Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; Sp9(2): 375-378
Received: 16-01-2020
Accepted: 17-02-2020

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An analysis of farm efficiency of KVK adopted and non-adopted farmers in Janjgir district of Chhattisgarh

Sneha Pandey, Mamta Patel and Vinit Jaiswal

Abstract
In this study, an attempt was made to measure the technical, allocative and economic efficiency of agricultural production in district Janjgir of Chhattisgarh. At the same time an attempt was also made to identify the various socio economic and ecological factors determining the Technical Efficiency levels in district. For the research From Janjgir Krishi vigyan Kendra a list of 45 adopted farmers were obtained and equal numbers of non-adopted farmers were selected by proportionate random sampling method. The study was based on primary data collected from various sample respondents. Primary data were collected by using pretested interview schedule and personal interview of selected respondents by survey method. The required secondary data collected from annual report and other publication of Krishi Vigyan Kendra. The analysis of data was done using different analytical tools, keeping in view objective of the study Income measures and Technical efficiency, Economic Efficiency, Scale Efficiency and Allocative Efficiency.

Keywords: KVK, Chhattisgarh, farmers

Introduction
In this study, an attempt was made to measure the technical, allocative and economic efficiency of agricultural production in district Janjgir of Chhattisgarh. At the same time an attempt was also made to identify the various socio economic and ecological factors determining the Technical Efficiency levels in district. Such information was useful to identify the district with low efficiency and suggest measures to improve the efficiency of district.
The study used DEA approach. Data envelopment analysis (DEA) is a nonparametric method in operations research and economics for the estimation of production frontiers It is used to empirically measure productive efficiency of decision making units (DMUs). Although DEA has a strong link to production theory in economics, the tool is also used for benchmarking in operations management, where a set of measures is selected to benchmark the performance of manufacturing and service operations. In benchmarking, the efficient DMUs, as defined by DEA, May not necessarily form a "production frontier", but rather lead to a "best-practice frontier" (Cook *et al*. 2014).

Significance of the Study
Most of the researchers used to measure efficiency differentials among farms with simple measures, such as yield per hectare and cost per unit of output, which are easy to calculate and understand, but tell us very little about the reasons for any observed differences among farms. Yield-per-hectare figures are of little use when the amounts of non-land inputs used (such as labour and fertilizer) differ among farms. Cost per unit of output generally addresses the problems with yield comparisons, but they can also be quite misleading measures of performance when input prices differ across geographical regions. Furthermore, simple cost comparisons do not tell us what portion of the cost difference is due to inefficient use of the given input bundle (technical inefficiency) and what part is due to the incorrect choice of input ratios, given the input prices faced by the farmer (allocative inefficiency). In addition, neither yield nor unit cost measures tell us anything about the existence, or otherwise, of scale economies. So, in this study, an attempt was made to avoid the problems inherent in these simple measures were taken by constructing non-parametric production frontiers using data envelopment analysis (DEA) and then used them to produce a range of efficiency measures. Here four different measures: technical efficiency, allocative efficiency, economic efficiency and scale efficiency.

Objective of the study

To work out the technical, allocative, economic, and scale efficiency of the adopted and non-adopted farmers

Methodology

T-Test: Two sample Assuming Unequal Variance

Technical Efficiency

The technical efficiency was examined by Data Envelopment Analysis (DEA) using R software. Farrell identified three types of efficiency, technical efficiency, allocative efficiency (referred to by Farrell as "price efficiency"), and economic efficiency (referred to by Farrell as "overall efficiency"). Technical efficiency (TE) refers to the ability of a DMU to produce the maximum feasible output from a given bundle of inputs, or the minimum feasible amounts of inputs to produce a given level of output.

The former definition is referred to as output-oriented TE, while the latter definition is referred to as input-oriented TE. Allocative efficiency (AE) refers to the ability of a technically efficient DMU to use inputs in proportions that minimize production costs given input prices. Allocative efficiency is calculated as the ratio of the minimum costs required by the DMU to produce a given level of outputs and the actual costs of the DMU adjusted for TE. Economic efficiency (EE) is the product of both TE and AE (Farrell, 1957).

Thus, a DMU is economically efficient if it is both technically and Allocative efficient. Economic efficiency is calculated as the ratio of the minimum feasible costs and the actual observed costs for a DMU.

The technical efficiency score of the nth farm was found out using following DEA linear programming formulation:

$$TE_n = min_{\lambda,\theta_n}\, \theta_n$$

s. t.

$$\sum_{i}^{I} \lambda_i X_{ij} - \theta_n X_{nj} \leq 0$$

$$\sum_{i}^{I} \lambda_i Y_{ik} - Y_{nk} \geq 0$$

$$\sum_{i}^{I} \lambda_i = 1$$

$$\lambda_i \geq 0$$

Where subscript i, j and k are used for ith farm, jth input and kth output. The symbol X denotes input while Y denotes output λ_i is the non-negative weight associated with ith farm. When $\sum_i^I \lambda_i$ is set equal to one, then variable return to scale (VRS) prevails and when this constraint is omitted then constant returns to scale (CRS) prevails.

