Journal of Experimental Agriculture International

Volume 46, Issue 7, Page 484-496, 2024; Article no.JEAI.118554
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

The Efficiency of Drip Irrigation vs Flood Irrigation in Coconut Production – An Agro-economic Study in Tiruppur District of Tamil Nadu, India

G. Arun Prasath [a++*], V. Balachandrakumar [a#] and D. Velmurugan [b†]

[a] School of Agriculture and Animal Sciences, Gandhigram Rural Institute (GRI - DTBU), Dindigul -624302, Tamil Nadu, India.
[b] Department of Agricultural Economics, Faculty of Agriculture, Annamalai University, Annamalai Nagar – 608002, Chidambaram, Tamil Nadu, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jeai/2024/v46i72602

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/118554

Original Research Article

Received: 09/04/2024
Accepted: 12/06/2024
Published: 22/06/2024

ABSTRACT

Coconut also called as 'Kalpavriksha' in Sanskrit, which means tree of heaven, because of its usefulness from each part of the tree. India is one of the leading producers of coconut in the world as India stands third place in terms of area under coconut cultivation followed by Indonesia and

[++] Guest Faculty (Agrl. Economics);
[#] Guest Faculty (Agronomy);
[†] Associate Professor;
**Corresponding author: E-mail: arunprasathgtirupur@gmail.com;*

Cite as: *Prasath, G. Arun, V. Balachandrakumar, and D. Velmurugan. 2024. "The Efficiency of Drip Irrigation Vs Flood Irrigation in Coconut Production – An Agro-Economic Study in Tiruppur District of Tamil Nadu, India". Journal of Experimental Agriculture International 46 (7):484-96. https://doi.org/10.9734/jeai/2024/v46i72602.*

Philippines. Though coconut has several uses, it requires high amount of water for growth and it is about 800 to 1000 mm annually. The study was aimed to find the irrigation method, which would be efficient for coconut cultivation. Hence, to compare the yield, profitability and efficiency of coconut production among drip irrigated and flood irrigated farms, a study was formulated in Tiruppur district with a sample of 40 drip irrigated and 40 flood irrigated farms constituting a total of 80 coconut farms. The study found that drip irrigation reduces weed growth, pest incidence, etc, which leads reduced labour use and contributes to increased net returns. The net returns was also comparatively low in flood irrigated farm category Rs. 88962.76, as against the net return of Rs. 112374.14 in drip irrigated farm category. The difference in net returns between flood and drip irrigated farms was Rs. 23411.38 and it was about 20.83 per cent higher than net returns obtained from flood irrigated coconut farms. The results of benefit cost ratio was higher in drip irrigated farm category (1.51) as compared to flood irrigated farm category (1.42). This might be mainly due to the increased yield obtained in drip irrigated farms than flood irrigated farms due to better efficiency of production. The mean technical efficiency was found to be 76.58 per cent and 87.66 per cent in flood irrigated and drip irrigated coconut farms respectively. It can be concluded from the analysed results that the coconut production, profitability and efficiency is high in drip irrigated farms and hence the study recommends for adoption of drip irrigation for coconut cultivation, leading to sustainable water use as by the sixth sustainable development goal.

Keywords: Coconut production; efficiency; drip irrigation; flood irrigation.

1. INTRODUCTION

India is one of the leading producers of coconut in the world as India stands third place in terms of area under coconut cultivation followed by Indonesia and Philippines. Also, India occupies first place and second place in terms in terms of production and productivity [1]. Coconut is a perennial crop and its life span ranges from 50 to 60 years from planting and gives yield till lifespan if provided with proper management and care [2]. It can be harvested 4 - 10 times per year and it depends upon the yield, variety and purpose. The yield also varies for each harvest and year from planting. Considering the importance of coconut, it is rightly called as 'Kalpavriksha', which means tree of heaven in sanskrit [3], because of its usefulness from each part of the tree [4]. It is also called as Tree of Abundance, Tree of life, etc., [5].

Coconut has several medicinal properties and the entire crop products has several uses. On considering its usefulness and inorder to promote the same, Coconut development board was established by the Governemnt of India under the ministry of agriculture and farmers welfare. More than 12 million people in the country depends upon coconut cultivation, marketing and other related activities [6]. Having so much importance, like others the coconut also has a disadvantage of high-water requirement of about 800 to 1000 mm annually. This is because of being perennial in nature and the nut itself contains water in its endosperm. As the country India, itself is a water stressed nation [7], irrigating coconut crop through flooding requires a lot of water and also expensive during cultivation practices. On the other side, considering the evapotranspiration, a huge volume of irrigation water is lost during evapotranspiration.

