



RESEARCH ARTICLE

A study on farmer's perception and buying behavior towards the use of Tamil Nadu Agricultural University Coconut tonic: An Empirical Analysis

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Abstract

One of the most popular and extensively utilized palm trees is the Coconut palm, often known as the "tree of life" or "Kalpavriksha." Agricultural economy of Tamil Nadu heavily depends on the production of Coconuts, especially in the Coimbatore area where productivity levels are significantly high. To enhance nut yield and palm health, the Tamil Nadu Agricultural University introduced the TNAU Coconut tonic, a nutrient formulation designed to supply essential macro-and micronutrients along with growth regulators. This study was undertaken with a sample size of 105 Coconut farmers selected purposively from 3 major Coconut-growing blocks of the Coimbatore district, namely, Kinathukadavu (45), Pollachi North (30) and Pollachi South (30). Primary data were collected through personal interviews using a structured schedule. The study examined the socio-economic profile, adoption behaviour, farmer satisfaction and constraints confronted by farmers in adopting TNAU Coconut tonic. The results revealed that most respondents had higher secondary education, agriculture as their primary occupation, an annual income between ₹5–10 lakhs and operational holdings of 5–10 acres under tall varieties. Agricultural scientists and State Department officials were the primary sources of information and most farmers purchased the tonic directly from TNAU centers and applied it once a year even though the recommendation is twice a year. The paired t-test results indicated a significant increase of 131.24 nuts/tree after application. Kendall's Coefficient of Concordance Kendall's (W) was 0.655, showed a high level of farmer satisfaction, mainly due to yield improvement and better palm health. The high cost and limited availability of the tonic were identified as major constraints. While subsidies, demonstrations and integration into government schemes may improve adoption, the study lacks a cost-benefit or economic feasibility analysis, which is essential for evaluating its practicality. This should be considered as a limitation and addressed in future research.

Keywords: adoption behavior and farmer satisfaction; growth regulators; nutrient formulation

Introduction

The Coconut palm (*Cocos nucifera* L.), referred to as "Kalpavriksha" or the "tree of heaven," is a versatile and multifunctional crop of immense economic significance in India (1, 2). It provides copra, Coconut water, coir, Coconut oil, shelter, medicines and livelihood security to millions of people in rural areas (3). The Indian Coconut sector is a vigorous constituent of the national economy, supporting over 10 million people and contributing more than ₹12000 crore annually. India ranks as a premier Coconut-producing nation globally, with the third advance estimates for 2023–24 indicating a total cultivated area of 23.33 lakh ha and a production of over 21373 million nuts. This sustained expansion underscores the pivotal role of this crop in the agricultural sector (4). Among the major Coconut-growing states, Tamil Nadu is the leading cultivator, followed by Kerala. This crop is extensively grown throughout the state, with major production hubs in

Coimbatore, Thanjavur, Kanyakumari and Erode (4). According to the Department of Horticulture and Plantation Crops, the state's area under Coconut cultivation in 2023–2024 was approximately 4.88 lakh ha (5).

Historically, dependence on chemical fertilisers has been a primary strategy, but their harmful effects are increasingly depleting environmental and ecosystem health (6). In recent decades, substantial growth in both the global demand and supply of Coconuts and their derivatives has further solidified the sector as a crucial economic pillar for cultivating nations (7). In a Coconut system, the demand for nutrient replacement often increases faster than uptake and loss, especially given the palm's limited root surface for absorption. Therefore, maintaining an adequate and balanced nutrient supply is essential for optimal growth (8). This has led to growing global interest in organic and climate-resilient farming methods, pushing the market for

sustainable solutions, such as TNAU Coconut tonic and similar products, to a forecasted USD 8 billion by 2030 (9). While the technical benefits of the TNAU Coconut tonic are established, there is a need to understand the on-ground reality of its adoption. Therefore, this study aimed to investigate the constraints impeding the acceptance of TNAU Coconut tonic technology amid Coconut growers, evaluate the key benefits realised by users and analyse farmers' perception and buying behavior towards this root-feeding technique over time (10).

