and the study is based on secondary data collected from Annual report of agricultural data from the Department of agriculture, co operation and farmers Welfare, Government of India, Krishi Bhawan, New Delhi. Data envelopment analysis is used to calculate Technical efficiency among the states in India.

The structure of the paper is organized as follows; the Review of relevant literature is described in IV. The methodology, used for analysis is discussed in detail in section V. Empirical investigation based on total production of oil seeds among 21 states data structure, is carried out in section VI. Finally the paper ends with discussion and conclusion on empirical investigation.

II DATA ENVELOPMENT ANALYSIS

Data Envelopment Analysis is a Linear programming based technique for measuring the relative performance of organizational units with multiple inputs and outputs which makes comparisons difficult. This paper shows how relative efficiencies can be determined and targets for inefficient units set.

The present study measures the technical efficiency and scale efficiency. However the Technical efficiency is major criteria for measuring efficiency in agriculture because technically efficient farmer is one who produces maximum output for a given amount of input, conditionally on the production technology available.

There is an increasing concern with measuring and comparing the efficiency of organizational units such as local authority departments, schools, hospitals, shops, bank branches and similar instances where there is a relatively homogeneous set of units.

The usual measure of efficiency i.e.,

Efficiency = Output / Input

III DECISION MAKING UNITS

The Decision Making Units (DMU) is a collection or team of individuals who participate in a buyer decision process. Generally, DMU relates to business or organizational buying decisions.In engineering, DMUs may take such forms as airplanes or their componentssuch as jet engines. For the purpose of securing relative comparisons, a group ofDMUs is used to evaluate each other with each DMU having a certain degree ofmanagerial freedom in decision making.

IV REVIEW OF LITERATURE

Charnes et al (1978)[1] proposed DEA to assess the relative efficiency of a set of homogenous decision making units (DMUs) with multiple inputs and multiple outputs. DEA has been dramatically developed in the last three decades and is known as a popular non-parametric technique which only requires a simple set of inputs and outputs values. According to (coelli, Rao & Battese, 1998)[2], the constant returns to scale (CRS) DEA model is only appropriate when the Area is operating at an optimal scale. Some factors such as financial constraints, etc., may not allow an Area to operate optimally. To capture this possibility (Banker, Charnes & Cooper 1984)[3] introduced the (VRS) Variable returns to scale DEA model. This version is scale DEA model. This version is popularly known as BCC model. A description on DEA's literature can be seen in Ray (2004)[4].

Dungana R.B., Nuthali P.L., Nartea.,G.V.,(2004).[5],In this the author found the inefficiency of Nepalese rice farms under Data Envelopment Analysis based on the empirical findings in development strategies and policy implication. Dastgir et al (2012)[6] analyzed the financial statements of 100 firms accepted in Tehran stock exchange by using window DEA model based on output oriented BCC model during the period between 2005 and 2010. The results showed that from among the companies involved in the sample, none of them was able to preserve 100% of their efficiency during the time period mentioned.

Y.C.Linetal (2013)[6] evaluates the Decision making unit to assess economical and environmental factors with multiple inputs and multiple outputs under Data Envelopment Analysis. EtichE. Bett .E NyanwaroS. Kizito .K.(2014)[7] analyzed to identify factors to find the influence in technical efficiency of Sorgham production among small holder farmers in lower eastern Kenya.

VMODEL SPECIFICATION

General input minimization CCR DEA model and BCC DEA model is presented here.

Let there be 'n'; DMUs and each DMU consumes i=1 2 …p inputs and produces r=1 2 ..q outputs.

The input oriented model is,

Min θ

Subject to constraints:

$\sum X_{ik}\lambda_k \leq \theta X_{i0}$,i=1,2,….p

$\sum Y_{rk}\lambda_k \geq Y_{r0}$,r=1,2,…q

$\lambda_k \geq 0, for all k = 1,2 \ldots n$

where θ represents the efficiency score of input p, λ's represent the dual variables that identify the benchmarks for inefficient units.

The corresponding Output oriented CCR model is,

Max φ

Subject to constraints:

$\sum X_{ik}\lambda_i \leq X_{i0}$, i=1,2,….p

$\sum Y_{rk}\lambda_k \geq \varphi y_{r0}$, r=1,2,…q

$\lambda_k \geq 0, for\ all\ k = 1,2 \ldots n$

The efficiency which results is equal to one, always given by the CCR model and the DMUs with the lowest input or with highest output levels are related efficient. BCC model allows for variable returns to scale unlike the CCR model. BCC model measures technical efficiency as the convexity constraint ensures that the composite units are of similar scale size as the unit being measured.