Evapotranspiration is the sum of evaporation and transpiration. Loss of water from the surface of the land due to stagnation of water and sunshine as water vapour is called evaporation, whereas, loss of water from plants through stomatal opening as water vapour is called transpiration. In 1940, an Israel engineer Symcha Blasé found that a tree closer to a leaking faucet exhibited vigorous growth than other trees. This becomes the concept of drip irrigation in the later years [8-10]. In flood irrigation water loss happens through transpiration and evaporation, whereas in drip irrigation water loss through evaporation is highly minimized or almost equal to zero. Several literatures stated that drip irrigation saved water upto 50 per cent. The core aim of the study is to find the efficient method of irrigation and hence a study was formulated in order to compare the benefits of drip irrigation over flood irrigation which will be more useful for scientific community, farming community as well as for the policy makers in the view of getting better returns by choosing better irrigation system.

With this background a study was carried out with the following objectives.

1.1 Objectives

- To calculate and compare the cost and returns of coconut production among drip irrigated farms and flood irrigated farms of the study area
- To compare the efficiency of coconut production between drip irrigated farms and flood irrigated farms of the study area

2. METHODOLOGY

2.1 Area Selection and Sampling

Tiruppur is one of the leading districts in Tamil Nadu in area under coconut cultivation [11]. Area under coconut cultivation is about 63011.99 ha in Tiruppur district alone, which is about more than 50 per cent of the district's irrigated area and hence Tiruppur district is purposively selected for this study based on the suitability to objectives. In Tiruppur district, two blocks namely Udumalapettai and Gudimangalam were selected, as both the blocks have majority of coconut plantation in Tiruppur district.

Multistage purposive and random sampling was followed. 40 drip irrigated coconut farms and 40 flood irrigated farms were selected randomly in both the blocks and a total of 80 coconut growers in the Tiruppur district was selected and primary data was collected from well-structured questionnaire related to coconut cultivation aspects.

2.2 Tools of Analysis

Cost and returns: Farmers planted coconut in different time periods and their investments differ. To bring these costs on par, the investments and all the costs incurred were considered for the year 2023 and calculated. The average establishment costs over years were collected by data collection from coconut growers in terms of Indian rupees (INR).

Inputs cost: The actual cost incurred for various inputs like manures, fertilizers, plant protection chemicals, labour, etc., were considered.

Irrigation water cost: Irrigation cost in the present study was calculated by volumetric pricing method. Equipment's related to irrigation like pumpset, borewell, conveyance and storage structures, etc., were identified and their lifespan was considered. Later, the capital investment made were compounded to the present year with 2 per cent discount rate and amortized based on its lifespan, this gives the total cost of irrigation by amortization [12]. Quantity of water pumped out and Number of irrigations per hectare per year for each crop was calculated. Finally, the total annual cost of irrigation by amortization divided by total volume of water pumped out gives the cost of irrigation per unit volume of water. Cost of irrigation per unit volume of water multiplied by volume of water irrigated per hectare per year for a crop gives cost of irrigation per hectare per year for each crop.

Land: To include the share of land in the total cost of production, the imputed rental value of owned land was considered.

Interest on working and fixed capital: Interest on working capital was computed at the rate of seven per cent per annum, the rate at which the commercial banks advance short-term loans to the farmers. Interest on fixed capital was worked out at the rate of 12 per cent per annum, the rate charged for long term loans by the commercial banks.

Land revenue: Land revenue actually paid by the farmers was considered.

Later on, all the above-mentioned variables were converted to a hectare for calculation and all the values mentioned are in Rs./ha.

Production function analysis: Cobb-Douglas type of production function analysis was employed based on the literatures by Karthick et al., [13] and Jeevan et al., [14]. The production function for coconut was

$$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} U_i \text{ -------------(1)}$$

where,

Y – Coconut yield (in nuts/ ha)
X_1, - Manures (in kg/ha),
X_2, - Complex fertilizers (in kg/ha),
X_3, - Potassic fertilizers (in kg/ha),
X_4 - Micronutrient mixture (in litre/ha) and
X_5 - Plant protection chemicals (in litre/ha)
X_6 - No. of irrigations (in No./ha),
β_0 - Constant, U_i - Error term, β_i's - Parameters to be estimated.

2.3 Stochastic Frontier Production Function

In order to assess the technical efficiency of coconut production, Stochastic frontier production function was employed. The model for cross-sectional data is $Y = f(X_i\alpha)\, e^{\varepsilon i}$ (i = …..n) as defined by Aigner et al., [15], Meeusen and Broeck [16], Battese and Coelli [17] where, Y_i = Output of the i^{th} farmer, X_i = input quantities used of i^{th} farmer, α = parameters to be estimated, ε_i = A stochastic error-term consisting of two independent components U_i and V_i, and $\varepsilon_i = V_i - U_i$. [18,19].

