International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 21, 2020, pp.-10354-10356.
Available online at https://bioinfopublication.org/pages/jouarchive.php?id=BPJ0000217

Research Article

ANALYSIS OF TECHNICAL EFFICIENCY OF MAIZE PRODUCTION IN GUNTUR DISTRICT OF ANDHRA PRADESH-A DATA ENVELOPMENT ANALYSIS

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Received: November 01, 2020; Revised: November 11, 2020; Accepted: November 12, 2020; Published: November 15, 2020

Abstract: Maize is globally a top-ranking cereal not only in productivity but also as human food, animal feed and as a source of large number of industrial products. Despite enormous importance of maize crop, maize farmers to be helped to increase productivity, the focus should not only be on whether or not they have adopted productivity enhancing technologies, but it is necessary to carefully examine whether they are even making maximum use of the technologies on inputs available to them. The present study aimed to measure the level of technical efficiency and yield loss due to inefficiency levels of maize producers' in Guntur District of Andhra Pradesh. The results indicated that the minimum, maximum and average yields of maize production in the sample households were 1950, 10125 and 5159 kg/ha, respectively. The Data Envelopment Analysis was employed to analyze efficiency in maize production. The mean technical efficiency (TE) was found to be 64%, and about 3250.56 kg of maize output per hectare was lost due to inefficiency factors implying there is a room for improvement in technical efficiency by36% with the present technology. The study concluded that there is considerable difference in the efficiency level among plots. Hence suggested that if inputs are used to their maximum potential, there will be considerable gain from improvement in technical efficiency.

Keywords: *Data Envelopment Analysis, Technical efficiency, Non-parametric method, Yield gap*

Citation: S.R.P. Kambhampaty, *et al*., (2020) Analysis of Technical Efficiency of Maize Production in Guntur district of Andhra Pradesh-A Data Envelopment Analysis. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 21, pp.- 10354-10356.

Academic Editor / Reviewer: Santhosh D B, Dr Vijay Prajapati, Dr R. S. Umakanth

Introduction

Maize is one of the major cereal crops in the world after wheat and rice. The importance of maize lies in its wide industrial uses besides serving as human food and animal feed and fodder. In India 55 percent of grain produce concurrently is used for food purposes, about 14 percent for livestock feed, 18 percent for poultry feed, 12 percent for starch and 1 percent for seed. Maize is grown all through the year due to its photo-thermo insensitive character and highest yield potential among the cereals. It has great potential to increase the productivity, profitability, stability and sustainability and is currently being produced in many of the countries of the world. In India maize used to be a subsistence crop for the farmers few years ago but with the rising allocation of wheat and rice at affordable prices in the public distribution system at the central as well as the state level, farmers have moved away from maize consumption and it has led to a rise in its marketable surplus. Maize is mostly grown by small and marginal farmers. Hence, improved price discovery and better realization of crops become key in giving a push to maize production in India [1]. India is the sixth largest producer of maize in the world contributing 2.29% in total maize production of the world. In the midst of different maize producing states, Andhra Pradesh has occupied the fourth place in area in the year 2016-17. In the same year the gross maize cultivated area was 2.5 lakh ha with a production of 16.53 lakh tones. Guntur occupied first in productivity with 7565 kg/ha, second place in production (290000 tonnes) and fourth place in area in maize cultivation (35000 ha) in A.P. The present study aimed to analyze the technical efficiency of maize producers in Guntur district of Andhra Pradesh.

Materials and Methods

The study was conducted in Guntur District of Andhra Pradesh State, purposively selected based on its potential maize production. Sample respondents were selected based on multistage stage sampling procedure. Primary data was obtained through interview method with 60 maize producers using a well-structured interview schedule to obtain the data pertaining to farm production, input usage and other variables including socio economic and institutional factors during the agricultural year 2017-18.

Resource use efficiency can be defined as the ability to derive maximum output per unit of resource, the key to address effectively the challenges of realizing food security. The DEA approach was used to analyze the data for optimizing the measure of performance of each production unit and to determine the most preferable ones. The information obtained included the amount of input costs incurred during crop production such as human labour, fertilizer, seed, machine labour *etc.* and the yield as an output [2].

