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S Parthasharathi
Department of Agricultural and Rural Management, CARDS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

C Velavan
Department of Agricultural and Rural Management, CARDS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

A Rohini
Department of Agricultural and Rural Management, CARDS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

PM Shanmugam
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

M Prahadeeswaran
Department of Agricultural Economics, CARDS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Measurement of efficiency and profitability of the coir processing firms in the western zone of Tamil Nadu

S Parthasharathi, C Velavan, A Rohini, PM Shanmugam and M Prahadeeswaran

Abstract
Coir is an important natural fibre produced from the coconut. The coir processing firms provide both employment and entrepreneurial opportunities in the Western Zone of Tamil Nadu. In recent years coir processing firms faced many challenges in the domestic and export. In this context the present study aimed to measure the technical efficiency of coir processing firms. The primary data was collected from 50 modernized and semi-modernized coir processing firms. A stochastic frontier analysis was used to analyze the cost efficiency of the coir processing firms. The Benefit-Cost (BC) ratio revealed better the profitability of modernized firms, with a ratio of (1.28), compared to semi-modernized firms (1.01). It implied that the better profitability of the modernized firms compared to semi-modernized firms was mainly due to advancements in technologies like auto feeders, conveyors and producing two or more by-products. For technical efficiency, estimated variance parameters (γ) for modernized and semi-modernized coir processing firms were 0.94 and 0.95, respectively. This indicates that 94 percent and 95 percent of the output variation can be attributed to the firm's practices. The mean efficiency of the modernized firm was 94.27 percent and for semi-modernized firm was 84.03 percent. It is concluded from the study that modernized firms were comparatively more efficient and profitable than semi-modernized firms. Hence, semi-modernized firms have to upgrade their technology to become profitable.

Keywords: Coir processing firms, technical efficiency, stochastic frontier analysis, profitability, BC ratio

Introduction
The coir industry is a vital player in India's economy, utilizing the unique natural fiber extracted from coconut husks for various purposes. Coir yarn, obtained from spinning coconut husks, is used to create products like coir rope, mats, carpets, and more. India stands as a major coir producer, contributing nearly half of the global output. In Tamil Nadu, the coir industry has witnessed growth due to the abundant availability of coconut husks and high demand in international markets. The Coir Board and Government initiatives have actively support the industry by offering investment opportunities, skilled personnel, and market enhancements (www.coirboard.gov.in). The recent inclusion of the coir industry in the Prime Minister's Employment Generation Programme (PMEGP) is expected to further accelerate its modernization. Coir processing firms concentrated mainly in districts of Tamil Nadu, particularly in the western zone, thrives with numerous processing units producing various coir products. In recent years, coir processing firms are facing major challenges in the production and marketing of coir products. This situation lead many units to temporarily stopped production in the western zone of Tamil Nadu. Hence the present study aimed to measure the efficiency and profitability of coir processing firms in the state.

Research Methodology
The Western zone of Tamil Nadu is a major region known for its extensive coconut cultivation. This area includes Coimbatore, Erode, Tiruppur and parts of Namakkal, Dindigul and Theni districts of the state. The abundance of coconut cultivation in this zone ensures a plentiful supply of raw materials for coir processing firms. To conduct the study, a random sampling method was used to select 50 coir processing firms as samples from the Coir Manufacturers Association's registered members based on the technology adoption. A pretested interview schedule was used to collect the information from the sample.

Corresponding Author:
S Parthasharathi
Department of Agricultural and Rural Management, CARDS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Tools for analysis
Frontier production is used to analyze the technical efficiency and the benefit cost ratio used to measure the profitability of the coir processing firms is considered.

Frontier production function
Frontier production function represents the highest possible output for any given set of inputs using the best technology available, thus placing a limit or frontier on the observed values of the dependent variable in the sense that no observed value of the output is expected to lie above this frontier. The technical efficiency level of the coir processing firms and other factors affecting the inefficiency levels were estimated using the frontier approach. The empirical model was specified for coir processing firms using Cobb – Douglas frontier production function (Tadesse and Krishnamoorthy, 1997) [5] which is defined as follows:

$$Ln\ Y_i = ln\beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + V_i - U_i$$

Where, Y_i is the output (value of the produced in the coir processing firms) of the ith firms, V_i represents the random variation in output resulting from factors outside the coir processing firms and U_i is the technical inefficiency effects. The technical inefficiency model represented by U_i is expressed as,

$$U_i = \delta_0 + \delta_1\gamma_1 + \delta_2\gamma_2 + \delta_3\gamma_3 + \delta_4\gamma_4 + \delta_5\gamma_5 + \delta_6\gamma_6$$