To address the unique nutritional challenges faced by Coconut cultivators in Tamil Nadu, the Department of Crop Physiology at Tamil Nadu Agricultural University (TNAU) has developed a targeted solution. In 2003, they released the "TNAU Coconut tonic," a novel crop booster designed to deliver essential nutrients and growth regulators directly to the palm's vascular system through root feeding. To guarantee effective absorption, a dosage of 200 mL per palm twice annually is recommended. This method ensures the efficient delivery of liquid supplements to plants, overcoming the limitations of traditional soil application (10, 11). Farmers who utilise tonics had greater yields and revenues, according to research (11). Within Tamil Nadu, the Coimbatore district records superior productivity levels due to favourable agro-climatic conditions, with Pollachi taluk serving as a significant cultivation area (12). Farmers with higher technical knowledge and education are better equipped to handle management issues, whereas a lack of expertise is often linked to limited productivity (13). However, despite the availability of such scientifically proven technologies, Coconut farmers often underproduce relative to the crop's potential. This gap is largely attributed to a general unawareness of the latest scientific advancements, a lack of necessary technical knowledge for their application and reluctance to integrate these innovations into farming practices (14).

Despite its economic importance, Coconut farming faces a broad spectrum of challenges that differ across regions and are shaped by socioeconomic and environmental factors. These difficulties manifest in areas such as input procurement, production processes, economic constraints, extension services and marketing dynamics (15). Furthermore, factors such as price, availability and severe labour shortages for farm operations can limit the adoption of new technologies (16).

Materials and Methods

Study area selection and sampling method

The study was carried out in Coimbatore district of Tamil Nadu, one of the leading Coconut-producing regions known for its extensive cultivation area and high productivity. Based on their significance in Coconut production and the adoption of improved agricultural technologies, 3 major Coconut-growing blocks-Kinathukadavu, Pollachi North and Pollachi South-were purposively selected for the analysis. A purposive sampling technique was employed to select respondents, as the study specifically targeted Coconut farmers with relevant experience and active involvement in the use of TNAU Coconut tonic. Accordingly, the study is framed as an exploratory and descriptive analysis of tonic users rather than a generalised population study. This method was preferred over probability sampling due to the limited and localised availability of adopters, making it more

feasible to focus on information-rich cases aligned with the study objectives. However, it is acknowledged that purposive sampling may introduce sampling bias and limit the generalisability of the findings, as the sample may not fully represent the entire population of Coconut farmers. A total sample size of 105 farmers was selected, comprising 45 respondents from Kinathukadavu, 30 from Pollachi North and 30 from Pollachi South, ensuring adequate representation from each block for meaningful comparison and analysis. Data collection was conducted between December 2025 and January 2026. In this study, Percentage analysis was used to calculate the percentage of general characteristics of farmers using TNAU Coconut tonic. The Paired T test was used to show the usage behavior of farmers towards TNAU Coconut tonic. Likert scale and Kendall's Coefficient of Concordance statistical method were used to show the satisfaction level of farmers towards TNAU Coconut tonic. Response Priority Index method to show the constraints faced by farmers in using the TNAU Coconut tonic.

Data collection

Primary data

This work was mainly based on primary data. Data were gathered directly from the selected respondents through structured personal interviews by means of a pre-tested schedule. The personal interview method was adopted to ensure the clarity of responses, minimise non-response errors and enhance the reliability and accuracy of the information collected. The interview schedule was designed to capture information related to socio-economic characteristics, usage behavior, perception, satisfaction level and constraints associated with the use of TNAU Coconut tonic. In line with the goals of the study, the gathered data were assembled and tabulated for additional statistical analysis.