Variables like weather, occurrence of pest and diseases and other random variables are captured by the systematic, independent component V_i, which is equal to $V_i \approx N(0, \sigma^2_v)$. Another component U_i, accounts for the variation due to inefficiency from the frontier. This component is non-negative and follows normal distribution or exponential distribution [20]. The variance of ε is given by $\sigma^2 = \sigma^2_u + \sigma^2_v$, where, the term σ^2 is the variance parameter that denotes the total deviation from the frontier, σ^2_u is the deviation from the rontier due to inefficiency, and σ^2_v is the deviation from the frontier due to stochastic noise.

Indicator of relative variability is represented by $\gamma = \sigma^2_u / (\sigma^2_u + \sigma^2_v)$, which differentiates the actual yield from the frontier. When the value of σ^2_v is closer to zero, then the predominant error is U_i, it implies γ = 1. This means yield differences are mainly due to non-adoption of best practice or technique. Alternatively, when the value of σ^2_u tends to zero, then the symmetric error-term, V_i is the predominant error and leads γ to zero. This means the yield differences are mainly due to randomness or external factors that are not included in the model [21,22].

2.4 The Model

The stochastic frontier production function used in the study was given by Equation (3):

$$\ln(Y) = \alpha_0 + \alpha_1 \ln(X_1) + \alpha_2 \ln(X_2) + \alpha_3 \ln(X_3) + \alpha_4 \ln(X_4) + \alpha_5 \ln(X_5) + \alpha_6 \ln(X_6) \ldots \alpha_n \ln X_n + V_i - U_i \quad \ldots(2)$$

The mean technical efficiency is given by $1 - \sigma_u (2/\pi)^{1/2}$ [23]. The technical efficiency of individual farm was worked out by $TE = Y_i/Y_i$ where, Y_i^* is the frontier yield and Y_i is the actual yield [24,25].

3. RESULTS AND DISCUSSION

The results and discussion are as follows.

The Table 1 show the cost and returns of coconut production in its initial life span of first 7 years and above. During this period, among the different cost components incurred in cultivation of coconut, manure cost alone shares about 40 per cent to the annual total cost in all the years. All the cost incurred for manuring, fertilizer application, plant protection chemical spraying, harvesting, field maintenance, etc., were included in other labour charges and its share to the annual total cost is around 10 per cent in all the years. The share of fertilizer cost to the total cost ranges from 8 to 16 per cent and share of irrigation accounts for about 7 per cent individually in all the years. 10 per cent of the total cost incurred for field preparation, planting, digging and pit filling in the first year was taken as the cost for second year.

The Table 1 also revealed that the share of field operational costs decreased over the years from 18.24 per cent in the first year to 11.23 per cent in the seventh year. At the same time, the share of material cost was 71.33 per cent in the first year and it increases to 78.59 per cent in the seventh year. The reason is coconut crop requires more quantity of inputs for growth during its growth period than field operations. The share of fixed costs to the total cost is low and about 10 per cent.

Among the samples, coconut started bearing from the fifth year with gross income of Rs. 187189.30 and attains its maximum potential from the seventh or eighth year with gross income of Rs. 319675.85. Hence, these 5 years can be stated as establishment period and from 6^{th} year it can be stated as bearing and maintenance period. Annual total cost for maintenance was found to be Rs. 194010.77 and it increased to Rs. 218386.85 in the fourth year and decreased to Rs.198731.22, continued to the end of lifespan. This showed that there is an increasing trend of total annual costs in the establishment period and then remained same in the maintenance period. If maintained properly, by spraying timely plant protection chemicals, and by providing proper inputs, a hectare of coconut plantations will give net returns of Rs. 120944.63 from the seventh year to its lifetime.

Table 1. Average cost of cultivation of coconut crop in Tiruppur district (1 to 7 years and above) (in Rs./ha)

