International Research Journal of Agricultural Economics and Statistics
Volume 3 | Issue 1 | March, 2012 | 128-132

Research Paper

Measurement of economic and allocative efficiency of soybean growers- A data envelopment analysis approach

■ B.G. NAIR, G. B. MALTHANE AND A.S. DESHMUKH

See end of the paper for authors' affiliations

Correspondence to :
B.G. NAIR,
Department of Agricultural Economics, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

Paper History :
Received : *03.11.2011;*
Revised : *18.12.2011;*
Accepted : *02.02.2012*

ABSTRACT : The study was undertaken for the economic and allocative efficiency at farm level in respect of soybean crop by selecting farmers growing soybean in Amravati district. They were grouped in three. Group I for small farmers, Group II for medium farmers and Group III for large farmers. The primary data were collected by survey method and the analysis was done by using Data Envelopment Analysis computer programme. The analysis revealed that the mean allocative efficiency for small farmers, medium farmers and large farmers was found to be 0.0, 69.09 and 61.4 per cent, respectively.The mean economic efficiency for small farmers, medium farmers and large farmers was found to be 0, 66.0 and 35.5 per cent, respectively.

KEY WORDS : Allocative and economic efficiency of farmer, Economic efficiency of soybean growers, allocative efficiency of soybean growers, Technical efficiency, Cost efficiency

HOW TO CITE THIS PAPER : Nair, B.G., Malthane, G.B. and Deshmukh, A.S. (2012). Measurement of economic and allocative efficiency of soybean growers- A data envelopment analysis approach, *Internat. Res. J. agric. Eco. & Stat.,* **3** (1) : 128-132.

INTRODUCTION

Agriculture is basically characterized by wide variation in topography, climate, input use, production and productivity. Production is seasonal and still dependent on the vagaries of nature. The rapid and continuous increase in population exerts pressure on demand for agricultural commodities, which can be met only by adequate supply of agriculture output. Average income of Indian population is estimated to go up to Rs. 20,813 from Rs. 19,649 a year back. Despite of many advances in technology, the potential productivity is not yet realized. Technological progress and technical efficiency improvement are the two key sources of long-term agriculture growth and hence more attention should be paid to promote then through investing in research and development and extension services (Kalirajan and Shand, 1994). In this direction a positive agricultural production policy plays an important role, thus there is need for a sound empirical knowledge about the growth in inputs, outputs and productivity

The area under soybean in Vidarbha as well as India is continuously increasing and its dual utility as a pulse and oilseed. Soybean is called as 'poor mans meal' due to its high nutritive value.

The parametric approach assumes a functional relationship between output and input and uses statistical techniques to estimate the parameters of the function. The non-parametric approach, in contrast, constructs linear piecewise function from empirical observations on input and output without assuming any apriori functional relationship between them. We used the non-parametric Data Envelopment Analysis (DEA) technique developed by Charnes *et al*. (1978) (CCR) and Bankers *et al*. (1984) (BCC) for the measurement of efficiency of soybean grower.

MATERIALS AND METHODS

The measurement of relative efficiency where there are multiple possibly incommensurate inputs and outputs was addressed by Farrell and developed by Farrell and (1957) focusing on the construction of a hypothetical efficient unit, as a weighted average of efficient units, act as a comparator for an inefficient unit.

Common measure for relative efficiency is :

$$\text{Efficiency} = \frac{\text{Weightedsumofoutputs}}{\text{Weightedsumofinputs}}$$

The efficiency of the soybean growers was measured by using the data envelopment analysis approach (DEA). DEA is a tool for measuring efficiency.

The variables of the above problem are the weights and the solution produces, the weights most favourable to unit go and also produce a measure of efficiency.

The algebraic model is as follows :

$$\text{Maximize : ho} = \frac{\sum_r u_r y_{r\,jo}}{\sum_i v_i x_{iio}}$$

Subject to,

$$\frac{\sum_r u_r y_{r\,j}}{\sum_i v_i x_{ij}} \leq 1 \text{foreachunitj}$$

$$u_r, v_i \geq \varepsilon$$

$$\varepsilon > 0$$

where,

u_r = The weight given to output r

y_{rj} = The amount of a output r from unit j

v_i = The weight given to input i

x_{ij} = the amount of input i from unit j

For the objective function, it is necessary to observe that in maximizing a fraction or ratio, it is the relative magnitude of the numerator and denominator that are of interest and not their individual values. It is thus possible to achieve the same effect by setting the denominator equal to a constant and maximize the numerator.