Where γ_1 to γ_5 represents the variables to indicate their possible contribution on technical inefficiencies of the coir processing firms.
β and δ are the coefficients of unknown parameters to be estimated, together with the variance parameters which are expressed in terms of

$$\sigma^2 = \sigma^2 u + \sigma^2 v$$

Where, the term σ^2 is the variance parameter that denotes the total deviation from the frontier, $\sigma^2 u$ is the deviation from the frontier due to inefficiency, $\sigma^2 v$ is the deviation from the frontier due to stochastic noise.

$$\gamma = \sigma^2 u / \sigma^2$$

The γ parameter has values between zero and one (Coelli *et al.*, 2003) [2]. The parameters of the stochastic frontier production function model were estimated by the maximum likelihood method, using the computer program frontier version 4.1.

Mean technical efficiency
Technical Efficiency (TE) is the term which is used to describe the selection of the best cost function out of all those that are currently being used by coir processing firms. Utilizing the frontier production function method, Farrell (1957) [3] proposed the idea of efficiency which is an illustration of the potential output that can be generated with a specific set of inputs and a particular technology. The technique was altered in several ways by Timmer (1971) [6], who also placed a Cobb Douglas type specification on the frontier and created an output-based measure of efficiency. The mean of the distribution of the u_i or the average technical

inefficiency, might be easily computed using Cobb Douglas production function. The mean technical inefficiency is σ_u ($\sqrt{1 / 2\pi}$) and the mean technical efficiency is $1 - \sigma_u$ ($\sqrt{1 / 2\pi}$) in the half-normal case (u_i distributed as the absolute value of N (0, $\sigma^2 u$) variables). According to Aigner *et al.* (1977) [1] and Schmidt and Lovell (1980) [7], one can assess the technical efficiency given their estimate of a. The average E_i, as proposed by Jondrow *et al.* (1982) [4] could be used to measure technological inefficiency.
Cobb-Douglas type stochastic frontier production function was specified for the study.

$$\ln Y = \beta_0 + \sum_{i+1}^{5} \beta_1 \ln X_i + v_i - u_i$$

Where,
Y-Value of output (Rs)
X_1-Expenditure on labours (Rs)
X_2-Expenditure on raw materials (Rs)
X_3-Electricity charges (Rs)
X_4-Water charges (Rs)
X_5-Maintenance and diesel charges (Rs)
B_0-intercept
β_1, β_2, β_3,……. β_5- coefficients to be estimated
v_i the zero-mean random error and U_i denoting the effect of production inefficiency
From the residual, the technical efficiency of the coir processing firms was estimated.

B/C ratio
B/C ratio is a ratio of total revenue to total cost and it is used to understand the profitability of coir processing firms.

$$\text{Benefit cost ratio} = \frac{\text{Gross returns}}{\text{Total cost of production}}$$

The criteria are as follows:
B/C > 1 = profitable,
B/C = 1 = neither profitable nor loss and
B/C < 1 = not profitable.

Results and discussion
Nature of Ownership
The type of ownership would influence the decision-making authority of the firm. Hence, the results of distribution of firms based on their level of modernization and the type of ownership structure is presented in Table 1

Table 1: Nature of ownership of the sample coir processing firm (in numbers)

S. No	Particulars	Modernized Firms	Semi Modernized Firms	Overall
1	Proprietor	19(76)	22(88)	41(82)
2	Partnership	6(24)	3(12)	9(18)
	Total	25(100)	25(100)	50(100)

(Figures in parentheses indicate percentage to total)

It is revealed from the results that 76 percent of modernized firms were owned by a single proprietor, while 24 percent were partnership firms among modernized firms. Among semi-modernized firms, 88 percent were owned by a single proprietor and 12 percent were partnership firms. Overall, the majority of both modernized and semi-modernized firms were

proprietor-owned. The coir processing firms are mostly come under micro and small industries category which remain an investment of 1-8 crores. Hence, these firms were started by their own savings or minimal loan from the banks by the promoters as sole proprietorship or partnership type.

Annual Turnover of the Company

The annual turnover of the company plays a major role in new technology adoption. The data were analyzed based on the distribution of firms categorized by their level of modernization and their average annual turnovers, and the results are presented in Table 2.

