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Technical Efficiency and Productivity of Organic and Conventional Farming System In Erode District

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ABSTRACT
A stochastic frontier production model was applied to estimate technical efficiency in a sample of Tamil Nadu in Erode district organic and conventional farms. The main purpose was to assess which production technique revealed higher efficiency. Statistical tests on the common production function model suggested that the two cultivation methods might lie on different frontiers. The study covered all the 30 farmers practicing organic farming system. In order to make a comparative study a control group of 30 farmers practicing conventional agriculture were selected from the neighborhood of organic farms. The criteria for selection of these farmers are that they represent the same characters of organic farmers in terms of socio – economic background, geographical location and crops grown. Analysis also estimated that efficiency plays a crucial role into the factors affecting productivity in the organic process. Some policy implications can be drawn from these findings.

***KEYWORDS**: Organic farming, Comparison analysis, Technical efficiency, stochastic frontier production models,*

I. INTRODUCTION

As is well established in the literature, productivity growth can be decomposed into technological change (TC) and technical efficiency (TE). This decomposition makes it possible to study the sources of productivity growth from different points of view Nishimizu 1982. Specifically, TE can be interpreted as a relative measure of managerial ability for a given technology, while TC evaluates the effect in productivity from the adoption of new production practices. In other words, gains in TE are derived from improvements in decision-making, which in turn are related to a host of variables including knowledge, experience and education. By contrast, TC relates to investments in research and technology (Nishimizu and Page 1982; Ahmad and Bravo-Ureta 1996). Development of organic methods raises significant research questions related to productivity and efficiency. In spite of the relevance of these topics, literature on the performance of organic farming is still insignificant, primarily, due to the relative unavailability of data on organic farms (Oude Lansink et al., 2002; Zanoli et. al, 2002). Above all, little attention has been paid to efficiency. Studies on productivity are certainly relevant, but also efficiency analysis provides useful information on the convenience or otherwise of adopting organic techniques (Cembalo and Cicia, 2002). In comparative studies between organic and conventional farms, efficiency analysis is particularly suitable for assessing the farmers' relative ability in optimizing internal resources. Furthermore, the utilization of an efficiency estimation approach is advisable in studies aimed at providing policy indications (Coelli et al., 2002; Lovell, 1995). Only in recent years has research literature proposed some comparative studies on technical and economic efficiency aimed at assessing efficiency differentials between organic and traditional farming (Tzouvelekas et al., 2001a, 2001b,

2002a, 2002b; Oude Lansink et al., 2002; Sipiläinen and Oude Lansink, 2005). These studies obtained controversial which technique reveals higher efficiency.. The study proposed in this paper aimed to estimate technical efficiency in a sample of Tamil Nadu organic farms. Using a parametric approach, a comparative analysis with sample of conventional farms was carried out to assess which method was more technically efficient.

The debate surrounding organic and conventional agriculture has sparked significant interest in the scientific community. One key aspect of this debate is the technical efficiency of organic and conventional farming systems. This review aims to synthesize the existing literature on technical efficiency in organic and conventional agriculture. The reviewed studies employed various methodologies, including stochastic frontier analysis (SFA), data envelopment analysis (DEA), and econometric models. The results showed that organic farming systems tend to have higher technical efficiency than conventional farming systems (Kumar et al., 2017; Sharma et al., 2018). However, some studies found that conventional farming systems have higher technical efficiency in certain contexts (Tiwari et al., 2018).

The findings of this review suggest that organic farming systems tend to have higher technical efficiency than conventional farming systems. This may be due to the use of more efficient production practices, such as crop rotation and organic amendments, in organic farming systems (Madau et al., 2017). However, the results also highlight the importance of context in determining technical efficiency. For example, conventional farming systems may have higher technical efficiency in areas with high levels of technology adoption (Wang et al., 2017). Further research is needed to explore the factors influencing technical efficiency in organic and conventional agriculture. Additionally, studies should examine the impact of technical efficiency on environmental sustainability and social equity in organic and conventional farming systems.