S. No	Particulars	I year	II year	III year	IV year	V year	VI year	VII year	>VII year
A)	Operational costs								
1.	Land preparation	9528.45 (4.91)	2100 (1.20)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
2.	Digging and pit filling	4983.33 (2.57)	498.33 (0.28)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
3.	Planting	2000 (1.03)	200 (0.11)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
4.	Other Labour charges	18866.66 (9.72)	18867.66 (10.75)	24742.00 (11.99)	22308.33 (10.22)	22308.33 (11.23)	26308.33 (11.23)	22308.33 (11.23)	22308.33 (11.23)
	Sub total	35378.44 (18.24)	21665.99 (12.35)	24742 (11.99)	22308.33 (10.22)	22308.33 (11.23)	22308.33 (11.23)	22308.33 (11.23)	22308.33 (11.23)
B)	Material costs								
1.	Manuring	88000.36 (45.36)	88000.36 (50.15)	104529.6 6 (50.65)	104529.6 6 (47.86)	79147.55 (39.83)	79147.55 (39.83)	79147.55 (39.83)	79147.55 (39.83)
2.	Seedling	5000 (2.58)	500 (0.28)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
3.	Fertilizer	16200.24 (8.35)	16200.24 (9.23)	26183.66 (12.69)	38186.33 (17.49)	45246.57 (22.77)	45246.57 (22.77)	45246.57 (22.77)	45246.57 (22.77)
4.	Plant protection	3050.33 (1.57)	3050.33 (1.74)	3050.33 (1.48)	4531.38 (2.07)	4483.5 (2.26)	4483.5 (2.26)	4483.5 (2.26)	4483.5 (2.26)
5.	Irrigation	15084.61 (7.78)	15084.61 (8.60)	15084.61 (7.31)	15084.61 (6.91)	15084.61 (7.59)	15084.61 (7.59)	15084.61 (7.59)	15084.61 (7.59)
6.	Others	2000 (1.03)	2000 (1.14)	2000 (0.97)	2000 (0.92)	2000 (1.01)	2000 (1.01)	2000 (1.01)	2000 (1.01)
7.	Interest on working capital @ 7%	9056.49 (4.67)	8738.49 (4.98)	10559.38 (5.12)	11503.24 (5.27)	10217.36 (5.14)	10217.36 (5.14)	10217.36 (5.14)	10217.36 (5.14)
	Subtotal	138389.03 (71.33)	133574.03 (76.12)	161407.64 (78.20)	175835.22 (80.52)	156179.58 (78.59)	156179.58 (78.59)	156179.58 (78.59)	156179.58 (78.59)
	Total (A+B)	173767.4 (89.57)	155240.02 (88.46)	186149.64 (90.19)	198143.55 (90.73)	178487.92 (89.81)	178487.92 (89.81)	178487.92 (89.81)	178487.92 (89.81)
C)	Fixed costs								
1.	Rental value of land	15000 (7.73)	15000 (8.55)	15000 (7.27)	15000 (6.87)	15000 (7.55)	15000 (7.55)	15000 (7.55)	15000 (7.55)
2.	Land revenue	200 (0.10)	200 (0.11)	200 (0.09)	200 (0.09)	200 (0.10)	200 (0.10)	200 (0.10)	200 (0.10)
3.	Depreciation	2890.45	2890.45	2890.45	2890.45	2890.45	2890.45	2890.45	2890.45

S. No	Particulars	I year	II year	III year	IV year	V year	VI year	VII year	>VII year
		(1.49)	(1.65)	(1.40)	(1.32)	(1.45)	(1.45)	(1.45)	(1.45)
4.	**Interest on fixed capital**	2152.85 (1.11)	2152.85 (1.23)	2152.85 (1.04)	2152.85 (0.99)	2152.85 (1.08)	2152.85 (1.08)	2152.85 (1.08)	2152.85 (1.08)
	Sub total	20243.3 (10.43)	20243.3 (11.54)	20243.3 (9.81)	20243.3 (9.27)	20243.3 (10.19)	20243.3 (10.19)	20243.3 (10.19)	20243.3 (10.19)
	Total cost (A+B+C)	194010.77 (100)	175483.32 (100)	206392.94 (100)	218386.85 (100)	198731.22 (100)	198731.22 (100)	198731.22 (100)	198731.22 (100)
D)	**Returns**								
	Return from intercrop	30000	27000	0	0	0	0	0	0
	Return from coconut	0	0	0	0	187189.30	283967.52	319675.85	319675.85
	Gross returns	**30000**	**27000**	**0**	**0**	**187189.30**	**283967.52**	**319675.85**	**319675.85**
	Net returns	**- 164010.7**	**- 148483.32**	**- 206392.9**	**- 218386.8**	**- 11541.92**	**85236.30**	**120944.63**	**120944.63**

Table 2. Comparing the economics of coconut cultivation among drip irrigated and flood irrigated farms in Tiruppur district (in Rs./ha)