Scale Efficiency: It is computed as ratio of technical efficiency under VRS to CRS.

Economic efficiency: Economic efficiency was found out by cost minimizing linear programming formulation.

$$MC_n = min_{\lambda, X*_{nj}} \sum_{j=1}^{J} P_{nj} X*_{nj}$$

s. t.

$$\sum_{i}^{I} \lambda_i X_{ij} - \theta_n X*_{nj} \leq 0$$

$$\sum_{i}^{I} \lambda_i Y_{ik} - Y_{nk} \geq 0$$

$$\sum_{i}^{I} \lambda_i = 1$$

$$\lambda_i \geq 0$$

Where MC_n the minimum is cost for the nth farm and P_{nj} is the price of jth input for nth farm. Then economic efficiency would be calculated as following

$$EE_n = \frac{\sum_{j=1}^{J} P_{nj} X*_{nj}}{\sum_{j=1}^{J} P_{nj} X_{nj}}$$

Allocative Efficiency: Allocative efficiency was obtained by dividing the economic efficiency of the sample farm by the corresponding technical efficiency.

Result and Discussion

Efficiencies range of adopted and non-adopted farmers

Technical Efficiency (vrs)

The data presented in this table (4.11) showed that the technical efficiency (vrs) had maximum (7) number of adopted farmers in the range of (0.91≤E<1.00) and minimum (1) number in the range of (0.21≤E<0.30). The technical efficiency (vrs) had maximum (11) number of non-adopted farmers in the range of (0.31≤E<0.40) and minimum (6) number in the range of (0.71≤E<0.80).

Technical Efficiency (crs)

The data presented in this table (4.11) showed that the technical efficiency (crs) had maximum (9) number of adopted farmers in the range of (0.41≤E<0.50) and minimum (1) number in the range of (0.21≤E<0.30). The technical efficiency (crs) had maximum (7) number of non-adopted farmers in the range of (0.91≤E<1.00) and minimum (1) number in the range of (0.81≤E<0.90).

Scale Efficiency

The scale efficiency had maximum (30) number of adopted farmers in the range of (0.91≤E<1.00) and minimum (1) number in the range of (0.21≤E<0.30). The scale efficiency had maximum (36) number of non-adopted farmers in the range of (0.91≤E<1.00) and minimum (9) number in the range of (1.00≤E<2.00).

Economic Efficiency

The data presented in this table (1) showed that the economic efficiency had maximum (20) number of adopted farmers in the range of (0.51≤E<0.60) and minimum (1) number in the range of (0.21≤E<0.30).The data presented in this table (1) showed that the economic efficiency had maximum (23) number of adopted farmers in the range of (0.61≤E<0.70) and minimum (2 and 2) number in the range of (0.41≤E<0.50) and (1.00≤E<2.00) respectively.

Allocative Efficiency

Here the allocative efficiency had maximum (17) number of adopted farmers in the range of (1.00≤E<2.00) and minimum (1, 1 and 1) number in the range of (0.21≤E<0.30), (0.41≤E<0.50) and (2.01≤E<3.00) respectively. The data presented in this table (1) showed that the allocative efficiency had maximum (11, 11) number of adopted farmers in the range of (0.81≤E<0.90) and (1.00≤E<2.00) respectively and minimum (1) number in the range of (0.21≤E<0.30).

Analysis of t-test of Adopted and Non-adopted Farmers Technical Efficiency (vrs)

The data present in this table (2) shows the result of t-test: two samples assuming unequal variance it observes that in case of technical efficiency (vrs) the t-test (0.326) is less than T-Critical two-tail (2.008). Mean and Variance are 0.56 and 0.47 for adopted farmers and 0.62 and 0.03 for non-adopted farmers respectively and degree of freedom is 50.

Technical Efficiency (crs)

In case of technical efficiency (crs) the t-test (1.534) is less than T- Critical two-tail (1.987). Mean and Variance are 0.52 and 0.03 for adopted farmers and 0.58 and 0.03 for non-adopted farmers respectively and degree of freedom is 88.

Scale Efficiency

In case of scale efficiency, the t-test (2.501) is more than T-Critical two-tail (2.014). Mean and Variance are 1.15 and 0.11 for adopted farmers and 1.02 and 0.001 for non-adopted farmers respectively and degree of freedom is 45.

Economic Efficiency

In case of economic efficiency, the t-test (2.287) is more than T- Critical two-tail (2.014). Mean and Variance are 0.63 and 0.04 for adopted farmers and 0.54 and 0.016 for non-adopted farmers respectively and degree of freedom is 73.

Allocative Efficiency

In case of allocative efficiency, the t-test (0.502) is less than T- Critical two-tail (1.98). Mean and Variance are 0.99 and 0.14 for adopted farmers and 0.95 and 0.10 for non-adopted farmers respectively and degree of freedom is 85.

The findings find support with the work of Rahman (2003) [13], Anang *et al.* (2016) [5] and Zongli *et al.* (2017) [17].

