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Abstract

India had developed a vast and rich traditional agricultural knowledge since ancient times and presently finding solutions to problems created by over use of agrochemicals. Todays' modern farming is not sustainable in consonance with economics, ecology, equity, energy and socio-cultural dimensions. The entire agricultural community is trying to find out an alternative sustainable farming system, which is ecologically sound, economically and socially acceptable. Sustainable agriculture is unifying concept, which considers ecological, environmental, philosophical, ethical and social impacts, balanced with cost effectiveness.The answer to the problem probably lies in returning to our own roots. Traditional agricultural practices, which are, based on natural and organic methods of farming offer several effective, feasible and cost effective solutions to most of the basic problems being faced in conventional farming system. With having such a due importance of organic farming in India, the government has initiated the programs like National Programme for Organic Production (NPOP) in 2000 and National Project on Organic Farming (NPOF) in 2004. Availability of quality organic inputs is critical for success of organic farming in the country. Setting up of organic input units are being financed as credit-linked and back-ended subsidy through NABARD and NCDC under NPOF Capital investment subsidy scheme. Three types of organic input production units namely; fruit/vegetable waste units, bio-fertilizer unit and vermi-hatchery units are being subsidized @ 25 per cent of their total project costs respectively. Around 455 vermi-hatchery units, 31 bio-fertilizer units and 10 fruit and vegetable waste units were sanctioned across different states by NABARD till May, 2009. But, NCDC has so far sanctioned only two bio-fertilizer units in Maharashtra state. This paper made a humble attempt to know the present status of these units, capacity utilization and their efficiency. A sample of 40 vermi-hatchery units were selected for the present study from four states namely; Gujarat, Maharashtra, Punjab and U.P respectively based on their weights in total population. A model based non-parametric Data Envelopment Analysis (DEA) was used for analyzing the efficiency of organic input units. Multiple regression models are also used to estimate the drivers for efficiency in vermi-hatchery units. The average installed capacity of the sample unit was 150 TPA. But, the mean production was around 76.2 TPA. The average capacity utilization rate was only 50.8 per cent which indicates nearly half of its full potential. Across different states, this value was the highest in Maharashtra (124.6%) followed by U.P (70.0%), Punjab (22.0%) and Gujarat (16.1%). The main reasons for low capacity utilization were lack of demand, poor production skills and insufficient infrastructure. The estimated mean technical, allocative and economic efficiencies of sample vermi-hatchery units under DEA-CRS model were 63.7, 50.95 and 32.95 per cent respectively. The results clearly indicate the low technical, allocative and economic efficiency of sample units. Correspondingly, the mean values for DEA-VRS model were 83.39, 59.42 and 50.24 per cent. These values conclude that organic inputs are suffering from both allocative inefficiency as well as scale inefficiency. Factors like size of the unit, contribution of family labor have shown positive relation with technical as well as scale-efficiencies. Participation in the training programs was also enhancing technical efficiency. The age of the unit and subsidies discouraged the scale-efficiency.

Key words: Efficiency, organic input units, DEA analysis, drivers for efficiency

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The performance of the agricultural sector influences the growth of the Indian economy. Agriculture (including allied activities) accounted for 15.7 per cent of the Gross Domestic Product (GDP-at constant prices) in 2008-09 as compared to 21.7 per cent in 2003-04. Notwithstanding the fact that the share of this sector in GDP has been declining over the years, but its role remains critical as it accounts for about 52.1 per cent of the employment in the country. Agricultural sector also contributed 10.2 per cent of national exports in 2008-09 (Economic Survey, 2009-10). Agriculture provides food for more than one billion people and yields raw materials for agro-based industries. Modernization of Indian agriculture has began during the mid-sixties which resulted in the 'Green Revolution' making the country a food grain surplus nation from a deficit one depending on food imports. But, modern agriculture has also yielded several problems besides creating a very unsustainable system for mankind (Worthington, 1980). Cultivation of crops became more dependent on inputs purchased from the market, and farmers began to sell a greater share of the crop in the market. The rising costs of cultivation and uncertain output prices made the modern agriculture system non-viable.

Further, it is also proved that modern agriculture cannot be sustainable in long run because of the adverse changes being caused to the environment and the ecosystem (Kaiser, 2004). These implications are also experienced by declining crop yields and instability in crop production (Ramesh Chand, 2008). The necessity of having an alternative agriculture method which can function in friendly eco-system while sustaining and increasing the crop productivity is realized now. Organic farming is recognized as the best known alternative to the modern/conventional agriculture. Due to the rising input costs involved in modern farming and its un-sustainability due to overcapitalization has made organic farming a necessity in many agriculturally grown regions (Singh, 2009). Organic farming has been found to be as or more viable than conventional farming in the USA and European countries due to either higher yield or lower cost or higher market prices (Lampkin, 1994). Modern organic techniques have the potential to stabilize and even increase sustainable farm yields with increasing soil fertility, environmental sustainability and preserving biodiversity of the ecosystem. It will also increase the nutritional value of the produce and reduces the pesticide residues in it.

The important event in the history of the modern nascent organic farming in India was the unveiling of the National Programme for Organic Production (NPOP) in 2000. Later, Department of Agriculture and Cooperation, Ministry of Agriculture has also launched a central sector scheme entitled "National Project on Organic Farming (NPOF)" during Xth Five year plan. It includes capacity building through service providers; financial support to different production units engaged in production of bio-fertilizers, fruit and vegetable waste compost and vermi-hatchery units and human resource development through training on certification and inspection, production technology etc. The establishment of organic input production units under this scheme is being provided as credit-linked and back-ended subsidy by NABARD and NCDC. This paper focuses primarily on the issues like capacity utilization and efficiency of organic input units sanctioned under this scheme and factors influencing the efficiency of these units. Section I of this paper describes brief review, empirical model, sampling strategy and empirical results of the study while section II deals with factors influencing the efficiency of these units. The final section sums up the findings of the paper and suggests measures for strengthening the scheme.