Rajendran and Tholkappian (2010) in their study on "Is Organic in Farming a Panacea for Food and Nutritional Security in India?" in their article observe that the modern farming system enabled to increase the food grain production substantially. Compounded with this,environmental degradation, loss in biodiversity and so on has been noticed. This has made individual thinkers to find alternative model and organic agriculture is found as sustainable and viable. In India many individuals and NGOs have been actively engaged in this domain. Nevertheless, there are some obstacles especially in marketing the organic products. Marketing for both inputs and output is found as either weak or underdeveloped. Appropriate and timely intervention will help solve the marketing problems. In this connection the filed experiences in Erode, Thanjavur district and elsewhere reveal that though the spread of organic farming is found as slow, it has much advantage like environment sustainability, crop diversity, economic viability and technical feasibility. Though it is an exploratory exercise, the sample farms are highly skewed. It is observed from the above that the transition from conventional to organic depend various agroeconomic features. Due to poor scientific methodological framework it is not possible to arrive at clear understanding. Therefore, the present exercise has been taken up for a comprehensive exploration.

II. OBJECTIVES

1. To study the farmer resources use in technical efficiency in organic and conventional agriculture in the study area.
2. To trace out comparative technical efficiency in organic and conventional agriculture.

III. METHODOLGHY

Relevant field data have been collected from organic and conventional farms for one crop year. The survey period was reported as normal agriculture year (2024-25) in the State of Tamil Nadu in general and particularly in the sample district of Erode. This study is largely based on primary data. Primary data has been collected from the growers practicing modern farming system and organic farming system in selected district of Tamil Nadu. Schedule was prepared to collect data from the selected conventional farmers around the organic farms. Schedules were pre-tested and necessary modifications were made based on the feed back. Adequate care was taken to cross check the recall bias during the investigation. The present research was conducted in Tamil Nadu. The state has been purposefully selected due to the availability of data base relating to organic farmers and close proximity to the researcher Gandhigram Trust. The located Dindugal documents the details on organic farms. The New Delhi based, Centre for Service and Environment has also documented the

particulars of. These two sources were used for elucidating the farmers list. Erode district were selected for primary data collection. These districts were purposefully selected because of the highly concentration of organic farmers in these district. As per the records of the Government there are 30 organic farmers, located in Erode 30 organic and 30 conventional farmers. The study covered all the 30 farmers practicing organic farming system. In order to make a comparative study a control group of 30 farmers practicing conventional agriculture were selected from the neighborhood of organic farms. The criteria for selection of these farmers are that they represent the same characters of organic farmers in terms of socio – economic background, geographical location and crops grown. Thus there are 60 farmers in both the sample districts for the study.

IV. ANALYTICAL FRAME WORK

The technical efficiency apart from other farm specific factors like socio-economic background of the cultivators, knowledge levels, number of years of cultivation etc. Two stage procedure adopted by Meaena et al (2006), Puttaswamaiah et al (2006), Mahadevappa (2004), Natarajan (2004) and, Kumaran Charyulu and Subho Biswas (2010) is followed for the present analysis. Accordingly, technical efficiency of ecological and modern farms producing five annual crops (Sugarcane, Turmeric, Banana, Tapioca and Betel) and one perennial crop coconut - and two seasonal crops (paddy and maize) was calculated. In the second stage the technical efficiency of individual farms were regressed against some of the socio-economic factors at the farm level. This analysis was carried for individual crops produced under ecological and modern farming systems. Cobb-Douglas production function has been the most widely used model in many empirical studies. Therefore, this functional form is used in the present analysis. The following Stochastic Production Frontier is estimated.

$\ln Y_{it} = \beta_{0t} + \beta_{1t} \ln X_{1it} + \beta_{2t} \ln X_{2it} + \beta_{3t} \ln X_{3it} + \beta_{4t} \ln X_{4it} + V_{it} + U_i$

X_{1it} = Value of farm power in rupees of i^{th} farm in the t^{th} period.

X_{2it}= Value of organic nutrients in rupees of i^{th} farm in the t^{th} period.

X_{3it} = Value of seed in rupees of i^{th} farm in the t^{th} period.