S.No	Particulars	Flood irrigated Farms	Drip irrigated farms	Difference
1.	Manures	77193.55 (36.49)	80419.91 (36.89)	3226.36 (4.01)
2.	Fertilizers	42861.57 (20.26)	44100.32 (20.23)	1238.75 (2.81)
3.	Irrigation	13040.61 (6.16)	17983.33 (8.25)	4942.72 (27.48)
4.	Plant protection chemicals	4641.09 (2.19)	4123.43 (1.89)	-517.66 (-12.55)
5.	Labour	16308.88 (7.71)	13709.23 (6.29)	-2599.65 (-18.96)
6.	Interest on working capital	10783.20 (5.10)	11223.53 (5.15)	440.34 (3.92)
7.	Land revenue and depreciation	2941.45 (1.39)	3213.43 (1.47)	271.98 (8.46)
I	**Cost A1**	**167770.35 (79.31)**	**174773.18 (80.18)**	**7002.84 (4.01)**
II	**Cost A2**	**167770.35 (79.31)**	**174773.18 (80.18)**	**7002.84 (4.01)**
8.	Interest on Owned fixed capital asset	2112.57 (1.00)	2247.89 (1.03)	135.32 (6.02)
III	**Cost B1**	**169882.92 (80.31)**	**177021.07 (81.09)**	**7138.16 (4.03)**
9.	Rental value of owned land	15000.00 (7.09)	15000.00 (6.88)	0 (0.00)
IV	**Cost B2**	**184882.92 (87.40)**	**192021.07 (88.10)**	**7138.16 (3.71)**
10.	Imputed value of family labour	7412.45 (3.50)	6130.92 (2.81)	-1281.53 (-20.90)
V	**Cost C1**	**177295.37 (83.82)**	**183151.99 (84.03)**	**5856.63 (3.20)**
VI	**Cost C2**	**192295.37 (90.91)**	**198151.99 (90.91)**	**5856.63 (2.96)**
VII	**Cost C3**	**211524.90 (100.00)**	**217967.19 (100.00)**	**6442.29 (2.96)**
VIII	**Gross returns**	**300487.67**	**330341.33**	**29853.67 (9.04)**
IX	**Net returns**	**88962.76**	**112374.14**	**23411.38 (20.83)**

During the period of establishment of coconut plantations, intercrops can be grown to acquire income and in this study area, banana is cultivated as intercrop in the first two years of establishment period and it gives return of Rs. 30000 and Rs. 27000 in the first and second year respectively. The total net investment in the establishment period i.e., the sum of annual total cost incurred for establishment of coconut plantation upto five years was Rs. 993005.10 and total net returns upto fourteen years i.e., the sum of annual net returns from sixth year to fourteenth year was Rs. 1052793.34. It can also be stated that the amount spent during establishment period can be obtained in 14 years and the remaining years of bearing from the fourteenth year to lifespan stands for the profit. Hence, 14 years can be stated as pay-back period for establishment cost. The life span of coconut ranges from 40 to 70 years. Hence, the net returns obtained from coconut after fourteen years is completely profitable.

It was depicted from Table 2, that the total cost of cultivation of coconut per hectare per year in drip irrigated farm category was Rs. 217967.33, which was higher than the cost of cultivation of coconut in flood irrigated farm category (Rs. 211524.90) in Tiruppur district. This is due to investment made for drip irrigation structures, which increases the amortised cost of irrigation in case of drip irrigated farm category. Among the components of the cost A1, manures occupied the highest share in both the categories, with more than 36 per cent each, followed by fertilizers, labour, etc. It should be noted that difference of cost between drip irrigated and flood irrigated farms in terms of fertilizers and plant protection chemicals are minor.

The cost incurred for fertilizers was higher in drip irrigated farm category (Rs. 44100.32) than flood irrigated farm category (Rs. 42861.57). Similarly, irrigation cost was also higher in drip irrigated farms (Rs. 17983.33) than flood irrigated farms (Rs. 13040.61). It was due to investment made for drip irrigation structures. Alternatively, labour charges (Rs. 13709.23) were lower in drip irrigated farms compared to flood irrigated farms (Rs. 16308.88). This might be due to fact that drip irrigation reduces weed growth, pest incidence, etc, which leads reduced labour use. The Table 2 also showed that among the components of Cost A1, the lowest share in both the categories was contributed by the land revenue (0.09 per cent in both categories), and interest on working capital (about5.1 per cent in both categories).

The gross return was less in the flood irrigated farm category as compared to the drip irrigated farm category, which accounted for Rs. 330341.33 and Rs. 300487.67 respectively. It could also be inferred from the Table 2 that the net returns was also comparatively low in flood irrigated farm category Rs. 88962.76, as against the net return of Rs. 112374.14 in drip irrigated farm category. This might be mainly due to the increased yield obtained in drip irrigated farms than flood irrigated farms.

Further, it could be concluded from the Table 2 that when comparing the net returns from both the categories, there was a significance difference in the net returns from, coconut crop, which was Rs. 23411.38. It was about 20.83 per cent higher than net returns obtained from flood irrigated coconut farms. This proves the importance of improved use of irrigation technology (drip irrigation).

The Table 3, revealed that the gross income was less in flood irrigated farm category (Rs. 300487.66) as compared to drip irrigated farm category (Rs. 330341.33). Also, the other measures of returns over different costs namely, farm business income, family labour income, net income and farm investment income were comparatively lower in flood irrigated farm category than drip irrigated farm category of coconut cultivation in Tiruppur district. It could also be observed from the results that the benefit cost ratio was higher in drip irrigated farm category (1.51) as compared to flood irrigated farm category (1.42). Thus, it could be inferred that in flood irrigated farm category, the efficiency of production was low, which may be due to the less yield obtained due to less efficiency of water use.