I

Efficiency of Organic Input Units

Productivity growth and the use of additional inputs are the two major forces behind increased agricultural production. Productivity has two major components: a) technical change, and b) technical efficiency (Good *et al*., 1993). Efficiency is a very important factor of productivity growth especially in developing agricultural economies, where resources are scarce and opportunities for developing and adopting better technologies have lately and dwindling. Such economies can benefit a great deal from inefficiency studies which show that it is still possible to increase production and productivity by improving efficiency, a usually neglected source of productivity, without increasing the resource base or developing new technologies. Estimates of efficiency can also help to decide whether to improve efficiency or to develop new technologies to raise productivity (Sharma and Sharma, 2002).

Efficiency of firm is measured in terms of its relative performance that is, efficiency of a firm relative to the efficiencies of firms in a sample. A formal econometric approach for estimating relative efficiency is with reference to the "best practice frontier". Best practice frontier, a term originally coined by Farrell (1957) denotes maximum output that can be obtained with a given set of input quantities for a given set of firms in a sample. He also proposed that the efficiency of a firm consists of two components: technical efficiency, which reflects the ability of a firm to obtain maximum output from a given set of inputs, and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology. These two measures are then combined to provide a measure of total economic efficiency. The output and input perspective will coincide when measuring technical efficiency under Constant-Return-to-Scale (CRS). The allocative and economic efficiency measures however are completely different in nature and are not likely to coincide for other reasons than by chance. Further more, the observations of Farrell input-and output-orientated technical efficiency measures are equivalent to the input output distance functions, discussed in Shephard (1970) and Fare and Primont (1995).

So far, we have discussed the efficiency of operations of a firm with respect to the production technology frontier at a given level of input and output prices. It is possible that a firm is both technically and allocatively efficient but the scale of operation of the firm may not be optimal. Suppose the firm is using a Variable-Return-to-Scale (VRS) technology, then the firm involved may be too small in its scale of operations, which might fall within the Increasing-Return-to-Scale (IRS) part of the production function. Similarly, a firm may be too large and it may operate within the Decreasing-Returns-to-Scale (DRS) part of the production function. In both of these cases, efficiency of the firms might be improved by changing their scale of operations, i.e., to keep the same input mix but change the size of operations. If the underlying production technology is a globally Constant-Returns-to-Scale (CRS) technology then the firm is automatically scale efficient. Fare, Grosskopf and Roos (1998) presented a definition of scale efficiency and use it in deriving a decomposition of productivity change over time. Balk (2001) provided a formal framework to define scale efficiency and to study the role of scale efficiency in productivity change. Balk then compared and evaluated some of the earlier attempts in the literature (Fare *et al*, 1994; Ray and Desli, 1997; Grifell-Tatje and Lovell, 1999; Wheelock and Wilson, 1999; and Zofio and Lovell, 1999) to decompose productivity change into efficiency change, technical change and scale change.

Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) techniques are commonly used tools to measure firm-level inefficiencies. Techniques like index number methods, which implicitly assume that all firms are fully efficient. Now, we relax this assumption and used to estimate frontier functions and measure the efficiencies of firms relative to these estimated frontiers. Frontiers have been estimated using many different methods over the past 40 years. Lovell (1993) provided an excellent introduction to this literature. DEA which involves mathematical (non-parametric) programming where as SFA uses econometric (parametric) methods for measuring firm level efficiencies.

Data Envelopment Analysis Vs Stochastic Frontier Approach

Many studies have showed that the results of efficiency are sensitive to the method selected for estimate the efficiency scores. The choice of method to use is in no way obvious, but has to be decided in every case. The quality of the data, the appropriateness of various functional forms, and the possibility of making behavioural assumptions will heavily influence the relative appropriateness of DEA and SFA. For example, the DEA approach, compared to the SFA doesn't require any specific functional form to be selected, neither are any behavioural assumptions needed as long as allocative efficiency is not considered. However, DEA is a deterministic approach, meaning that it doesn't account for noise in the data. All deviations from the frontier will thus be accounted for as inefficiencies. Therefore the DEA efficiency scores are likely to be sensitive to measurements errors and random errors. The SFA on the other hand accounts for random errors and has the advantage of making inference possible (Coelli et al, 2002). However, SFA is sensitive to the choice of functional form.

In summary, it is concluded that none of the proposed methods of measuring efficiency relative to an estimated frontier is perfect. However, they all provide substantially better measures of efficiency than simple partial measures (Coelli, 1995). Further, detailed comprehensive reviews of the two approaches were provided by Lovell (1993), Ali and Seiford (1993), Coelli (1995), Bauer (1990), Fried *et al*. (1993), Bravo-Ureta and Pinheiro (1993). In general, a large number of studies on efficiency measurements argue that a researcher can safely choose any of the methods since there are no significant differences between the estimated results (Coelli, Sandura and Colin, 2002). Hence, the present study followed DEA technique for analyzing the efficiency of organic input units in India. The dual output (vermi-compost and worms) nature of organic input units is also one of the reasons for the selection of DEA technique compared to SFA.

Specification of Model (Data Envelopment Analysis)

DEA involves the use of linear programming methods to construct a non-parametric piecewise surface (or frontier) over the data, so as to be able to calculate efficiencies relative to this surface. More detailed reviews of the DEA methodology were also presented by Seiford and

Thrall (1990), Lovell (1993), Ali and Seiford (1993), Lovell (1994), Charnes et al (1995) and Seiford (1996).