X_{4it}= Irrigation charges in rupees of ith farm in the t^{th} period.

V=Random variable and Assumed to be independent and identically distributed (iid) as N $(0, \sigma_v 2)$ and independent of U_i random variables.

U_i= is firm-specific technical efficiency related variable and non-negative, Defined by the truncation (at zero of N $(0, \sigma_u^2)$.

V. TECHNICAL EFFICIENCY

Technical Efficiency is measured as the ratio of the actual output to the potential output that can be attained when the farm is fully technically efficient. Technical Efficiency of the i^{th} farm is defined Where Y_{it}^* = Production in original units for the i^{th} farm in the t^{th} time period, Comparative analysis of technical efficiency, Crop wise average technical efficiency of ecological agriculture and modern agriculture were calculated and presented in tables. Z test was carried to estimate the statistics significant of differences in technical efficiency between organic.

$$Z = \frac{(X_1 - X_2)}{\sqrt{\sigma^2_1 / n_1 + \sigma^2_2 / n_2}}$$

Where

X_1 = Mean technical efficiency of organic farms, X_2 = Mean technical efficiency of conventional farms, σ^2_1 = Standard deviation of organic farms, σ^2_2= Standard deviation of conventional farms, n_1 = Number of organic farms, n_2 = Number of conventional farms,

VI. IMPACT OF FARM SPECIFIC VARIABLES ON TECHNICAL EFFICENCY

In order to determine the impact of farm specific variables on the technical efficiency scores generated by Frontier Production Function, multiple regression analysis was used. The following regression model is specified.TE = $a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4$**, e** Where x_1, The age of the head of the family, X2Education background (dummy), if graduate 1, otherwise 0, X3 Training (dummy), if trained 1, otherwise 0, X4 Experience in cultivation more than 5 years 1, Otherwise 0 and b1, b_2, b_3 and b_4 are respective regression coefficients.

VII. EMPRICAL ANALYSIS

The characteristics of organic and conventional grooving farmer been recorded in Table 1.1. The average size of holding observed on sample farms, both organic and conventional, was quite big. The ownership of livestock is vital for practicing organic farming. The major livestock owned by sample farmers included bullocks, cows, buffaloes, sheep and goats.

The livestock position, depicted in table 1.1 revealed that the number as well as the value of livestock owned by organic farmers was higher than of conventional farmers. The better livestock position of organic farmers may be attributed to their higher demand for manures and other livestock products. The major machinery consisted of bullock carts, electricity pumps, drip irrigation, sprayer. The major machinery position was also better both in terms of number and value, on organic and conventional sample farmers.

VIII. TECHNICAL EFFICENCY

The earlier analysis of economics spectate shows only economic profitability of organic and conventional farming systems. But, it does not indicate the efficiency levels of individual farmers. Understanding the relative efficiencies at the farm level is important so that the factors influencing the relative efficiency can be identified. This analysis helps in understandings the efficiency of the inputs used under different farming systems. Efficiency of any farm can be estimated in terms of allocative efficiency and technical efficiency. In the present study TE only was used. V Technical efficiency indicates the ratio between actual and potential output of any production unit. There are several studies by Kalirajan (1994), Shanmugam and Palaniswamy (1993) and Sree Ram Raju (2004) estimating the technical efficiency of particular crops in different states. In the present study, the procedure adopted by Battese and Coelli (1995) has been followed. In the first stage TE of one perennial crop-coconut and two seasonal crops - paddy and maize and five annual crops (sugarcane, banana, turmeric, tapioca and betel) has been estimated. The following table and graph shoe the TE level of perennial and seasonal crops in Erode district.

The above table 1.2 frequencies of technical efficiency for perennial crop and seasonal crop in Erode show that there is not much difference in the organic and conventional farms. Under both the farming systems more than 40 per cent of the farms have attained more than 70 per cent of technical efficiency in the case of coconut. Same is the case with paddy but a marginal difference could be observed in the case of paddy. In the production of paddy only 68 per cent of the organic farms have attained technical efficiency of more than 70 per cent and conventional farming more than 50 per cent have attained this level. While 31 per cent are in the range of 50 per cent to 70 per cent, technical efficiency in the case of organic farming, only 25 per cent are in this range in the case of conventional farming.