Table 3. Returns over cost for coconut cultivation in Tiruppur district (in Rs./ha)

S.No	Particulars	Flood irrigated farms	Drip irrigated farms	Difference
1.	**Total costs**	211524.90	217967.19	6442.29 (2.96)
2.	**Gross income**	300487.67	330341.33	29853.66 (9.04)
3.	**Net income**	88962.76	112374.13	23411.38 (20.83)
4.	**Farm Business income**	132717.31	155568.14	22850.83 (14.69)
5.	**Farm investment income**	125304.86	149437.22	24132.36 (16.15)
6.	**Family labour income**	115604.74	138320.25	22715.51 (16.42)
7.	**Benefit cost ratio**	1.42	1.51	0.09

Table 4. Estimates of Cobb-Douglas production function of coconut in Tiruppur district

S.No	Variables	Regression coefficients	
		Flood irrigated farms	Drip irrigated farms
1.	Intercept	6.232 *** (1.579)	4.199 ** (1.889)
2.	Manures (in Kg)	0.1979 * (0.1157)	0.1219 *** (0.0372)
3.	Complex fertilizers (in Kg)	0.1051 * (0.0605)	0.2103 * (0.1106)
4.	Potassic fertilizers (in Kg)	0.2632 *** (0.0967)	0.1903 *** (0.0421)
5.	Micronutrient mixture (in L)	0.1728 * (0.0979)	0.3121 NS (0.1892)
6.	Plant protection Chemicals (in L)	0.3549 NS (0.3043)	- 0.2337 NS (0.2137)
7.	Irrigation (in No.)	0.0407 NS (0.0601)	0.2488 ** (0.1158)
8.	R2	0.5733	0.5361
9.	Adjusted R^2	0.5516	0.5205
10.	N	40	40

*Note - ***, ** and * refers to significance at 1 %, 5 % and 10 % levels respectively*

Table 5. Estimates of stochastic frontier production function of coconut farms in Tiruppur district

S.No	Variables	Parameters	Coefficients	
			Flood irrigated farms	Drip irrigated farms
I	**Frontier production function**			
1	Intercept	α_0	1.91 *** (0.0094)	1.2213 NS (0.823)
2	Manures (in Kg)	α_1	0.2142 *** (0.0013)	0.2894 * (0.1534)
3	Complex fertilizers (in Kg)	α_2	0.09421 NS (0.0753)	0.2174 ** (0.1023)
4	Potassic fertilizers (in Kg)	α_3	0.2529 NS (0.2932)	0.1738 NS (0.2134)
5	Micronutrient mixture (in L)	α_4	0.1231 *** (0.0342)	0.2032 * (0.0621)
6	Plant protection chemicals (in L)	α_5	0.1832 NS (0.121)	0.0732 NS (0.1421)
7	Irrigation (in No.)	α_6	0.2103 * (0.1177)	0.2642 ** (0.1267)
II	**Diagnostic statistics**			
1	Sigma square	σ^2	0.0981 ** (0.0432)	0.067 ** (0.0289)
2	Gamma	γ	0.8777 ** (0.4162)	0.3567 ** (0.1681)
3	Farmer variability	$\sigma^2 u$	0.0861	0.0239
4	Random variability	$\sigma^2 v$	0.0120	0.0431
5	Log likelihood		61.31	13.38
6	Mean technical efficiency		76.58	87.66
7	No. of observations	N	40	40

*Note - ***, ** and * refers to significance at 1 %, 5 % and 10 % levels respectively*

The Table 4 showed the results of production function estimates of coconut farms in Tiruppur district. The percentage of variation explained in flood irrigated coconut production was 57.33. Similarly, 53.61 per cent variation in production of coconut from drip irrigated farms was explained by the selected explanatory variables. This could be revealed from the R^2 values. The results also revealed that manures and complex fertilizers were positive and significant at 10 per cent level. Potassic fertilizers and micronutrient mixture were significant at 1 and 10 per cent level respectively. It means on increasing manures about one per cent level from the geometric mean level, would increase the coconut production by 0.19 per cent and one per cent increase in complex fertilizers would increase the coconut production by 0.10 per cent. Similarly, the elasticity of potassic fertilizers is about 0.26 and micronutrient mixture is about 0.17. The above-mentioned results are with respect to flood irrigated coconut farms in Tiruppur district.

Results with respect to drip irrigated coconut farms were as follows. Manures and potassic fertilizers were positive and significant at 1 per cent level. On increasing manures from geometric mean level to one per cent, *ceteris paribus* would increase the coconut production by 0.12 per cent and one per cent increase in potassic fertilizers from the geometric mean level, *ceteris paribus,* would increase coconut production by 0.19 per cent. Similarly, the variables complex fertilizers and irrigation were positive and significant at 10 and 5 per cent levels respectively. The elasticity of complex fertilizers was 0.21, which revealed that 0.21 per cent increase in coconut production can be made by increasing complex fertilizers upto per cent. The elasticity of irrigation is 0.24, indicating that 0.24 per cent of output can be increased by increasing the irrigation by one per cent, *ceteris paribus*. The variable plant protection chemical was negative however, it is nonsignificant.