Assume there is a data on K inputs and M outputs on each of N firms or DMU's. For the ith DMU these are represented by the vectors x_i and y_i, respectively. The K x N input matrix, X, and the M x N output matrix, Y, represent the data of all N DMU's. The purpose of the DEA is to construct a non-parametric envelopment frontier over the data points such that all observed points lie on or below the production frontier. Given the CRS assumption, this can be represented as:

The best way to introduce DEA is via the ratio form. For each DMU we would like to obtain a measure of the ratio of all outputs over all inputs, such as $u'y_i / v'x_i$, where u is an M x 1 vector of output weights and v is a K x 1 vector of input weights. To select optimal weights we specify the mathematical programming problem:

$$
\begin{aligned}
&\text{Max}_{u,v}\ (u'y_i / v'x_i) \\
&\text{st} \quad u'y_j / v'x_j \le 1, \quad j = 1, 2 \ldots N, \\
&u, v \ge 0 \qquad\qquad (1)
\end{aligned}
$$

This involves finding values for u and v, such that the efficiency measure of the ith DMU is maximized, subject to the constraint that all efficiency measures must be less than or equal to one. One problem with this particular ratio formulation is that it has an infinite number of solutions. To avoid this one can impose the constraint $v'x_i = 1$, which provides:

$$
\begin{aligned}
&\text{Max}_{u,v}\ (\mu' y_i), \\
&\text{st} \quad \gamma' x_i = 1, \\
&\mu' y_j - \gamma' x_j \le 0, \ j = 1, 2 \ldots N, \\
&\mu, \gamma \ge 0 \qquad\qquad (2)
\end{aligned}
$$

Where the notation change from u and v to μ and γ reflects the transformation, this form is known as the multiplier form of the linear programming problem.

Using the duality in linear programming, one can derive an equivalent envelopment form of this problem:

$\text{Min}_{\theta,\lambda}\ \theta,$

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

$\theta x_i - X\lambda \geq 0,$

$\lambda \geq 0$ (3)

Where θ is a scalar and λ is N x 1 vector of constants. This envelopment form involves fewer constraints than the multiplier form (K+M < N+1), and hence is generally the preferred form to solve. The value of θ obtained will be the efficiency score for the ith DMU. It will satisfy θ ≤1, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU, according to the Farrell (1957) definition. Note that the linear programming problem must be solved N times, once for each DMU in the sample. A value of θ is then obtained from each DMU.

The CRS assumption is only appropriate when all DMU's are operating at an optimal scale. Imperfect competition, constraints on finance, etc, may cause a DMU to be not operating at optimal scale. The use of the CRS specification when not all DMU's are operating at the optimal scale will result in measures of TE which are confounded by Scale efficiencies (SE). The use of the VRS specification will permit the calculation of TE devoid of these SE effects. The CRS linear programming can be easily modified to account for VRS by adding the convexity constraint: $N1'\lambda = 1$ to (3) to provide:

$\text{Min}_{\theta,\lambda}\ \theta,$

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

$\theta x_i - X\lambda \geq 0,$

$N1'\lambda = 1$

$\lambda \geq 0$ (4)

Where N1 is an N x 1 vector of ones, this approach forms a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provides technical efficiency scores which are greater than or equal to those obtained using the CRS model.

Many studies have decomposed the TE scores obtained from a CRS DEA into two components, one due to scale inefficiency and one due to "pure" technical efficiency. If there is a difference in the two TE scores for a particular DMU, then this indicates that the DMU has scale inefficiency, and that the scale inefficiency can be calculated from the differences between the VRS TE score and the CRS TE score.

CRS TE = VRS TE x SE (5)

If one has price information and is willing to consider a behavioural objective, such as cost minimization and revenue maximization, then one can measure both technical and allocative efficiencies. The cost minimization vector of input quantities given the input prices is determined using:

$\text{Min}_{\lambda, xi^*} \; w_i' xi^*$,

Subject to $-yi + Y\lambda \geq 0$,

$xi^* - X\lambda \geq 0$,

$N1' \lambda = 1$

$\lambda \geq 0$, (6)

Where w_i is a vector of input prices for the i-th DMU and xi* (which is calculated by the LP) is the cost-minimizing vector of input quantities for the i-th DMU, given the input prices w_i and the output levels y_i. The total cost efficiency (CE) or economic efficiency of the ith DMU would be calculated as

$CE = w_i' xi^* / w_i' xi$

That is, the ratio of minimum cost to observed cost. One can then calculate the allocative efficiency residually as AE = CE / TE

In many studies the analysts have tended to select input-oriented models because many DMU's have particular orders to fill (ex. production units) and hence the input quantities appear to be the primary decision variables, this argument may not be as strong in all industries. In some industries the DMUs may be given a fixed quantity of resources and asked to produce as much output as possible. In this case an output orientation would be more appropriate. Essentially one should select an orientation according to which quantities (inputs or outputs) the managers have most control over. Further, Coelli and Perelman (1996) concluded in their study that the choice of orientation will have only minor influences upon the score obtained. Hence, this study adopted only input orientation rather than output orientation because the sample related to organic production units where output determines by inputs.

Each observation included two outputs i.e., average vermi-compost production (Y1) per unit per annum in tons and sale of worms (Y2) per unit per annum in kg. In the input category, four variables were included. They were raw materials qty (X1) mainly dung in tons per annum, qty of worms used per annum (X2) in kg, units of labor used (both hired and own) per annum (X3) and no.of months electricity (X4) used per annum. The unit prices of four input variables were also used in the calculation of cost-DEA functions. Under this approach, both CRS and VRS models were applied to data with input orientation. The DEA models were estimated using programme DEAP 2.0 (Coelli, 1996).

Sampling Strategy

To promote organic farming in the country and to increase the agricultural productivity while maintaining the soil health and environmental safety; organic input units are being financed as credit-linked and back-ended subsidy through NABARD and NCDC. These units will not only reduce the dependency on chemical fertilizers but also efficiently convert the organic waste in to plant nutrient resources. Three types of organic input production units namely; Fruit/vegetable waste units, Bio-fertilizer unit and Vermi-hatchery units are being supported @ 25 per cent of their total project costs with maximum ceiling respectively. Around 455 vermi-hatchery units, 31 bio-fertilizer units and 10 fruit and vegetable waste units were sanctioned across different states by NABARD till May, 2009 (see Appendix table 1). But, NCDC has so far sanctioned only two bio-fertilizer units in Maharashtra state. However, the present paper is mainly focusing only vermi-hatchery units. A sample of 40 vermi-hatchery units were purposively selected from four states namely; Gujarat, Maharashtra, Punjab and U.P based on their respective weights in the total population (table 1). The sample vermi-hatchery units were chosen in two to three groups/clusters in each state in order to minimize the travel costs and time. A well structured and pre-tested questionnaire was administered to extract quantitative data with utmost emphasis was placed on qualitative issues through interaction with the promoters of units.