Here, We employed output oriented DEA(Data envelopment Analysis model)to evaluate the production of oilseeds. The scale assumption is Variable returns to scale and the slacks calculated using multi-stage method. The version involving Φ is referred to as an output oriented envelopment DEA program as it aims to maximize output production, subject to the given resource level.

θ_B=min θ

Subject to: $\sum X_{ik}\lambda_k \leq \theta X_{i0}$, i=1,2,….p

$\sum Y_{rk}\lambda_k \geq Y_{r0}$, r=1,2,…q

$\sum \lambda_k = 1$

$\lambda_k \geq 0, k = 1,2 \ldots n$

The corresponding BCC Output oriented model is,

Max Φ

Subject to constraints:

$\sum X_{ik}\lambda_k \leq X_{i0}$

$\sum Y_{rk}\lambda_k \geq \Phi Y_{r0}$

$\sum \lambda_k = 1$;where k=1….n

$\lambda_k \geq 0$,k=1 2 …n

Here this data is based on efficiency based output oriented model.

VIEMPIRICAL INVESTIGATION

Table 1: Input and Output data

S.NO	STATES	PRODUCTION('000 Tonnes)	YIELD(Kgs/Hect)	AREA('000 Hectares)
1	ANDHRAPRADESH	873	955	914
2	ASSAM	185	605	306
3	BIHAR	128.2	1076	119.2
4	CHHATTISGARH	149.6	501	298.9
5	GUJARAT	4101.8	1603	2558.6
6	HARYANA	849.2	1608	528.2
7	HIMACHAL PRADESH	8.6	738	11.7
8	JAMMU AND KASHMIR	40.5	677	59.7
9	JHARKHAND	176.9	681	259.6
10	KARNATAKA	867	651	1331
11	KERALA	0.6	1175	0.5
12	MADHYA PRADESH	6243.5	851	7336
13	MAHARASHTRA	2375	566	4193
14	ODISHA	114.5	642	178.3
15	PUNJAB	61.3	1318	46.5
16	RAJASTHAN	5710.6	1181	4834.8
17	TAMIL NADU	919.1	2230	412.2
18	TELUNGANA	496	1105	449
19	UTTAR PRADESH	863.5	668	1292
20	UTTARAKHAND	36	1091	33
21	WEST BENGAL	937.4	1181	793

To strengthen any study the calculationof basic descriptive statistics is essential. Here the author carried out the Descriptive analysis and it is presented below:

Table 2:Descriptive statistics

MEAN	1197.014286	1004.904762	1235.9615
MAXIMUM	6243.5	2230	7336
MINIMUM	0.6	501	0.5
STANDARD DEVIATION	1857.985584	431.3091588	1937.7708
N	21	21	21

Here the Mean, Standard deviation, Maximum and Minimum value have been found out for those 21 DMU'S. The average value for the 21 DMU'S for the output 1 is 1197.014286, output 2 is 1004.904762 and for the input the average value is 1235.9615. The standard deviation for the output 1 is 1857.985584, 431.3091588 for the output 2 and 1937.7708 for the input.

The maximum value for the production (output 1) is 6243.5,for the yield(output 2) is 2230 and for the Area(input is 7336. The minimum value among the output 1 is 0.6 , the output 2 is 501 and for the input 1 is 0.5.

Table 3: CCR Efficiency Scores

DMU'S	Φ	STATUS
1	2.3364	Inefficient
2	3.6900	Inefficient
3	2.0661	Inefficient
4	4.444	Inefficient
5	1.3908	Inefficient
6	1.3870	Inefficient
7	2.924	Inefficient
8	3.2679	Inefficient
9	3.2679	Inefficient
10	3.4246	Inefficient
11	1	Efficient
12	2.6178	Inefficient
13	3.9370	Inefficient
14	3.4722	Inefficient
15	1.6778	Inefficient
16	1.8868	Inefficient
17	1	Efficient
18	2.020	Inefficient
19	3.3333	Inefficient
20	2.0202	Inefficient
21	1.8867	Inefficient

In this the states Andhra Pradesh, Assam, Bihar, Chattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, MadhyaPradesh, Maharashtra, Odisha, Punjab, Rajasthan, Telungana, Uttar Pradesh, Uttarkhand, and West Bengal are Inefficient states.

These DMU's could attain its efficiency through slack and Radial movement i.e., these states could not give maximum output for the given level of input.