Table 1: Efficiency range of adopted and non-adopted farmers.

Efficiency Range	VRS		CRS		SE		EE		AE	
	Adopted	Non-Adopted	Adopted	Non-Adopted	Adopted	Non-Adopted	Adopted	Non-Adopted	Adopted	Non-Adopted
0≤E<0.10	-	-	-	-	-	-	-	-	-	-
0.11≤E<0.20	2	-	2	-	-	-	-	-	-	-
0.21≤E<0.30	1	-	4	-	-	-	-	-	1	-
0.31≤E<0.40	6	11	6	6	-	-	2	3	-	-
0.41≤E<0.50	8	7	9	10	-	-	9	1	1	-
0.51≤E<0.60	5	10	8	9	-	-	20	6	2	4
0.61≤E<0.70	6	9	7	9	-	-	4	23	5	3
0.71≤E<0.80	5	6	5	7	-	-	-	-	7	5
0.81≤E<0.90	2	-	4	1	-	-	-	8	4	11
0.91≤E<1.00	7	-	-	3	30	36	10	3	7	10
1.00≤E<2.00	3	-	-	-	14	9	-	1	17	11
2.01≤E<3.00	-	-	-	-	1	-	-	-	1	1

Table 2: Analysis of t-test of adopted and non-adopted farmers

Particular	Technical Efficiency (VRS)		Technical Efficiency (CRS)		Scale Efficiency		Economic efficiency		Allocative Efficiency	
	Adopted	Non-Adopted	Adopted	Non-Adopted	Adopted	Non-Adopted	Adopted	Non-Adopted	Adopted	Non-Adopted
Mean	0.56	0.62	0.52	0.58	1.15	1.02	0.630	0.540	0.994	0.957
Variance	0.477	0.033	0.033	0.030	0.119	0.001	0.045	0.016	0.146	0.101
Observation	45	45	45	45	45	45	45	45	45	45
Hypothesis	0		0		0		0		0	
Df	50		88		45		73		85	
t stat	0.326		-1.534		2.501		2.287		0.502	
P(T≤ t) one-tail	0.372		0.064		0.008		0.012		0.308	
T Critical one-tail	1.675		1.662		1.679		1.665		1.662	
P(T≤t) two-tail	0.745		0.128		0.016		0.025		0.616	
T Critical two-tail	2.008		1.987		2.014		1.992		1.988	

Competitively Analysis of Technical, Scale, Economic and Allocative Efficiency

The Analysis of technical, scale, economic and allocative efficiency of adopted and non-adopted farmers is presented Table 3.

Technical Efficiency (vrs) and (crs)

The Technical efficiency (vrs) on an average was 0.56 for adopted farmer and 0.62 for non-adopted farmers the difference between mean efficiency technical (vrs) for adopted and non-adopted farmers was not significant at 5 percent level of significance. The same in the case of technical efficiency (crs) where non-adopted farmer at higher mean efficiency level compare to adopted farmer but the difference was not significantly different from zero. the findings were supported with the work of Dhungana *et al.* (2004) [10], Akinbode *et al.* (2011) [3], Ajao *et al.* (2012) [2] and Ahmed *et al.* (2015) [1]

Scale Efficiency

The scale efficiency indicate that both adopted and non-adopted farmers are under increasing returns to scale they are scale efficient meaning that they are still increase the area under cultivation and the difference between adopted and non-adopted farmer scale efficiency is significantly different from 0 and 5 percent level of significance.

Economic Efficiency
The Mean economic efficiency is significantly higher for adopted farmers (0.63) compare to non-adopted farmers (0.54) meaning that they are better in cultivating crops and distributing budget among various inputs compare to non-adopted farmers.

Allocative Efficiency
The allocative efficiency average scope for adopted farmers is 0.99 compare to 0.95 for non-adopted farmers, however the difference between the two allocative score is not significant meaning that both farmers have equal allocative efficiency.

Table 3: Competitively analysis of technical, scale, economic and allocative efficiency

Particulars	Adopted farmers	Non-adopted farmers	Significance of difference
Technical Efficiency (vrs.)	0.56	0.62	Non-Significant
Technical Efficiency (crs.)	0.52	0.58	Non-Significant
Scale Efficiency	1.15	1.02	Significant
Economic Efficiency	0.63	0.54	Significant
Allocative Efficiency	0.99	0.95	Non-Significant

(Significance of difference at five percent level of significance)

Conclusion
In case of Technical Efficiency (VRS), Technical Efficiency (CRS) and Allocative Efficiency there was no significant difference between adopted and non-adopted farmers on the other side in case of Scale Efficiency and Economic Efficiency there was significant difference adopted and non-adopted farmers. In case of Economic Efficiency independent variable caste ST and fertilizers quantity were significant. In case of Allocative Efficiency independent variable family size was positively significant. In case of Scale Efficiency independent variable variety type swarna, land holding medium, land holding small, age, nonfarm income 1 and 2 were significant. Technical Efficiency independent variable adoption status yes and land holding small were significant.

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