Table 1 Details of sample units selected for the study

Unit type	Punjab	Uttar Pradesh	Gujarat	Maharashtra	Total sample for study
Vermiculture hatchery units	6 (42)	17 (115)	13 (86)	4 (29)	40 (272)

Note: Figures in the parentheses indicates total no.of units sanctioned in that state

Primary Details of Sample Units

The state-wise primary details of the selected units is presented in table 2. On whole, only 22 out of 40 units were functioning on the day of visit. The number of non-functioning units were maximum (100 per cent) in case of Gujarat. The main reasons for not functioning were: lack of demand for vermi-compost, neither JMC visit nor subsidy release from NABARD, death of worms in high temps and heavy rains and floods. The percentage of non-functioning units was 25 and 23.5 per cent respectively in case of Maharahstra and U.P states. But, in case of Punjab all six units were functioning well. Almost all the 40 sample units were completed the establishment of units. None of the sample unit is still under construction process. Nearly 97.5 per cent units have finished their construction with in stipulated period of six months. A lone unit in U.P has crossed its timeline of six months for establishment of unit. The average time taken from sanctioning of the loan to completion of unit was 96 days. The state-wise average time taken was the highest in case of Maharashtra followed by U.P, Punjab and Gujarat. It indicates that most of structures constructed in Gujarat were taken very less time.

Table 2 Primary details of sample units (no. of units)

Item	Gujarat	Maharashtra	Punjab	Uttar Pradesh	Over all
Units functioning on day of visit					
a. Functioning	0	3	6	13	22
b. Not functioning	13	1	0	4	18
Units construction					
a. Completed	13	4	6	17	40
b. Not completed	0	0	0	0	0
Construction completed with in					
a. Stipulated six months time	13	4	6	16	39
b. Not completed	0	0	0	1	1
Average time taken from sanctioning to completion of unit (days)	51	165	54	126	96

Item	Gujarat	Maharashtra	Punjab	Uttar Pradesh	Over all
Any refund of advance subsidy					
a. Yes	8	0	0	0	8
b. Avg. amount (lakh)	0.50	N.A	N.A	N.A	0.50
Completion certificate given to bank					
a. Yes	12	3	6	17	38
b. No	1	1	0	0	2
Joint Monitoring committee (JMC) visited					
a. Completed	8	3	6	11	28
b. Not completed	5	1	0	6	12
Final subsidy received (Rs.)					
a. Yes	1	3	4	11	19
b. Avg. amount (lakh)	0.81	0.75	0.75	0.75	0.75
Average age of the unit (months)					
a. Less than or equals to 12	4	1	0	2	7
b. Between 13-24	2	0	6	7	15
c. > 24	7	3	0	8	18
Encountered problems in getting subsidy from NABARD					
a. Yes	11	0	2	7	20
b. No	2	4	4	10	20
Any permission/license obtained for marketing					
a. Yes	0	1	0	0	1
b. No	13	3	6	17	39

If the promoter could not able to construction the unit with in stipulated period of six months time or if Joint Monitoring Committee (JMC) would visit and feels that the standards are not up the mark of NABARD, then NABARD will recall the advance subsidy amount from the borrower/beneficiary. Overall, 8 units out of 40 sample units repaid their advance subsidy to NABARD because their standards of establishment of units was not up to the mark of NABARD stipulated guidelines. All these repaid units were located in Gujarat state only. The average amount they paid back to NABARD was Rs.50,000 per unit. This concludes that the units constructed in Gujarat were very poor and inefficient when compared to other state units.

When the project is nearing in completion, the promoter will inform the bank by the way of submission of a completion certificate. This will initiate the action for JMC visit. Almost 95.0 per cent of sample promoters have submitted their completion certificates to banks. One each from Gujarat and Maharashtra were not submitted to bank till date. This was due to lack of awareness among promoters as well as bank officials. But, so far NABARD conducted JMC visits only in 70 per cent sample units. Nearly, 30 per cent of sample units were still waiting for JMC visits and final subsidy amounts. This indicates a huge delay in the process of subsidy release. Among the four states, the delays were more pronounced in Gujarat (38%) and U.P (35 %) states. Out of the 28 units (70%) who completed JMC visits, only 19 units (67.8%) have received the final subsidy amounts. The average amount they received was Rs.75,000 per unit. Around 32 per cent of units were still waiting for release of final subsidy amounts by NABARD. This was another bottleneck in the scheme where lot of time was consuming for processing.

On whole, 45 per cent of sample units were established more than two years back. 37.5 per cent of units were belonging to the age range of between 13 and 24 months. Seven units (17.5 per cent) were having less than one year old age. In total, nearly 82.5 per cent of the sample units were established more than one year back. Across different states, units with age more than two years were present more in U.P followed by Gujarat and Maharashtra. When we asked about their problems in getting the subsidy from NABARD, nearly half of the sample promoters were expressed that they faced problems. The proportion of the promoters faced problems were more in Gujarat (55%) followed by U.P (35%) and Punjab (10%). A lone farmer in the entire sample was succeeded in obtaining the license/certification for marketing his product. Remaining 39 promoters (97.5%) did not have any license or permission for marketing their product. This is another loophole in the scheme that who will certify; how to obtain, what is the cost etc details; many of the promoters were not aware off.