Table 2: Annual Turnover of the sample coir processing firms (in numbers)

S. No	Particulars	Modernized Firms		Semi modernized Firms	
		Numbers	Average turnover/year	Numbers	Average turnover/year
1	2-3 (crores)	0(0)	-	15(60)	2.5
2	3-4 (crores)	5(20)	3.5	8(32)	3.5
3	4-5 (crores)	9(36)	4.5	2(8)	4.5
4	5-6 (crores)	8(32)	5.5	0(0)	-
5	6-7 (crores)	2(8)	6.5	0(0)	-
	Total	25(100)		25(100)	

(Figures in parentheses indicate percentage to total)

It could be observed that among modernized firms, there were no firms with turnovers in the 2-3 crores range. The most common turnover range for modernized firms was 4-5 crores, accounted to 36 percent of the total, with an average annual turnover of 4.5 crores. In contrast, among semi-modernized firms, the majority (60 percent) of the firms were within the 2-3 crores turnover range, with the average of 2.5 crores per year. Modernized firms showed a more diversified range of turnovers across categories, while semi-modernized firms had concentrated in 2-3 crores range.

Procurement of Raw Materials

The procurement of raw material is mainly through three ways – direct purchase, through traders and through direct suppliers. Each sample firm purchased their raw materials from more than one source. The results of source of purchase raw materials are presented in Table 3

Table 3: Procurement of Raw Materials by the sample coir processing firms (in numbers)

S. No	Particulars	Modernized Firms	Semi modernized Firms	Overall	Cost of load (Rs/load)
1	Direct Purchase	4(57)	3(75)	7(63.64)	6000
2	Through Traders	2(29)	1(25)	3(27.27)	6500
3	Direct Suppliers	1(14)	0(0)	1(9.09)	5500
	Total	7(100)	4(100)	11(100)	

(Figures in parentheses indicate percentage to total)

Among modernized firms, the majority (57 percent) of the firms purchased raw materials directly from the farmers, while 29 percent choose to procure through traders, and 14 percent source from direct suppliers. In contrast, among semi-modernized firms, a higher proportion (75 percent) engaged in direct purchase and 25 percent utilizing traders for procurement. Notably, no semi-modernized firms had received directly from the suppliers. Overall, direct purchase was the preferred method for both modernized and semi-modernized firms, contributing to 63.64 percent of the total procurement distribution. The cost of load varied from Rs.5500 per load to Rs.6500 per load.

Volume of Processing Raw Materials

The volume of processing raw material by the sample coir processing firms depends on technology adopted by the firms. The average weight of the load will be around two tonnes which accounted between 12000-15000 number coconut husk. Volume of processing raw material depends on technology adoption which mentioned in Table 4.

Table 4: Volume of Processing Raw Materials by the sample coir processing firms (in numbers)

S. No	Volume (loads/day)	Modernized Firms	Semi modernized Firms	Overall
1	<4	0(0)	16(64)	16(32)
2	4-5	2(8)	5(20)	7(14)
3	5-6	6(24)	4(16)	10(20)
4	6-7	11(44)	0(0)	11(22)
5	7-8	6(24)	0(0)	6(12)
	Total	25(100)	25(100)	50(100)

(Figures in parentheses indicate percentage to total)

Among modernized firms, volume of processing was concentrated predominantly in the range of 6-7 loads per day, accounting to 44 percent among modernized firms. However, among the semi-modernized firms, the majority (64 percent) came less than 4 loads per day range category. Interestingly, there are no semi-modernized firms processing 6-7 or 7-8 loads per day category. The less than 4 loads per day category was more common among semi-modernized firms, accounted to 32 percent of the total distribution. The range of 6-7 loads per day category was the most common capacity among modernized firms, contributing to 22 percent of the overall distribution.

Technical Efficiency of the sample coir processing firms
To check the technical efficiency of the coir processing firms some of the variable such as raw materials, electricity charges, labour wages, maintenance and diesel charges and packing charges are considered and the results are presented in Table 5.