This version was introduced by Banker *et al.* (1984). model. BCC version is more flexible and allows variable return to scale. The resultant linear programme is as follows :

$$\text{Maximize : ho} = \sum_r u_r y_{rjo}$$

Subject to,

$$\sum_i v_i x_{ijo} = 1$$

$$\sum_r u_r y_{rj} - \sum_i v_i x_{ij} - u \leq o \quad j = 1,2,...n$$

$$u_r, v_i \geq \varepsilon$$

In this model uo indicates the return to scale possibilities.

An $u_o < 0$ implies local increasing returns to scale.

If $u_o = 0$ this implies local constant return to scale.

An $u_o > 0$ this implies local decreasing returns to scale.

Economic efficiency :

In order to derive overall economic efficiency (EE), the following cost minimizing DEA model under constant return to scale assumption was used (CRS) :

$$\text{MinMC}_j(y_j x^*_{ij} C_{ij}) = C_{ij} x^*_{ij}$$

Such that : $\sum y_i \lambda_j - y_j \geq 0;$

$$x^*_{ij} - \sum x_{ij} \lambda_j \geq 0;$$

$$\lambda_j \geq 0 \qquad \forall_j$$

where,

MCj (yi x* yj Cij) = Minimum total cost under CRS assumption.

λj = Weight to be used as multipliers for the input levels of the j^{th} form to indicate the input levels that the farm should aim at to achieve efficiency.

Economic efficiency is defined as the ratio of minimum two actual observed costs.

$$EEj(x_j, x_{ij}, C_{ij}) = \frac{[MC(y_j x_{ij} c_{ij})]}{(c_{ij} x_{ij})}$$

Economic efficiency is defined as the ratio of minimum two actual observed costs,

Allocative efficiency :

Allocative efficiency is defined as the ability of farm to equate marginal value product and marginal cost.

Allocative efficiency (AE) is computed by using Farrell (1957) decomposition relationship :

$$AEj(y_i, x_{ij}, c_{ij}) = \frac{[EE_j(x_j, x_{ij}, c_{ij})]}{[TE_j(y_j, x_{ij})]}$$

RESULTS AND DATA ANALYSIS

The results of the present study as well as relevant discussions have been presented under following sub heads:

Results of small farmers :

The results obtained from the analysis revealed that the technical, allocative and economic efficiency of small farmers was found to be zero that is these farmers were technically efficient.

Allocative and economic efficiencies of medium farmers :

The allocative efficiency was calculated by the ratio of economic efficiency to the technical efficiency. Table 1 shows the allocative and economic efficiencies of the medium farmers. From Table 1 it can be seen that only 4 farms were economically efficient. It can also be seen that the farms which were economically efficient also had allocative efficiency equal to 1. It can also be noted that only farm 49 was having allocative efficiency less than 50 per cent with the value of 0.413 *i.e.* 41 per cent. It can be noted that 3 farms were having economic efficiency less than 50 per cent with the lowest value of 0.413 *i.e.* 41.3 per cent for farm 49.

The mean technical efficiency, allocative efficiency and economic efficiency of the medium farmer was found to be 0.943, 0.699 and 0.660, respectively.