Tools and analysis

In accordance with the particular goals of the study, the gathered data were methodically coded, tabulated and analysed using the proper statistical methods.

Both descriptive and inferential statistical techniques were employed to ensure a comprehensive interpretation of the results. The analytical framework adopted for each objective is described as follows.

Percentage evaluation

The overall traits of farmers who utilised the TNAU Coconut tonic were investigated using percentage analysis. Socioeconomic factors such as age, education, yearly income, farming experience, landholding size and cropping pattern were easier to categorise and understand using this technique. The frequency of respondents in each category was divided by the total number of respondents and the result was multiplied by 100 to determine the percentage. The demographic and farm-related characteristics of the sample farmers may be clearly shown and compared thanks to this technology.

Paired t-Test

To measure the usage behavior and impact of TNAU Coconut tonic on yield, a paired t-test was performed. This inferential statistical test was used to compare the mean yield per tree before and after the application of the tonic among the same group of farmers in the study. To ascertain if the observed difference between 2 related sample means was statistically significant, the paired t-test

was employed. At the 5 % significance threshold, the computed t-value was contrasted with the crucial t-value. The null hypothesis was rejected when the P-value was less than 0.05, indicating that the tonic's application had a substantial impact on Coconut yield.

Likert Scale and Kendall's Coefficient of Concordance (W)

In this study, "satisfaction level" refers to how satisfied farmers are with this product. A 5-point Likert scale, ranging from "Highly Dissatisfied" to "Highly Satisfied," was used to gauge farmers' satisfaction with TNAU Coconut tonic. A number of factors, including impact on output, enhancement of soil health, product quality, price perception, availability at sales locations and ease of application, were rated by farmers. The degree of agreement among respondents on these characteristics was evaluated using Kendall's Coefficient of Concordance (W). W has a value between 0 and 1, with values nearer 1 denoting moderate to strong responder agreement. The consistency of the farmers' satisfaction ratings was ascertained with the use of this metric. Farmers that use TNAU Coconut tonic are very satisfied, as indicated by Kendall's W of 0.655.

Response Priority Index (RPI)

The Response Priority Index (RPI) method was used to rank constraints because it accounts for both the frequency and severity of responses, providing a more accurate prioritisation of issues faced by farmers. This technique ranks constraints based on their relative importance, as perceived by the respondents. Farmers were asked to prioritise various constraints, such as high cost, limited availability, lack of awareness and technical difficulties. The RPI was computed by assigning appropriate weights to each rank and deriving the index value. Constraints with higher RPI values are considered more severe and critical. This method enables the systematic identification and prioritisation of major adoption barriers. The greater the RPI, the higher the position of that constraint (17).

$$(RPI)I = \sum_{j=1}^{\bar{k}} f_{ij} X_{[(k+1)-j]} / \sum_{j=1}^{\bar{k}} \sum_{i=1}^k f_{ij}$$

Where,

RPI_i = Response priority index for i^{th} constraint

F_{ij} = Number of responses for the j^{th} priority of the i^{th} constraint ($i = 1, 2, \dots, l; j = 1, 2, 3, \dots, k$),

$\sum_{j=1}^k f_{ij}$ = Total number of responses for the i^{th} constraint,

K = Number of priorities (1 - Strongly agree, 2 - Agree, 3 - Moderate, 4 - Disagree, 5 - Strongly disagree),

$X_{\{(k+1)-j\}}$ = Scores for the j^{th} priority,

$\sum_{i=1}^l \sum_{j=1}^k f_{ij}$ = Total number of responses to all constraints. (Eqn. 1)

Results and Discussion

The demographic characteristics of the farmers, such as gender, age classification, educational qualification, occupation, family income, farming experience, farm size, cultivar growth, source of information about TNAU Coconut tonic, place of purchase and frequency of application were analysed and the results are presented. In addition, farmers' usage behaviour of TNAU Coconut tonic, their satisfaction levels and the constraints faced were also examined and are discussed in the following sections. However, the study does not account for variations in soil fertility, irrigation practices and pest and

disease management, all of which can significantly influence Coconut yield. As these factors were not controlled within the scope of the study, they are acknowledged as limitations and their omission may affect the interpretation of the relationship between TNAU Coconut tonic usage and yield performance.