Financial Details of Sample Units

The summary of financial information of sample units is presented in table 3. On an average, 5.9 lakh per unit was the financial outlay. The outlay was the highest in case of Maharashtra (6.3 lakh). While, this amount was same in case of Gujarat and U.P states (5.9 lakh). But, it was the lowest in case of Punjab state (5.7 lakh). The average promoters' contribution in the total outlay was 1.6 lakh. However, this amount was the highest in Maharasthra followed by Gujarat. The mean bankers' loan amount was 4.3 lakh per unit. The bankers' loan amount was the highest in U.P followed by Punjab states. Nevertheless, the eligible subsidy amount was uniform as a whole and across states i.e., 1.5 lakh per unit. But, the actual mean subsidy received till date per unit was Rs.0.93 lakh only. There was a huge gap of 0.57 lakh between these two figures. This gap was the highest in case of Gujarat (1.23 lakh) followed by U.P (0.27 lakh) and Punjab (0.25 lakh). The difference was the lowest in Maharashtra (0.19 lakh). The main reasons for this difference were: not obeying the NABARD standards and requirements and a lot of delay in final subsidy release after JMC visited the unit.

Overall, on an average, the actual amount spent by promoters for establishment of each single unit was Rs. 5.4 lakh. Among the four states, the amount spent on each unit was the highest in Punjab (8.2 lakh) followed by Maharashtra (7.6 lakh) and U.P (5.4 lakh). The amount was the lowest in case of Gujarat (3.5 lakh) which indicates the poor establishment of units. The average time taken from proposal submission to approval from financial bank was 1.65 months (roughly 50 days). The time requirement was the lowest in case of Punjab (one month) and the highest in case of Maharashtra (1.75 month). But, the time period was more or less similar in case of Gujarat and U.P states.

Table 3 Financial details of sample units (Rs. lakh per unit)

Item	Gujarat	Maharashtra	Punjab	Uttar Pradesh	Over all
Total financial outlay (a + b)	5.9	6.3	5.7	5.9	5.9
Promoters contribution (a)	1.8	2.2	1.5	1.5	1.6
Bankers loan (b)	4.1	4.1	4.2	4.4	4.3
Subsidy eligible	1.5	1.5	1.5	1.5	1.5
Actual subsidy received till date	0.27	1.31	1.25	1.23	0.93
Actual amount spent	3.5	7.6	8.2	5.4	5.4
Average time taken from proposal submission to approval from Bank (months)	1.23	1.75	1.0	2.2	1.65
Sanctioned Bank type					
a. Commercial	13	1	2	15	31
b. Cooperative	0	3	4	2	9
ROI range (%)	10 -12	12.5	10.5-12	11-13.75	-
Problem faced in getting approval from the financial Bank					
a. Yes	1	0	2	3	6
b. No	12	4	4	14	34

Nearly 78 per cent of the sample units were financed by commercial banks. Only the remaining 22 per cent were supported by district cooperative banks. The cooperative banks sanctioned more number of units than the commercial banks in case of Maharashtra and Punjab states. But, in case of Gujarat (100%) and U.P (88%) states; they were dominated by commercial banks. The range of interest rate on bank loans was found to be the highest in U.P followed by Maharashtra. But, these ranges were a little bit low in case of Gujarat when compared with Punjab. Only, 15 per cent of the promoters opined that they faced problems in getting approval from the financial banks.

Capacity Utilization of Sample Units

The details of capacity utilization of sample units are presented in table 4. Capacity utilization is a concept refers to the extent to which an enterprise actually uses its installed productive capacity. Thus, it refers to the relationship between actual output that 'is' produced with the installed equipment and the potential output which 'could' be produced with it, if capacity was fully used. The results presented in table and discussed were referring to the capacity utilization of organic input units in the last one year.

Table 4 Capacity utilization of sample units (TPA)

Item	Gujarat	Maharashtra	Punjab	Uttar Pradesh	Over all
Average installed capacity	150	150	150	150	150
Current capacity utilization	24.2	187	33	105	76.2
Capacity utilization rate (%)	16.1	124.6	22.0	70.0	50.8
Average no.of working days per annum (days)	319.6	365.0	325.0	337.0	332.0
Average working hours per day	5.1	6.7	2.3	6.3	5.3
Average recovery rate (%)	48.0	52.5	33.3	39.7	42.7
Gestation period per cycle (days)	46.5	35	60	50	48.8
Avg no. of cycles per year (range)	5-7	10-15	3-5	6-8	7-9

The average installed capacity of the sample units was 150 Tons Per Annum (TPA). On the whole, the average capacity utilization was around 76.2 TPA. The average capacity utilization rate was only 50.8 per cent which indicates nearly half of its full potential. Across different states, the average capacity utilization was the highest in Maharashtra followed by U.P, Punjab and Gujarat. The actual production in Maharashtra units was more than its installed potential. The lowest capacity production was observed in Gujarat at the rate of 24.2 TPA. The capacity utilization rate was one sixth of the actual potential (16.1%). The reasons for low capacity utilization were the lack of demand, poor production skills and insufficient infrastructure. Even though the units in Punjab were well equipped, their productivity was also low. This is because of lack of demand for vermi-compost. In case of U.P, the average utilization rate was 70.0 TPA. The demand was slowing picking up due to its nearness to different export channels in Delhi.

In general, the average number of working days per annum was 332 days. The number of working days per annum was higher in Maharashtra (365 days) and lower in case of Gujarat state. The number of working days per year was on par in case of Punjab and U.P even though their capacity utilization rates were different. This may be explained with the differences in number of working hours per day. On an average, the number of working hours per day was 5.3 hours. This value was very high in case of Maharashtra (6.7 hours) while it was low in case of Punjab (2.3 hours).

On the whole, the average recovery rate per unit was 42.7 per cent. Across different states, the highest recovery rate was noticed in case of Maharashtra (52.5%) followed by Gujarat, U.P and Punjab. The high recovery rate in Maharashtra may be one of the reasons for its high productivity. Even though, the recovery rate was high in Gujarat, the productivity was low because of lack of production skills and influence of climatic parameters (high temperatures, heavy rains etc). The average gestation period per cycle for the entire sample was 48.8 days. It is dependent on various parameters like no.of worms per cubic meter, age of the worms, raw material type and production season. This period was the lowest in Maharashtra due their higher efficiency levels while it was the highest in Punjab. Overall, the average number of cycles per annum produced by the organic inputs was 7 to 9 cycles. This number was very low in case of Punjab because of its highest gestation period. The number of cycles was the highest in Maharashtra due to its low gestation period and more number of working days per year. There was wide range of factors which could influence the number of cycles per annum per unit.