Table 1: Allocative and economic efficiencies of medium farmers

Firm	TE	AE	CE
1.	1.000	0.739	0.739
2.	0.723	0.678	0.490
3.	1.000	0.704	0.704
4.	1.000	0.647	0.647
5.	1.000	0.674	0.674
6.	1.000	0.642	0.642
7.	1.000	0.627	0.627
8.	0.930	0.555	0.517
9.	0.804	0.674	0.542
10.	1.000	1.000	1.000
11.	0.748	0.693	0.518
12.	0.950	0.698	0.663
13.	0.900	0.693	0.624
14.	0.911	0.686	0.626
15.	0.879	0.732	0.643
16.	1.000	0.596	0.596
17.	1.000	0.774	0.774
18.	0.905	0.701	0.634
19.	1.000	0.766	0.766
20.	0.991	0.840	0.832
21.	1.000	1.000	1.000
22.	0.907	0.920	0.835
23.	0.982	0.663	0.651
24.	1.000	0.680	0.680
25.	1.000	0.574	0.574
26.	1.000	0.593	0.593
27.	1.000	0.704	0.704
28.	1.000	0.628	0.628
29.	1.000	0.535	0.535
30.	0.642	0.650	0.417
31.	0.783	0.671	0.526
32.	1.000	0.583	0.583
33.	0.856	0.718	0.615
34.	1.000	0.647	0.647
35.	1.000	0.674	0.674
36.	1.000	0.642	0.642
37.	1.000	0.627	0.627
38.	0.930	0.555	0.517
39.	0.804	0.674	0.542
40.	1.000	1.000	1.000
41.	0.748	0.693	0.518
42.	0.950	0.698	0.663
43.	0.928	0.697	0.647
44.	1.000	0.682	0.682
45.	0.854	0.575	0.492
46.	1.000	0.852	0.852
47.	0.880	0.662	0.582
48.	1.000	1.000	1.000
49.	1.000	0.413	0.413
50.	0.879	0.628	0.551
51.	0.999	0.731	0.730
52.	1.000	0.704	0.704
53.	1.000	0.613	0.613
54.	1.000	0.647	0.647
55.	1.000	0.774	0.774
56.	0.907	0.920	0.835
Mean	0.943	0.699	0.660

Table 1 : Contd.....

Table 1 : Contd.....

Note : TE = Technical efficiency, CE = Cost efficiency, AE = Allocative efficiency = CE/TE.

Allocative efficiency and economic efficiency score of medium farmers :

Table1gives the detail frequency of the allocative and economic efficiency score of the farms of medium farmers.

It can be seen from Table 2 that no farm was having the allocative and economic efficiency between 0.000 - 0.300. 1 farm had AE and 3 farms had EE between 0.301-0.500, 35 farms had AE and 36 farms have EE between 0.501 - 0.700, whereas 12 farms had AE and 9 farms had EE between 0.701 - 0.900. It can be very clearly noted that out of the 56 farms, only 8 AE farms and EE farms each were in the highly allocatively and economically efficient zone of 0.901 - 1.000.

Table 2 : Allocative efficiency and economic efficiency score of medium farmers

Efficiency score	Allocatively efficient	Economically efficient
0.000 - 0.300	0	0
0.301 - 0.500	1	3
0.501 - 0.700	35	36
0.701 - 0.900	12	9
0.901 - 1.000	8	8
Total	56	56

Allocative and economic efficiencies of large farmers :

The allocative efficiency is calculated by the ratio of economic efficiency to the technical efficiency. Table 3 shows the allocative and economic efficiencies of the other farmers.

From Table 3 it can be seen that only 2 farms were economically efficient. It can also be seen that the farms which were economically efficient also had their allocative efficiency equal to 1. It can also be noted that only 15 farms were having allocation efficiency less than 50 per cent with the lowest value of 0.281 *i.e.* 28.1 per cent. About 60 farms were having economic efficiency less than 50 per cent with the lowest value of 0.112 *i.e.* 11.2 per cent for farm 58.