Socio-economic profile of farmers

The adoption of TNAU Coconut tonic was higher among middle-aged farmers, with 37.14 % in the 35–44 age group and 29.52 % above 55 years. Most respondents had higher secondary (31.43 %) and secondary education (25.71 %) and 76.19 % depended primarily on agriculture. A majority (63.81 %) earned ₹5–10 lakhs annually and 46.67 % had less than 20 years of farming experience, indicating that moderately experienced and economically stable farmers are more likely to adopt the technology.

Regarding usage behaviour, a majority of farmers (83.80 %) applied the tonic once a year, while 16.19 % applied it twice a year. The recommended dosage involves root feeding at about 200 mL per palm, typically applied twice annually under standard practice. These findings suggest that farmers tend to follow relatively low-frequency application patterns while maintaining the prescribed dosage levels for effective utilisation of the tonic. The socio-economic characteristics of farmers are presented in Table 1.

Comparison of the yield before and after usage of TNAU Coconut tonic

The impact of TNAU Coconut tonic on yield was analysed using a paired sample t-test by comparing the average yield per tree per year before and after its application. However, the "before application" yield data were primarily based on farmers' recall, which may introduce recall bias. The study does not rely on documented historical records and this limitation should be considered while interpreting the results. The null hypothesis (H_0) stated that there is no significant difference in mean yield before and after the use of TNAU Coconut tonic ($\mu_d = 0$), whereas the alternative hypothesis (H_1) stated that there is a significant difference in mean yield due to its application ($\mu_d \neq 0$). The results showed that the mean yield increased from 90.33 nuts per tree per year before application to 131.24 nuts after application, indicating a substantial improvement in productivity. The test was conducted with 105 observations and 104 df. The calculated t-value (-39.313) is far greater in absolute terms than the critical t-value (± 1.983) at the 5 per cent level of significance. Moreover, the $p < 0.001$ for both 1-tailed and 2-tailed tests was < 0.001 , which is less than 0.05. Because the calculated p-value is lower than the significance level and the absolute t-value exceeds the critical value, the null hypothesis is rejected. Therefore, it was concluded that the application of TNAU Coconut tonic had a statistically significant positive effect on Coconut yield, confirming its effectiveness in enhancing productivity. The results of the paired t-test are presented in Table 2. The relationship between yield before and after application is illustrated in Fig. 1, which shows a clear positive trend.

Farmer's satisfaction level and degree of agreement towards the use of TNAU Coconut tonic

A majority of farmers were satisfied with yield (60 % satisfied and 40 % highly satisfied) and product quality (70.47 % satisfied and 29.52 % highly satisfied). The level of agreement among farmers regarding satisfaction was assessed using Kendall's Coefficient of Concordance (W), which yielded a value of 0.655 with a chi-square value of 349.772 (df = 6) and a significance level of $p = 0.000$,