The DEA technique adopted by [3] was adopted in the present study. If there are K inputs and M outputs on each of the N firms or Decision-making units (DMUs), then $K \times N$ input matrix, X, and $M \times N$ output matrix, Y, represent the data pertaining to all N DMUs. For the i^{th} DMU, inputs and outputs were represented in terms of X_i and Y_i vectors, respectively. Then for the i^{th} DMU, first a ratio measure $\mu' Y_i / v' X_i$ was obtained where μ and v are output and input weights, respectively. The optimal weights are given by the following mathematical programming problem.

Max $_{\mu,v} (\mu' Y_i / v' X_i)$

subject to

$(\mu' Y_j / v' X_j) \leq 1 \qquad j = 1,2,.......,N$
$\mu, v \geq 0$
Imposing the constraint $v'X_i = 1$ to avoid an infinite number of solutions to the above-mentioned equation and considering the dual problem, the DEA model can be rewritten as:
Min $\theta, \lambda . \theta$
subject to
$- y_i + Y\lambda \geq 0,$
$\theta x_i - X\lambda \geq 0,$
$\lambda \geq 0$
Where, θ is a scalar and λ is a $N \times I$ vector of optimal weights attached to each of the efficient DMUs. θ represents Technical Efficiency (TE) score of the i^{th} DMU. The criterion used by [4] and [5] was used in the present study to decide the cut-off score for efficient farmers. Farmers that operated at 0.90 or more score were considered as 'efficient farmers'. The ratio of cost of economically efficient inputs to actual cost yields a measure of economic efficiency, and the ratio of economic efficiency to technical efficiency provides a measure of allocative efficiency. The efficiency score obtained from the above model corresponds to Constant Returns to Scale (CRS) [6].

Yield gap due to technical inefficiency
Yield gap is estimated using the formula given below

$$TE_i = \frac{Y_i}{Y_i^*} = \frac{f(X_i;\beta)\exp(v_i - \mu_i)}{f(X_i;\beta)\ \exp(v_i)} = \exp(-\mu_i)$$

Then, solving for Y_i^*, the potential yield of each household is represented as

$$Y_i^* = (Y_i)/(TE_i) = (f(X_i;\beta)\ \exp(v_i))$$

Where, TE_i is the technical efficiency of the i^{th} sample household in Maize production; Y_i^* is the potential output of the i^{th} sample household in maize production, and Y_i is the actual/observed output of the i^{th} sample household in maize production [7, 8].

Results and Discussion
Estimation of technical efficiency
Frequency distribution of technical efficiency of Maize producers of Guntur district of Andhra Pradesh is presented in [Table-1]. The results of efficiency analysis revealed that technical efficiency of the maize producers varied from a minimum of 22% to a maximum of100% with a mean of 64% [9, 10]. In other words, on average maize producer households in the study area incurred a 36% loss in output due to technical inefficiency. This implies that on average output can be increased by at least 36% while utilizing existing resources and technology, if inefficiency factors are fully addressed or more precisely, on the average, output can be expanded by as much as36% if appropriate measures are taken to improve technical efficiency [11]. This result suggested that a few households were not utilizing their production resources efficiently, indicating that they were not obtaining maximum output from their given quantity of inputs [12].
Another implication of this result is that if the average farmer in the sample were to achieve the technical efficiency (TE) level of the most efficient counterpart, then the average farmer could realize a36% cost savings [*i.e.*, (1-(64/100)) $*$ 100] in terms of total production costs and maximizing their maize productivity. Thus, sample households could on average, reduce production cost by36% by reducing input applications to the technically efficient input mix. A similar calculation for the most technically inefficient household reveals a cost saving of 78% [*i.e.*, (1 − (22/100)) $*$ 100]. Therefore, in short run, it is possible to reduce production cost in maize production in the study area by an average of 78% by adopting the technology and techniques used by the best performers. Improved efficiency would reduce production costs and increase the gross margin of maize production and enhance profitability [13, 14].
To give a better indication of the distribution of the technical efficiencies, a frequency distribution of the predicted technical efficiencies is presented in [Fig-1]. The frequencies of occurrences of the predicted technical efficiencies in range indicate that the highest number of household have technical efficiencies between 0.20 and 0.36. The sample frequency distribution indicates a clustering of technical efficiencies in the region 0.20- 0.36 efficiency ranges, representing 30% of the respondents [15]. The findings also revealed that 16 farms, this emitted that about 26.67% of the farms fall under the category of relatively efficient farmers (technical efficiency above 88%) with the assumption of constant return to scale.