Economics of Vermi-compost Production

The summary of economics of vermi-compost production across different states is presented in table 5. The results clearly proved that the production of vermi-compost was a profitable venture in India. The weighted average cost production per quintal was Rs.334 and price realization for the same was Rs.502. The weighted net margin per quintal of vermi-compost production was Rs.168. This is a quite significant margin in agri-business sector. Among different states, the cost of production was the highest in Gujarat followed by Punjab, U.P and Maharashtra. Good production skills, higher market demand and economies of scale of production are may be the reasons for higher productivity and low cost of production in Maharashtra. Per quintal price realization was the highest in U.P followed by Punjab, Maharashtra and Gujarat. Proximity to Delhi Metropolitan and vermi-compost export channels helped U.P state to realize more price. Even though, the productivity and market demand was relatively lower in Punjab, presence of green houses and nurseries in Chandigrah facilitating to get reasonable price for vermi-compost. The average net margin per quintal was the highest in U.P while it was the lowest and higher negative value in Gujarat state. By administering proper training to promoters and providing technical know-how in vermi-compost production would yield good results in Gujarat state as well.

Table 5 Summary of economics of vermi-compost production in India (Rs)

Item	Gujarat	Maharashtra	Punjab	U.P	Weighted average
Cost of production per quintal (Rs)	1137	218	433	324	334
Price realization per quintal (Rs)*	189	447	488	678	502
Net margin per quintal (Rs)	-948	229	55	354	168

* Including the sale of worms

Efficiency of Organic Inputs

The frequency distribution, mean, maximum, minimum and standard deviation of technical, allocative and economic efficiencies both under CRS and VRS models of DEA approach for sample organic input production units is presented in table 6. Both input and output quantities and their unit prices per unit per annum were collected and used for this efficiency analysis (see Appendix table 2). The estimated mean technical, allocative and economic efficiencies under DEA-CRS model were 63.7, 50.95 and 32.95 per cent respectively. Similarly, values for the three efficiencies under DEA-VRS model were 83.39, 59.42 and 50.24 per cent respectively. In terms of technical efficiency, about 45 per cent of the sample units have more than 90 per cent efficiency under the VRS model. Under the CRS model, only 20 per cent of the sample units have more than 90 per cent efficiency. In case of allocative efficiency, majority of sample units (40 per cent) fell under less than 50 per cent category under VRS model while 47.5 per cent of the same belonged to less than 50 per cent category under CRS assumption. The economic efficiency of most of the organic inputs (85 per cent) under CRS model distributed under less 50 per cent category. Correspondingly under VRS model, the largest part of sample (57.5 per cent) were also scattered in the same class. It is concluded from the table that majority of the sample organic units (47.5 per cent) were come under less than 50 per cent technical efficiency under CRS assumption, indicating that the organic production units were inefficient. To supplement the above statement, the most frequent interval of allocative and economic efficiency was 1 to 50 per cent under both CRS and VRS assumptions. Further, it signifies that the organic production units in India were suffering from both technically inefficiency in using resources as well as unable to allocate inputs in the cost minimizing way.

Table 6 Frequency distribution of efficiency of organic input units (n=40)

Efficiency (%)	CRS			VRS		
	TE	AE	EE	TE	AE	EE
1-50	47.5	47.5	85.0	12.5	40.0	57.5
51-60	5.0	17.5	2.5	2.5	7.5	10.0
61-70	5.0	10.0	0.0	5.0	20.0	10.0
71-80	12.5	7.5	5.0	10.0	2.5	2.5
81-90	10.0	10.0	2.5	25.0	20.0	10.0
91-100	20.0	7.5	5.0	45.0	10.0	10.0
Max (%)	100	100	100	100	100	100
Min (%)	25.4	12.8	8.8	44.6	16.3	13.4
Mean (%)	63.7	50.95	32.95	83.39	59.42	50.24
Standard deviation (%)	24.0	25.7	24.1	18.8	25.2	26.4

The average comparison of efficiencies of organic input units across states and regions is presented in table 7. Among the four states, the mean technical efficiency was the highest for Maharashtra followed by U.P, Gujarat and Punjab under CRS model. But under VRS model, the highest technical efficiency was found in Maharashtra followed by Gujarat, U.P and Punjab. In case of allocative efficiency and economic efficiency, Maharashtra stood first both under CRS and VRS assumptions. It indicates that Maharahstra units were much more efficient than any other states. In remaining three states, the second best units were found in U.P based on AE and EE under CRS model. However, when we compared between the two regions, a slightly higher efficiency (TE, AE and EE) values were observed in Northern region under CRS assumption. These results were also supporting the cost of production calculations found in Northern region. But, this was reversed under VRS assumption.

Table 7 Average efficiency of organic input units across states and regions

State (no.of units)	CRS			VRS		
	TE	AE	EE	TE	AE	EE
Avg. Gujarat units (13)	0.55	0.39	0.21	0.93	0.58	0.55
Avg. Maharashtra units (4)	0.84	0.79	0.66	1.00	0.82	0.82
Avg. Western region (17)	0.62	0.48	0.32	0.95	0.63	0.61
Avg. Punjab units (6)	0.52	0.40	0.17	0.58	0.42	0.21
Avg. U.P units (17)	0.69	0.57	0.39	0.80	0.61	0.49
Avg. Northern region (23)	0.65	0.53	0.34	0.74	0.56	0.42

The scale efficiencies among organic input production units are summarized by state and region wise and presented in table 8. The scale efficiency index among sample varied from 32.7 per cent to 100 per cent, with a mean value of 77.7 per cent. In terms of scale efficiency, about 20 per cent sample showed constant returns to scale where as 7.5 per cent exhibited decreasing returns to scale. Majority of the units (72.5 per cent) demonstrated increasing returns to scale. Among four states, the highest scale efficiency was observed in Punjab state. The same value for U.P and Maharashtra states were almost equal. Gujarat was found to be the least scale efficient when compared between them. To complement the earlier results, the mean scale efficiency value was also higher Northern region when compared to Western region.