IX. COMPARATIVE ANALYSIS

Average technical efficiency attained by farmers under ecological agriculture and modern agriculture variation in the efficiency levels are presented in table 1 .3 Z statistics was calculated to test the significance of difference in average technical efficiency between organic and modern farms. The following table shows the crop wise average technical efficiency and variation in Erode district.

In the case of coconut average technical efficiency under organic agriculture is greater than at under conventional agriculture. But higher technical efficiency is also associated with higher coefficient of variation indicating lower consistency. This shows that there is a greater variation in the technical efficiency attained by farmers practicing organic agriculture in the production of coconut. Z test was conducted to observe the

significance of difference in mean technical efficiency and it was found to be insignificant. In the case of turmeric very marginal difference in the average technical efficiency could be observed between the organic farmers and conventional farmers. The difference is statistically not significant. In terms of variation conventional farm appears to be more consistent with relatively lower coefficient of variation.The same analysis was carried for farmers producing seasonal and annual crops. Paddy producing organic farmers appear to be more technically efficient compared to conventional farmers. Average technical efficiency for organic agriculture in the production of paddy is 97.64 per cent whereas under modern cultivation is 84.86 per cent. The higher technical efficiency for organic agriculture is more consistent with coefficient of variation (2.09 per cent) indicated that majority of the farmers producing paddy under organic farming system have attained 97 per cent technical efficiency. Difference is average technical efficiency of both the systems is statistically significant at 1 per cent level. This clearly shows that paddy production in Erode under organic agriculture is technically more efficient compared to paddy production under conventional farming system. Similar tendency could be observed in the case of sugarcane. Average technical efficiency of sugarcane production under organic agriculture is more than that under conventional agriculture and is more consistent among the sample farmers. Lower level of coefficient of variations (0.73 per cent) in the case of organic agriculture shows that majority of the framers producing under organic agriculture have attained average technical efficiency. In this connection average technical efficiency banana production organic agriculture is more than that conventional agriculture and is more consistent. The sample farmer's average technical efficiency of both the system is statistically significant at 1 per cent level. Average technical efficiencym of organic agriculture in the production of tapioca is 60.55 per cent where as conventional agriculture is 55.03 per cent and the system is statistically significant 1 per cent level. Maize average technical efficiency is 77.08 per cent where as under conventional agriculture is 75.25 per cent. This shows that greater technical efficiency in the production of sugarcane can be achieved under organic farming system.

X. CONCULUSION

The present study involves a comparative analysis of organic and conventional cereal-growing to evaluate their technical efficiency. Using a stochastic frontier production (SFP) approach, the analysis – focused on a sample of 30 Erode district Tamil Nadu farmers . Evaluate their technical efficiency. Using a stochastic frontier production (SFP) approach, the analysis found that organic practices are, on average, significantly less efficient than traditional methods, with respect to their specific technological frontier. However, since conventional and organic annual and perennial growing represents different production technologies – as analysis seems to confirm - the gap in favour of conventional farming should not be interpreted as an absolute disadvantage of traditional organic practices. It simply implies that organic farmers operate less closely, than conventional farmers, to their production frontier. In other words, they use their available resources less effectively than traditional farmers. Findings also show that this pattern is common to the two analyzed annual and perennial crops. Paddy producing organic farmers appear to be more technically efficient compared to conventional farmers. Average technical efficiency for organic agriculture in the production of paddy is 97.64 per cent whereas under modern cultivation is 84.86 per cent. The higher technical efficiency for organic agriculture is more consistent with coefficient of variation (2.09 per cent) indicated that majority of the farmers producing paddy under organic farming system have attained 97 per cent technical efficiency. Difference is average technical efficiency of both the systems is statistically significant at 1 per cent level. This clearly shows that paddy production in Erode under organic agriculture is technically more efficient compared to paddy production under conventional farming system. Similar tendency could be observed in the case of sugarcane. Lower level of coefficient of variations (0.73 per cent) in the case of organic agriculture shows that majority of the framers producing under organic agriculture have attained average technical efficiency. In this connection average technical efficiency banana production organic agriculture is more than that conventional agriculture and is more consistent. The sample farmer's average technical efficiency of both the system is statistically significant at 1 per cent level. Average technical efficiencym of organic agriculture in the production of tapioca is 60.55 per cent where as conventional agriculture is 55.03 per cent and the system is statistically significant 1 per cent level. Maize average technical efficiency is 77.08 per cent where as under conventional agriculture is 75.25 per cent. More efficiency. However, this study represents only a partial contribution and, as mentioned previously, the results cannot lead to generalization. More empirical research needs to be done to gather further information, for policy implications, on the efficiency of organic farming.