Table 3 : Allocative and economic efficiencies of large farmers

Firm	TE	AE	CE
1.	0.379	0.681	0.258
2.	0.415	0.567	0.235
3.	0.504	0.563	0.284
4.	0.575	0.499	0.287
5.	0.338	0.764	0.259
6.	0.388	0.752	0.291
7.	1.000	0.461	0.461
8..	1.000	0.281	0.281
9.	0.730	0.319	0.233
10.	0.373	0.986	0.368
11.	0.434	0.802	0.348
12.	0.400	0.611	0.244
13.	0.202	0.817	0.165
14.	1.000	1.000	1.000
15.	0.229	0.486	0.112
16.	1.000	0.708	0.708
17.	0.361	0.696	0.251
18.	0.591	0.658	0.388
19.	1.000	0.328	0.328
20.	0.604	0.568	0.343
21.	0.479	0.571	0.274
22.	0.380	0.858	0.326
23.	0.476	0.574	0.274
24.	1.000	0.311	0.311
25.	0.861	0.318	0.273
26.	0.812	0.327	0.265
27.	0.436	0.683	0.298
28.	0.960	0.389	0.374
29.	0.878	0.265	0.233
30.	0.857	0.000	0.000
31.	0.404	0.925	0.373
32.	0.894	0.302	0.270
33.	0.584	0.505	0.295
34.	0.644	0.699	0.451
35.	0.845	0.582	0.492
36.	0.606	0.669	0.405
37.	0.650	0.716	0.466
38.	0.513	0.687	0.353
39.	0.577	0.690	0.398
40.	1.000	0.337	0.337
41.	0.822	0.520	0.427
42.	0.477	0.808	0.386
43.	0.702	0.676	0.475
44.	0.447	0.831	0.372
45.	0.794	0.690	0.548
46.	0.765	0.775	0.593
47.	0.575	0.693	0.398
48.	0.637	0.768	0.489
49.	0.384	0.884	0.339
50.	0.431	0.769	0.331
51.	0.723	0.477	0.345
52.	0.567	0.555	0.315
53.	0.379	0.675	0.256
54.	0.388	0.752	0.291
55.	0.373	0.986	0.368
56.	1.000	1.000	1.000
57.	1.000	0.311	0.311
58.	0.229	0.486	0.112
59.	0.504	0.563	0.284
60.	0.476	0.574	0.274
61.	0.822	0.520	0.427
62.	0.434	0.802	0.348
Mean	0.618	0.614	0.355

Table 3 : Contd.....

Table 3 : Contd.....

Note : TE = Technical efficiency, AE = Allocative efficiency = CE/TE, CE = Cost efficiency

The mean technical efficiency, allocative efficiency and economic efficiency of the large farmers was found to be 0.618, 0.614 and 0.355, respectively.

Allocative efficiency and economic efficiency score of large farmers :

Table 4 gives the detail frequency of the allocative efficiency and economic efficiency score of the farms of large farmers.

Table 4 : Allocative efficiency and economic efficiency score of l large farmers

Efficiency score	Allocatively efficient	Economically efficient
0.000 - 0.300	2	25
0.301 - 0.500	14	30
0.501 - 0.700	24	2
0.701 - 0.900	12	0
0.901 - 1.000	10	5
Total	62	62

It can be seen from Table that 2 farm had allocative efficiency and 25 farms had the economic efficiency between 0.000 - 0.300. 14 farms were having AE and 30 farm had EE between 0.301 - 0.500. 24 farms were with AE and 2 farms were having EE between 0.501 - 0.700. 12 farms had AE and none had EE between 0.701 - 0.900. It can be very clearly noted that out of 62 farms, only 10 AE farms and 5 EE farms were in the highly allocatively and economically efficient zone of 0.901 - 1.000. Prasad (1975) and Vennesland (2005) have also made same contribution on economic efficiency of small scale farming in India and measuring fural economic development in norway, respectively.

Conclusion:

The mean allocative efficiency for small farmers, medium farmers and large farmers was found to be 0.000, 0.699 *i.e.* 69.9 per cent and 0.614 *i.e.* 61.4 per cent. It means that to become economically efficient, medium farmers and large farmers group are able to reduce the consumption of inputs by 5.7 and 26.4 per cent for medium and large farmers respectively.

Authors' affiliations:
G.B. MALTHANE, Department of Agricultural Economics, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

A.S. DESHMUKH, Department of Agricultural Extention, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

LITERATURE CITED

Farell, M.J. (1957). The measurement of productive efficiency. *J. Royal Statistical Soc*., **120** : 11-37.

Kaliranjan, K. P. and Shand, R. T. (1994). Modeling and measuring economic efficiency under risk. *Indian. J. Agric. Econ*., **49**(4) : 579-590.

Prasad,V. (1975). Economic efficiency of small scale farming of Farrukhabad dist. U. P. *Indian. J. Agri. Econ*., **30**(3): 238.

Vennesland, B. (2005). Measuring rural economic development in Norway using DEA. *Forest Policy & Econ*., **7**(1): 109-119.

——*—*—*—*—*—*