Table 8 Scale efficiencies in organic input units

State (n)	CRS – TE	VRS –TE	SE
Avg. Gujarat units (13)	0.55	0.93	0.59
Avg. Maharashtra units (4)	0.84	1.00	0.84
Avg. Western region (17)	0.62	0.95	0.65
Avg. Punjab units (6)	0.52	0.58	0.89
Avg. U.P units (17)	0.69	0.80	0.85
Avg. Northern region (23)	0.65	0.74	0.86

The relationship between size of the organic input unit and efficiency is summarized and presented in table 9. The sample units were classified in to three types based on their vermi-compost production per annum. Most of the sample units (65 per cent) fell under the category of small with a production of less than 50 TPA. Six and eight units respectively were grouped under medium and large categories. The results clearly indicate that there is a strong positive relationship between size of the unit and its efficiency. As the size of unit increases, all the three efficiency parameters increased significantly in almost all cases (except in medium VRS-AE) under both the CRS and VRS assumptions. These results clearly concluded that the large units were more efficient than the smaller units.

Table 9 Unit size and efficiency relationship

Size of the unit	Distribution of units	CRS			VRS		
		TE	AE	EE	TE	AE	EE
Small (1-50 tons)	26	0.51	0.44	0.21	0.80	0.56	0.45
Medium (51-100 tons)	6	0.81	0.54	0.45	0.82	0.55	0.46
Large (> 100 tons)	8	0.91	0.68	0.61	0.92	0.73	0.66

II
Factors Influencing Efficiency

The results of regression analysis to identify the factors influencing efficiency (CRS-TE, VRS-TE and SE) have been summarized and presented in table 10. The three efficiency parameters were regressed against different socio-economic characters of the promoters and with some policy related variables (like training and subsidy). A dummy variable (trained -1, untrained -0) was used to see the influence of training component on efficiency. Similarly, to evaluate the impact of subsidy on efficiency, six more private units (3 from Maharashra and one each from remaining three states) which were not subsidized by any means were added to the existing 40 sample units. For capturing these effects, a subsidy dummy was used (subsidized-1, not-0). To perceive state wise effects, three dummies (one each for Punjab, U.P and Gujarat) were used keeping Maharashtra as a control.

The best fit among the three regression equations was scale efficiency which exhibited the highest adjusted R-square of 0.625. Amongst different factors, size of the unit was positive and significant at one per cent level. Contribution of family labor was also positive and significant at 10 per cent level. But, the age of the unit (since no.of months it's operating) showed a negative and significant relation with scale efficiency. It indicates that the time progresses many units are become scale-inefficient. The dummy for capital incentive subsidy from NABARD exhibited negative relationship with efficiency. It concludes that with increase in subsidy amounts, the scale performance of organic input units are decreasing. The dummy for Punjab state was positively statistically significant at 1 per cent level. This indicated that the scale-efficiency difference between Punjab and Maharashtra units were significant. However, the dummies for U.P and Gujarat were also positive but not statistically significant.

Table 10 Determinants of efficiency in organic production units

Variable	CRS- TE Coefficient	VRS – TE Coefficient	SE Coefficient
Constant	24.39 (1.321)	67.01* (4.027)	48.37* (2.984)
Unit size	0.721* (5.369)	0.056 (0.357)	0.759* (6.314)
Education	0.002 (0.020)	0.023 (0.183)	-0.016 (-0.167)
Family labor	0.283** (2.328)	0.148 (1.045)	0.207*** (1.902)
Unit age	-0.221 (-1.588)	0.127 (0.779)	-0.343* (-2.756)
Own livestock	0.236 (1.468)	0.189 (1.006)	0.130 (0.908)
Dummy-training	0.280*** (1.905)	0.228 (1.324)	0.187 (1.420)
Dummy-subsidies	-0.167 (-1.247)	0.063 (0.402)	-0.230*** (-1.921)
Dummy-Punjab state	0.050 (0.284)	- 0.536** (-2.614)	0.466* (2.970)
Dummy – U.P state	0.133 (0.624)	-0.265 (-1.061)	0.316 (1.657)
Dummy –Gujarat state	0.194 (0.810)	0.262 (0.935)	0.069 (0.324)
No of observations (n)	46	46	46
Adjusted R-square	0.532	0.360	0.625

Figures in the parenthesis indicates t –values
* Significant at 1 per cent level
** Significant at 5 per cent level
*** Significant at 10 per cent level

The adjusted R-square value of regression equation for CRS-technical efficiency was 0.532. Unit size and family labor variables were positive and statistically significant at 1 and 5 per cent level respectively. The dummy for training component showed positive relation with technical efficiency. It reveals that attending more no.of training programs will enhance the efficiency of the units. The dummy on subsidy also exhibited negative sign with technical efficiency but it was not statistically significant. When the same independent variables regressed against VRS-TE, the adjusted R-square value was 0.360. Only, the dummy for Punjab state showed a negative and statistically significance at 5 per cent level.

Overall, the size of the unit and contribution of family labor have shown positive relation with technical efficiency as well as on scale-efficiency. Training programs are also enhancing the technical efficiency of units. The age of the unit and subsidies discouraged the scale-efficiencies. Among the four states, the efficiency differences were significant between the units in Punjab and Maharashtra states.

III
Conclusions and Policy Implications

Setting up of organic input units with capital investment subsidy is one of major component under NPOF for encouraging the organic inputs production since 2004. Availability of quality organic inputs is critical for success of organic farming in India. To promote organic farming in the country and to increase the agricultural productivity while maintaining the soil health and environmental safety; organic input units are being financed as credit-linked and back-ended subsidy through NABARD and NCDC. These units will not only reduce the dependency on chemical fertilizers but also efficiently convert the organic waste in to plant nutrient resources.