Table 5: Technical Efficiency of the sample coir processing firms

Variables	Modernized Firms		Semi Modernized Firms	
	Coefficient	t-value	Coefficient	t-value
Intercept	2.033	1.734	1.021	1.894
Expenditure on labour (Rs)	-0.127	-1.025	0.237*	2.275
Expense on raw material (Rs)	0.229**	3.558	0.005	0.451
Electricity charges (Rs)	0.274*	2.825	0.194**	4.194
Water charges (Rs)	0.114*	2.304	0.259*	2.594
Maintenance charges and diesel (Rs)	-0.0895	-0.7702	0.527	1.624
Sigma square (σ^2)	0.015		0.006	
Gamma (γ)	0.94		0.95	
Log likelihood	60.99		73.20	
Mean efficiency	94.27		84.03	

(** significant at 1% level, * significant at 5% level)

The result showed that the estimated variance parameter (γ) is 0.94 for modernized and 0.95 for semi-modernized coir processing firms. It reveals that 94 percent and 95 percent of variation in the output was due to the practices of the coir processing firms. In case of modernized coir processing firms, the coefficient of raw material was found to be significant at 1 percent level and coefficient of electricity charges and water charges found to be significant at 5 percent level. In case of semi modernized firms the coefficient of electricity was found to be significant at 1 percent level and coefficient of expenditure on labour and water charges was found to be significant at 5 percent level.

Cost efficiency estimation
The cost frontier approach attempts to measure full-cost minimization in the sample processing firms, Cost efficiency of coir processing firms is sub divided into modernized and semi modernized firms according to the efficiency in Table 6.

Table 6: Categorization of the sample coir processing firms based on cost efficiency

S. No	Frequency	Modernized firms	Semi modernized firms
1	<80	0(0)	5(20)
2	80-85	1(4)	11(44)
3	85-90	4(16)	9(36)
4	90-95	14(56)	0(0)
5	>95	6(24)	0(0)
	Total	25(100)	25(100)

(Figures in parentheses indicate percentage to total)

From the table, it is observed that majority of the modernized firms 56 percent had the cost efficiency ranging from 90-95 followed by 24 percent for the cost efficiency had more than 95 and about 16 percent firms came under 85-90. In case of semi modernized firms, 44 percent of the firms had the cost of efficiency ranging from 80-85 followed by 36 percent had the cost of efficiency ranging 85-90 and 20 percent of the firms shows less than 80 cost of efficiency.

Returns of Sample Coir Processing Firms
The returns from the sample coir processing firms were calculated by accounting all the by products produced by the firms which includes returns from fibre and its byproduct, and coir pith and its by product. The returns of processing firms are presented in Table 7.

Table 7: Returns of sample Coir Processing firms (Rupees per year)

S. No	Particulars	Modernized Firms (in lakhs)	Semi-modernized Firms (in lakhs)
1	Sale of coir fibre(includes fibre by-products)	116.64	75.60
2	Sale of coir pith (includes all pith by-products)	168.48	50.40
3	Gross return	285.12	126.00
	Net return	63.84	2.16
	BC ratio	1.28	1.01

It could be concluded from the results that, modernized firms generated higher revenue in both coir fibre (including fibre by-products) and coir pith (including all pith by-products) categories, with Rs. 116.64 lakhs and Rs. 168.48 lakhs respectively, compared to semi-modernized firms with Rs. 75.60 lakhs and Rs. 50.40. Regarding gross return, modernized firms got a total of Rs. 285.12 lakhs compared to Rs. 126.00 lakhs for semi-modernized firms, which indicated the promoter's greater revenue generation capabilities.

Modernized firms got 63.84 lakhs after deducting costs, while semi-modernized firms have a substantially lower net return of 2.16 lakhs. The Benefit-Cost (BC) ratio was 1.28 and 1.01 for the modernized and semi-modernized firms. It indicated that the modernized firms were more profitable than semi-modernized firms.

Conclusion
The study highlights significant differences in efficiency and

profitability of modernized and semi-modernized coir processing firms. Majority of modernized firms 56 percent exhibited cost efficiency between 90-95, with 24 percent exceeding 95, and about 16 percent ranging from 85-90. Semi-modernized firms showcased cost efficiency with 44 percent at 80-85, 36 percent at 85-90, and 20 percent below 80. Hence, it is concluded that modernized firm have high cost efficiency and returns compared with semi-modernized firms due to the advancement and adaptation of new technologies. Modernized firms tend to have higher turnovers, prefer direct procurement, handle larger processing volumes, and achieve better financial efficiency with a substantial net return of 63.84 lakhs and higher Benefit-Cost ratio of 1.28. On the other hand, semi-modernized firms exhibit lower turnovers, favoring direct procurement as well, but with lower processing volumes and less favorable financial performance with substantial net returns of 2.16 lakhs and with benefit cost ratio of 1.01 and it is suggested that the need for similar advancements in semi-modernized firms to enhance coir processing efficiency.

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