The following table provides reference set (peers) to the inefficient DMU. The inefficient DMU could improve its efficiency through their peers.

Table 4: Peer weights (CRS)

DMU's	PEER WEIGHT'S
1	$\lambda_{17} = 2.22$
2	$\lambda_{11} = 0.49, \lambda_{17} = 0.74$
3	$\lambda_{11} = 1.35, \lambda_{17} = 0.74$
4	$\lambda_{11} = 0.52, \lambda_{17} = 0.72$
6	$\lambda_{17} = 1.28$
7	$\lambda_{11} = 1.79, \lambda_{17} = 0.03$
8	$\lambda_{11} = 1.61, \lambda_{17} = 0.14$
9	$\lambda_{11} = 0.70, \lambda_{17} = 0.63$
10	$\lambda_{17} = 3.23$
12	$\lambda_{17} = 17.80$
13	$\lambda_{17} = 10.17$
14	$\lambda_{11} = 1.08, \lambda_{17} = 0.43$
18	$\lambda_{17} = 1.09$
19	$\lambda_{17} = 3.13$
20	$\lambda_{11} = 1.73, \lambda_{17} = 0.08$
21	$\lambda_{17} = 1.92$

Here for the states Andhra Pradesh, Assam, Bihar, Chattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Telungana, Uttar Pradesh, Uttarkhand, West Bengal Peer weights are given. For example, the inefficient DMU Uttarkhand could improve its efficiency by comparing its input and output with DMU 11 and DMU 17 i.e.,Kerala and Tamil Nadu.

Ranking of efficient DMUs based on peer count summary is presented in the following table.

Table 5: Ranking of DMUs

DMU's	PEER COUNT	RANK
11	9	2
17	18	1

- Here Tamilnadu is in first Rank and Kerala is in Second position.

BCC output oriented model provides the following results and it is presented in Table 6.

Table 6: BCC Efficiency Scores

DMU'S	Φ	STATUS
1	1.9048	Inefficient
2	3.2468	Inefficient
3	1.3928	Inefficient
4	3.8911	Inefficient
5	1	Efficient
6	1.2853	Inefficient
7	1.6393	Inefficient
8	1.9960	Inefficient
9	2.7173	Inefficient
10	2.6315	Inefficient
11	1	Efficient
12	1	efficient
13	2.2123	Inefficient
14	2.5641	Inefficient
15	1	efficient
16	1	efficient
17	1	efficient
18	1.9646	Inefficient
19	2.5773	Inefficient
20	1.1695	Inefficient
21	1.5822	Inefficient

Here the states Andhra Pradesh, Assam, Bihar, Chattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Maharashtra, Odisha, Telungana, UttarPradesh, Uttarkhand, West Bengal are Inefficient DMU's these States could not give maximum output for the given level of input. i.e., in CCR only 2 states are efficient and in BCC 6 states are efficient DMUs. This is due to the fact that BCC model has convexity constraint which admits Variable Returns to Scale assumption.

Peer weights for Variable Returns to Scale is given below in Table 7.

Table 7: Peers weights of VRS

DMU's	PEER WEIGHTS(INEFFICIENCY)
1	$\lambda_5 = 0.234, \lambda_{17} = 0.76$
2	$\lambda_{17} = 0.710, \lambda_{15} = 0.290$
3	$\lambda_{17} = 0.199, \lambda_{15} = 0.801$
4	$\lambda_{17} = 0.690, \lambda_{15} = 0.310$
6	$\lambda_5 = 0.054, \lambda_{17} = 0.946$
7	$\lambda_{15} = 0.243, \lambda_{11} = 0.757$
8	$\lambda_{17} = 0.036, \lambda_{15} = 0.964$
9	$\lambda_{17} = 0.583, \lambda_{15} = 0.417$
10	$\lambda_5 = 0.428, \lambda_{17} = 0.572$
13	$\lambda_{16} = 0.718, \lambda_5 = 0.282$
14	$\lambda_{17} = 0.360, \lambda_{15} = 0.640,$
18	$\lambda_5 = 0.017, \lambda_{17} = 0.983$
19	$\lambda_5 = 0.410, \lambda_{17} = 0.590$
20	$\lambda_{15} = 0.707, \lambda_{11} = 0.293$
21	$\lambda_{17} = 0.823, \lambda_5 = 0.177$

For example the inefficient DMU Andhra Pradesh could improve its efficiencyby comparing its output with Gujarat and Tamil Nadu.