Out of 40 sample units, only 22 units were functioning on the day of visit. The main reasons for not functioning are: lack of demand for vermi-compost, neither JMC visit nor subsidy release from NABARD, death of worms in high temps, heavy rains and floods. The number of non-functioning units were maximum (100%) in case Gujarat. NABARD has finished the conduct of JMC visits only in case of 70 per cent units. The remaining 30 per cent units are still waiting for JMC visits and final subsidy. This indicates a huge delay in the process of subsidy release. Out of the 28 units (70%) who completed JMC visits, only 19 units have received the final subsidy amounts. Almost 32 per cent of units are waiting for release of final subsidy. This was another bottleneck in the scheme where lot of time was consuming for processing. The average capacity utilization rate was only 50.8 per cent which indicates nearly half of its full potential. Across different states, this value was the highest in Maharashtra (124.6%) followed by U.P (70.0%), Punjab (22.0%) and Gujarat (16.1%). The main reasons for low capacity utilization are lack of demand, poor production skills and insufficient infrastructure. The estimated mean technical, allocative and economic efficiencies of sample vermi-hatchery units under DEA-CRS model were 63.7, 50.95 and 32.95 per cent respectively. Correspondingly, the mean values for DEA-VRS model were 83.39, 59.42 and 50.24 per cent. The results clearly indicate the low technical, allocative and economic efficiency of sample organic input units under NPOF scheme in India. The regression results concluded that the size of the unit, contribution of family labor have shown positive relation with technical as well as scale-efficiencies.

Prompt and timely visits by the Joint Monitoring committee (JMC) and quick disbursement of subsidy are the need of the hour for promotion of this scheme. The organic input units established under various schemes in the country should be linked up with suitable market channels to improve their capacity utilization or to make use of entire installed capacities. The technical efficiency of organic input production should also be enhanced by imparting more production skills to the promoters. The economic and scale efficiency of the units should also be improved by providing more technical guidance, quality seed stock and training programs. Finally, the quality organic input production in the country should be further encouraged with latest technologies and improved way of financial assistance.

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Appendix table 1

State-wise details of input units' sanctioned under NABARD

s.no	State	Vermi-hatchery units	Bio-fertilizer units	Fruit and vegetable waste units
1	Andhra Pradesh	5	6	-
2	Assam	21	-	1
3	Bihar	7	-	-
4	Chattisgarh	6	-	-
5	Delhi	-	-	1
6	Goa	-	1	1
7	Gujarat	86	3	1
8	Himachal Pradesh	1	1	-
9	Jharkhand	1	-	-
10	Karnataka	35	1	2
11	Kerala	1	2	2
12	Madhya Pradesh	22	1	-
13	Maharashtra	29	6	-
14	Meghalaya	-	1	-
15	Punjab	42	1	-
16	Haryana	8	1	-
17	Rajasthan	63	1	-
18	Tamil Nadu	5	2	1
19	Uttar Pradesh	115	-	1
20	Uttarakhand	1	2	-
21	West Bengal	7	2	-
	Total	455	31	10

Source: Head office, NABARD (as on May, 2009)

Appendix table 2

TE, AE and EE of sample units under both CRS and VRS model of DEA analysis (%)

	DEA-CRS Model			DEA-VRS Model			SE
Unit no	TE	AE	EE	TE	AE	EE	
1	50.0	18.5	9.2	100.0	38.2	38.2	50.0
2	50.0	18.5	9.2	100.0	38.2	38.2	50.0
3	50.0	18.5	9.2	100.0	38.2	38.2	50.0
4	50.0	18.5	9.2	100.0	38.2	38.2	50.0
5	100.0	33.9	33.9	100.0	36.8	36.8	100.0
6	100.0	33.9	33.9	100.0	36.8	36.8	100.0
7	48.6	31.2	15.2	100.0	75.7	75.7	48.6
8	37.5	23.5	8.8	100.0	89.4	89.4	37.5
9	37.5	72.7	27.3	100.0	98.0	98.0	37.5
10	34.7	34.2	11.9	44.6	30.8	13.8	77.8
11	56.2	55.6	31.3	100.0	88.0	88.0	56.3
12	37.5	62.1	23.3	100.0	68.6	68.6	37.5
13	62.5	85.3	53.3	73.9	81.4	60.2	84.6
14	82.5	28.9	23.8	83.9	29.3	24.6	98.3
15	82.3	56.8	46.7	83.4	64.8	54.0	98.7
16	80.4	26.2	21.0	80.5	26.4	21.3	99.9
17	50.0	58.3	29.1	72.4	87.7	63.5	69.0
18	68.3	68.3	46.6	69.6	67.8	47.2	98.2
19	37.5	57.8	21.7	83.0	69.6	57.8	45.2
20	56.2	52.0	29.2	83.5	63.9	53.4	67.4
21	25.4	45.4	11.5	77.5	39.8	30.9	32.7
22	100.0	100.0	100.0	100.0	100.0	100.0	100.0
23	44.1	82.5	36.4	63.6	87.4	55.6	69.4
24	46.7	92.1	43.0	53.4	80.9	43.2	87.4
25	80.7	49.5	39.9	81.6	51.5	42.0	98.9
26	79.2	55.1	43.6	80.6	59.0	47.6	98.2
27	79.6	53.3	42.4	80.8	55.8	45.1	98.5
28	71.0	25.6	18.2	75.4	30.5	23.0	94.2
29	100.0	98.7	98.7	100.0	100.0	100.0	100.0
30	100.0	19.3	19.3	100.0	24.8	24.8	100.0
31	40.5	64.4	26.1	46.4	65.8	30.5	87.4
32	40.5	64.4	26.1	46.4	65.8	30.5	87.4
33	40.5	43.8	17.8	45.8	43.8	20.1	88.5
34	40.5	43.8	17.8	45.8	43.8	20.1	88.5
35	75.0	12.8	9.6	81.8	16.3	13.4	91.7
36	75.0	12.8	9.6	81.8	16.3	13.4	91.7
37	100.0	88.7	88.7	100.0	100.0	100.0	100.0
38	37.5	88.8	33.3	100.0	62.9	62.9	37.5
39	100.0	71.1	71.1	100.0	82.3	82.3	100.0
40	100.0	71.1	71.1	100.0	82.3	82.3	100.0