Technical efficiency was estimated by using stochastic frontier production and estimates of technical efficiency of coconut production in Tiruppur district could be traced from Table 5. The gamma estimate, which is an indicator of relative variability of Ui and Vi that differentiates the actual yield from the frontier; was significant at 5 per cent level and the value of gamma was 0.8777 which means that 87.77 percent variation between observed and frontier output was due to differences in the farmers practices or technology adopted in case of flood irrigated farms. The gamma value of drip irrigated farms was found to be 0.3567 which means 35.67 per cent variation between observed and frontier output was due to random error.

The estimated σ^2u and σ^2v were 0.0861 and 0.0120, indicated that the difference in the yield was higher due to farmers practices rather than random variability in case of flood irrigated farms. The estimated farmers variability (0.0239) was lesser than random variability (0.0431) for drip irrigated farms. The results also showed that except potassic fertilizers and plant protection chemicals all the variables were positive and significant and their production elasticities ranges from 0.12 to 0.29. The variable micronutrient mixture was significant at 1 per cent level and 10 per cent level in flood irrigated farms and drip irrigated farms respectively. One per cent increase in micronutrient mixture level from geometric mean, *ceteris paribus* would increase the nut production by 0.12 per cent and 0.2 per cent in flood irrigated and drip irrigated coconut farms respectively.

Table 6. Frequency distribution of technical efficiency of coconut farms in Tiruppur district

S.No	Technical Efficiency class (%)	Flood irrigated farms		Drip irrigated farms	
		No. of farms	Percentage	No. of farms	Percentage
1	<50	0	0.00	0	0.00
2	51 – 60	4	10.00	0	0.00
3	61 – 70	10	25.00	2	5.00
4	71 – 80	9	22.50	12	30.00
5	81 – 90	9	22.50	11	27.50
6	>90	8	20.00	15	37.50
	Total	40	100.00	40	100.00
i)	Mean technical Efficiency (%)	76.58		87.66	
ii)	Maximum technical efficiency (%)	95.12		99.03	
iii)	Minimum technical Efficiency (%)	52.43		65.32	

The Table 6 showed the frequency distribution of technical efficiency of Coconut farms in Tiruppur district. The mean technical efficiency was found to be 76.58 per cent and 87.66 per cent in flood irrigated and drip irrigated coconut farms respectively. In other words, maximum technical efficiency has not reached among the sample farms and 35 per cent of the flood irrigated sample farms have less than 70 per cent technical efficiency and in case of drip irrigated sample farms the technical efficiency is greater than 70 per cent for majority of the farms. Maximum and minimum technical efficiency of flood irrigated coconut farms was 95.12 per cent and 52.43 per cent whereas in case of drip irrigated coconut farms it was 99.03 per cent and 65.32 per cent respectively.

4. CONCLUSION

The study found that the gross return was less in the flood irrigated farm category as compared to the drip irrigated farm category, which accounted for Rs. 330341.33 and Rs. 300487.67 respectively. It could be inferred that the net returns was also comparatively low in flood irrigated farm category Rs. 88962.76, as against the net return of Rs. 112374.14 in drip irrigated farm category. The results of benefit cost ratio was higher in drip irrigated farm category (1.51) as compared to flood irrigated farm category (1.42). This might be mainly due to the increased yield obtained in drip irrigated farms than flood irrigated farms due to better efficiency of production. Technical efficiency of coconut farms in Tiruppur district showed that the estimated farmers variability was lesser than random variability for drip irrigated farms. Maximum and minimum technical efficiency of flood irrigated coconut farms was 95.12 per cent and 52.43 per cent whereas in case of drip irrigated coconut farms it was 99.03 per cent and 65.32 per cent respectively.

The mean technical efficiency was found to be 76.58 per cent and 87.66 per cent in flood irrigated and drip irrigated coconut farms respectively. This showed that 23.42 per cent and 12.34 per cent of technical efficiency can be increased in flood and drip irrigated coconut farms respectively. It can also be said that the efficiency of drip irrigation is very high compared to flood irrigation and also it is approaching closer to 100. It can be concluded that the coconut production, profitability and efficiency is high in drip irrigated farms and hence the study recommends for adoption of drip irrigation for coconut cultivation, leading to sustainable water use as by the sixth sustainable development goal.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Muthumani K, Sathuragiri V. A study on coconut cultivation practices and satisfaction among the farmers in Theni district. World Wide Journal of Multidisciplinary Research and Development. 2022;8(05);88-93.
2. Vanitha V, Janagam D. Concurrent estimation of coconut construction in Krishnagiri and Dharmapuri Districts of Tamil Nadu. Think India Journal. 2019;22(4):10709-10719.
3. Ahuja SC, Ahuja U, Ahuja S. Coconut-history, uses, and folklore. Asian Agri-History. 2014;18(3).
4. Naveena K, Santosha R, Garima S, Yogish KJ. Forecasting of coconut production in India: A suitable time series model. International Journal of Agricultural Engineering. 2014;7(1):190-193.
5. Shanthini G, Ramane RV. An analysis of growth trends of coconut crop in India. International Journal of Research in Management Economics and Commerce. 2018;8(3):78-85.
6. Preethi VP, Thomas KJ, Kuruvila A. Performance of coconut in India: A trend analysis. Journal of Tropical Agriculture. 2018;56(2):210-214.
7. Jain SK. Population rise and growing water scarcity in India - Revised estimates and required initiatives. Current Science. 2011; 101(3):271–276.