Ranking of efficient DMUs based on peer count summary is presented in the following table:

Table 8: Ranking of DMUs

DMU's	PEER COUNT	RANK
5	7	3
11	2	4
12	Weakly efficient	-
15	8	2
16	1	5
17	12	1

Here also Tamil Nadu is in First Rank, Punjab is in Second Position,Gujarat is in third Place, Kerala Fourth and Rajasthan is in fifth position. Here Madhya Pradesh is weakly efficient which doesn't includes any lambda values.

Projection analysis for some DMUs has been given below

Results for firm: 1

Technical efficiency = 0.525
Scale efficiency = 0.816 (drs)

Projection summary

variable	original value	radial movement	slack movement	projected value
output1	873.000	790.173	0.000	1663.173
output2	955.000	864.393	264.022	2083.416
input 1	914.000	0.000	0.000	914.000

Listing of peers:

peer	lambda weight
5	0.234
17	0.766

Results for firm: 2

Technical efficiency = 0.308

Scale efficiency = 0.881 (drs)

Projection summary

variable	Original Value	Radial Movement	slack movement	projected value
output1	185.000	415.915	69.079	669.993
output2	605.000	1360.153	0.000	1965.153
input 1	306.000	0.000	0.000	306.000

Listing of peers

Peer	lambda weight
17	0.710
15	0.290

VII CONCLUSION

The widely used tool for measuring and analyzing efficiency is DEA. The selection of input variable here is Area and Output variables are yield and production. In CRS model two states Kerala and Tamil Nadu are efficient.In VRS model Six states are efficient i.e., Gujarat, Kerala, Madhya Pradesh, Punjab, Rajasthan and Tamil Nadu, under output oriented DEA-CCR ,BCC,CRS and VRS methods. Thus it can be concluded that there is some difference in efficiency identification of DMU's in output oriented DEA models. For each DMUs Peer weights and Rank values are found out separately for CRS and VRS models. Finally, we suggest that necessary steps should be taken to improve or strengthen the production and yield of oilseeds in India in upcoming years.

REFERENCES

1. Azadeh, A., Ghaderi, S.F., Mirjalili, M. and Moghaddam, M. 'Integration ofanalytichierarchy process and data envelopment analysis for assessment and optimization of personnel productivity in a large industrial bank', Expert Systems with Applications, 2011; 38(5): 5212–5225.
2. Banker RD, Charnes A, Cooper WW Some models for estimating technical and Scale efficiencies in data envelopment analysis. ManagSci1984; 30:1078–1092
3. A. Charnes, W.W. Cooper and E. Rhodes, "Short Communication; Measuring the Efficiency of Decision Making Units," *European Journal of Operational Research*1979; 3: 339.
4. A. Charnes, W.W. Cooper and E. Rhodes "Evaluating Program and Managerial Efficiency: An Application of Data Envelopment Analysis to Program Follow Through," *Management Science* 1981; 27: 668-697.
5. A. Charnes and W.W. Cooper, "Preface to Topics in Data Envelopment Analysis," *Annals of Operations Research* 1985; 2: 59-94.
6. A. Charnes, W.W. Cooper, E. Rhodes, Measuring the efficiency of DMUs, European Journal of Operational Research 1978; 2: 429–444.
7. Charnes A, CooperWW, Golany B, Seiford L, Stutz J Foundations of data envelopment analysis for Pareto-Koopmans efficient empirical production functions, Econom1985; 30:91–107
8. Cooper WW, Park KS, Pastor JT RAM: a range adjusted measure of inefficient for use with additive models, and relations to other models and measures in DEA. J product Anal 1999; 11:5–24
9. Färe R, Lovell CAK Measuring the technical efficiency of production. J Econ Theory 1978; 19:150–162
10. Dhungana R.B., NuthaliP.L.Nartea G.V.,'Meaauring the Economic inefficiency of Nepalese Rice farms.Using Data Envelopment Analysis. The Australian Journal of Agriculture and Resource Economics 2004; 48(2):347-69.
11. Etich, E., Bett, E., Nyamwaro, S., Kizito, K. 'Analysis of Technical Efficiency of Sorghum Production in Lower Eastern Kenya: A Data Envelopment Analysis (DEA) Approach', Jornal of Economics and Sustainable Development 2014;5(4): 58-65.

12. Y.C.Lin et al, Assessing the environmental impacts of high-altitude agriculture in Taiwan: A driver-pressure state-impact-response framework and spatial emergy synthesis Ecological Indicators, 2013; 32: 42-50.