Table-1 *Frequency distribution of technical efficiency of Maize producers*

TE Level	Frequency	Percentage
0.20-0.36	7	11.67
0.37-0.53	18	30.00
0.54-0.70	12	20.00
0.71-0.87	7	11.67
0.88-1.00	16	26.67
Total	60	100.00
Mean	0.64	
Minimum	0.22	
Maximum	1	

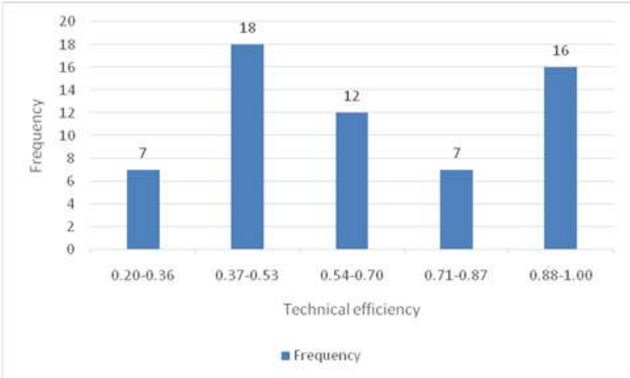

Fig-1 Frequency distribution of technical efficiency

Yield gap due to technical inefficiency
Yield gap due to technical inefficiency of maize producers are presented in [Table-2]. It was observed from the [Table-2] that mean technical inefficiency was 36% which caused 3250.56 kg/ ha yield gap of maize on the average with mean value of the actual output and the potential output of 5159.85 kg/ha and 8410.41 kg/ha, respectively. This showed that sample households in study area were producing on the average 3250.56 kg/ha lower maize output than their potential yield. [Fig-2] illustrated that under the existing practices there is a room to increase maize yield following the best-practiced farms in the study area.

Table-2 *Maize yield gap due to technical inefficiency*

Variable	Mean	Min	Max
Actual yield (kg/ha)	5159.85	1950	10125
TE estimates	0.64	0.22	1.0
Potential yield (kg/ha)	8410.41	3000	11503
Yield gap/loss (kg/ha)	3250.56	1050	1378

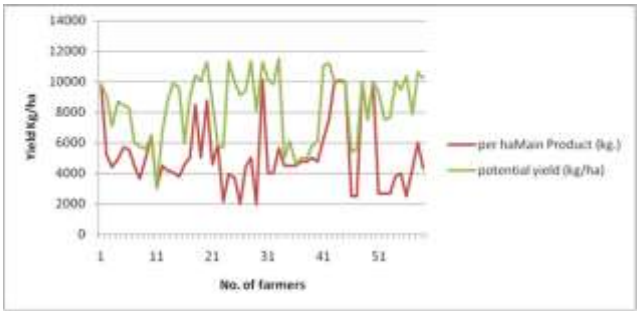

Fig-2 Comparison of the actual and the potential level of yield

Conclusion
The econometric analysis conducted to assess the productivity of maize and its determinants indicated that the productivity of maize was significantly determined by a number of factors in addition to the use of variable inputs such as labor, fertilizer and machine power. There is considerable difference in the efficiency level among plots. Hence if inputs are used to their maximum potential, there will be considerable gain from improvement in technical efficiency.

Application of research: Data Envelopment Analysis helps in cost minimization and profit maximization and also optimum utilization of resources with the technology available at the standpoint of the farmers

Research Category: Agricultural Economics

Abbreviations: DEA-Data Envelopment Analysis, TE-Technical Efficiency

Acknowledgement / Funding: Authors are thankful to Cost of Cultivation Scheme, Agricultural College, Bapatla, 522 101, Acharya N.G. Ranga Agricultural University, Lam, Guntur, 522 034, India. Authors are also thankful to Cost of Cultivation Scheme, Regional Agricultural Research Station, Palem, 509215, Professor Jayashankar Telangana State Agricultural University, Hyderabad, 500030, Telangana, India

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Research project name or number: Research station study

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Guntur district of Andhra Pradesh

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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