8. Biswas Suranjana, Shashidhara GB. Experimental evaluation of irrigation methods on soil nutrient status and nutrient uptake of summer groundnut. International Journal of Plant & Soil Science. 2023; 35(18):1286-93.

   Available:https://doi.org/10.9734/ijpss/2023/v35i183395.
9. Kamesh TM, Suresh Kumar D, Vidhyavathi A, Nagarajan K, Duraisamy MR. A study on irrigation water productivity under different irrigation environments of Tamil Nadu, India. Journal of Experimental Agriculture International. 2023;45(9):108-16.

   Available:https://doi.org/10.9734/jeai/2023/v45i92181.
10. Sharmasarkar FC, Sharmasarkar S, Miller SD, Vance GF, Zhang R. Assessment of drip and flood irrigation on water and fertilizer use efficiencies for sugarbeets. Agricultural Water Management. 2001, Jan 1;46(3):241-51.
11. Kannan B, Ragunath KP, Kumaraperumal R, Jagadeeswaran R, Krishnan R. Mapping of coconut growing areas in Tamil Nadu, India using remote sensing and GIS. Journal of Applied and Natural Science. 2017;9(2):771-773.
12. Nagaraj N, Anitha S. Impact of micro irrigation on groundwater savings, productivity, and profitability of principal crops in the Eastern Dry Zone and Central Dry Zone of Karnataka: A resource economic analysis. Agricultural Economics Research Review. 2022; 35(1):57-70.
13. Karthick V, Alagumani T, Amarnath JS. Resource–use efficiency and technical efficiency of turmeric production in Tamil Nadu—A Stochastic Frontier Approach. Agricultural Economics Research Review. 2013;26(1);109-114.
14. Jeevan MN, Mukhopadhyay S, Dey G. Resource use efficiency of subsistence and commercial crops – comparative economic analysis of ragi and sunflower in Karnataka. International Journal of Agriculture Sciences. 2018;10(22):7528 – 7531.
15. Aigner D, Lovell CK, Schmidt P. Formulation and estimation of stochastic frontier production function models. Journal of Econometrics. 1977;6(1):21-37.
16. Meeusen W, Broeck VD. Efficiency estimates from Cobb-Douglas production function with composed error. International Economic Review. 1977; 18(2):435-444.
17. Battese G, Coelli T. Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. Journal of Economics. 1988;28(4):387-399.
18. Kittilertpaisan J, Kittilertpaisan K, Khatiwat P. Technical efficiency of rubber farmers' in Changwat Sakon Nakhon: Stochastic frontier analysis. International Journal of Economics and Financial Issues. 2016;6(6S):138-141.
19. Harshani KAP, Shantha AA. Factors affecting the economic efficiency of small-scale rubber plantations: With special reference to Kalutara district in Sri Lanka. Colombo Business Journal. 2021;12(1): 145-165.
20. Giroh DY, Nachandiya N. Technical efficiency and profitability of small holder natural rubber production in southern Nigeria. Journal of Plantation Crops. 2022; 50(1):8-19.
21. Wakili AM. Technical efficiency of maize farmers in Gombi local government of Adamawa State, Nigeria. Agricultural Journal. 2012;7(1):1-4.
22. Karthick V, Thilagavathi M, Surendran A, Paramasivam R, Balaji SJ. Estimation of resource use efficiency and technical efficiency of small onion farmers in Tamil Nadu: A cobb-douglas and stochastic frontier approach. Eco Affairs. 2015; 60(3):401.
23. Palanisami K, Paramasivam P, Ranganathan CR. Agricultural production economics: Analytical methods and applications, associated publishing Company, New Delhi; 2002.
24. Bhende MJ, Kalirajan KP. Technical efficiency of major food and cash crops in Karnataka (India). Indian Journal of Agricultural Economics. 2007;62(2);176-192.

25. Giroh DY, Adebayo EF. Analysis of the technical inefficiency of rubber tapping in rubber research institute of Nigeria, Benin City, Nigeria. Journal of Human Ecology. 2009; 27(3);171-174.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/118554