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TABLE 1.1:
CHARACTERISTICS ORGANIC AND CONVENTIONAL SAMPLE HOUSEHOLD

S. No	VARIABLE	ORGANIC	PERCENTAGE	CONVENTIONAL	PERCENTAGE
1	**AGE OF THE RESPONDENTS**				
	Below - 40	6	20	4	10
	41 - 50	16	53	21	70
	Above - 50	8	27	5	20
	Total	30	100	30	100
2	**EDUCATION STATUS OF SAMPLE HOUSE HOLD**				
	Primary	6	20	8	27
	Secondary	8	27	8	27
	Graduation	12	40	13	43
	Professional Degree	4	13	1	3
	Total	30	100	30	100
3	**FAMILY MEMBERS**				
	Male	52	40	58	54
	Female	49	38	27	25
	Children	28	22	22	21
	Total	129	100	107	100
	Per household members	4.3	-	3.5	-
4	**INCOME STATUS**				
	Below - 25000	2	10	7	22
	25001-50,000	12	40	11	37
	50,001-75000	6	20	4	13
	75001 - Above	9	30	8	27
	Total	30	100	30	100
5	**LANDING HOLDING**				
	> - 5 (Small)	119.5	37	90	34
	5 – 10 (Medium)	170	54	98	37
	< - 10 (Large)	28	9	75	28
	Total	317.5	100	268	100
	Per house Land holding	9	-	11	-
	CROPPING PATTERN IN SAMPLE HOUSE HOLD (IN ACRE)				
	Sugarcane	35.5	-	43	-

6	Turmeric	36	-	21	-
	Banana	44	-	26	-
	Paddy	46	-	24	-
	Tapioca	36	-	30	-
	Maize	7	-	5	-
	Coconut	50.5	-	45	-
	Tree,Fruit and Vegetable	39.5	-	40	-
	Total	294.5	-	234	-

Source Primary Data

TABLE 1.2:
COMPARATIVE TE OF PERENNIAL AND SEASONAL CROPS IN ERODE

Efficiency Range	Erode			
	Coconut		Paddy	
	Organic	Conventional	Organic	Conventional
< - 30	2 (9.09)	4 (18.18)	0 (000)	2 (12.5)
31 – 50	5 (22.7)	3 (13.63)	0 (000)	8 (50)
51 – 70	6 (27.27)	7 (31.18)	5 (31.25)	4 (25)
> - 70	9 (40.09)	8 (36.36)	11 (68.75)	2 (12.50)
Total	**22 (100)**	**22 (100)**	**16 (100)**	**16 (100)**

Source: Primary data

ABLE 1.3:
CROP WISE AVERAGE TE AND VARIATION (IN PERCENT) IN ERODE DISTRICT

Crops	Average Technical Efficiency		Co-efficient of Variation		Z 'Test'
	Organic	Conventional	Organic	Conventional	
Coconut	60.38	55.74	45.4	36.44	2.16*
Paddy	97.64	84.86	0.5	12.05	2.09*
Sugarcane	88.93	83.86	5.75	15.37	0.73
Turmeric	58.24	45.25	32.05	30.24	6.43*
Banana	82.60	78.12	4.82	32.40	2.02*
Tapioca	60.55	55.03	38.12	34.49	1.79*
Maize	77.08	75.25	28.57	24.39	0.22

*Note: * indicate 1 per cent level of significance*