Table 1. Socio-economic profile of farmers

Sl. No.	Profile	Characteristics	Frequency	Percentage (%)
1	Gender	Male	102	97.14
		Female	3	2.86
2	Age (years)	> 55	31	29.52
		45–54	25	23.81
		35–44	39	37.14
		25–34	10	9.52
		15–24	0	0.00
3	Educational qualification	No formal	2	1.90
		Primary	4	3.81
		Middle	23	21.90
		Secondary	27	25.71
		Higher secondary	33	31.43
		Under graduate	13	12.38
		Post graduate	3	2.86
4	Occupation	Agriculture	80	76.19
		Agriculture + on farm	16	15.24
		Agriculture + off farm	9	8.57
5	Income	5–10 lakh	67	63.81
		> 10 lakhs	34	32.38
		< 5 lakhs	4	3.81
6	Farming experience	< 20	49	46.67
		21–30	37	35.24
		31–40	11	10.48
		41–50	7	6.67
7	Area under cultivation	up to 2.5 acre	28	26.67
		2.5–5 acres	24	22.86
		5–10 acres	27	25.71
		above 10 acres	26	24.4
8	Cultivar grown	Tall	90	85.71
		Dwarf	8	7.62
		Hybrid	7	6.67
9	Source of information	Fellow farmers	31	29.52
		Family/friends/neighbours	44	41.90
		Farmers organisations	53	50.48
		State Department officials	78	74.29
		Agricultural scientists	96	91.43
		Mass media (TV, internet, newspaper, magazine)	45	42.86
		Extension participation (kisan mela, exhibitions, trainings, demonstrations)	33	31.43
10	Place of purchase	TNAU	89	84.76
		Agricart	4	3.80
		Research station	12	11.42
11	Frequency of application	Once a year	88	83.80
		Twice a year	17	16.19

Table 2. Comparison of the yield before and after usage of TNAU Coconut tonic

Particulars	Average yield per tree/ year before usage of TNAU Coconut tonic	Average yield per tree/ year after usage of TNAU Coconut tonic
Mean	90.333	131.238
Variance	134.263	115.279
Observations	105	105
Pearson Correlation	0.428	
Hypothesised Mean Difference	0	
df	104	
t Stat	-39.313	
P(T<=t) one-tail	0	
t Critical one-tail	1.66	
P(T<=t) two-tail	0	
t Critical two-tail	1.983	

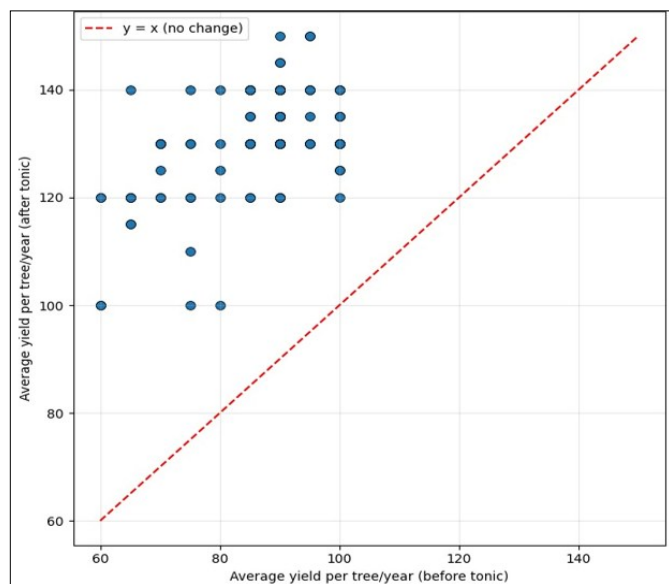


Fig. 1. Scatter plot (Impact of TNAU Coconut tonic on yield per tree).

indicating a statistically significant and high degree of agreement among respondents. Ranking analysis revealed that “effect on yield” (mean score 5.88) was ranked first, followed by “product quality” (5.60) and “environmental safety” (4.80). “Ease of application” (3.49) and “availability at sale points” (3.39) were ranked fourth and fifth respectively, while “price perception” (3.09) ranked sixth and “soil health improvement” (1.76) was ranked lowest. These findings indicate that yield performance and product quality are the most influential factors driving farmers’ satisfaction with TNAU Coconut tonic. The satisfaction levels and degree of agreement among farmers are presented in Table 3 and Table 4 respectively.

Table 3. Farmer’s satisfaction level towards the use of TNAU Coconut tonic

Factors	Effect on yield	Soil health improvement	Product quality	Price perception	Availability at sales points	Ease of application	Environmental safety
Highly dissatisfied	0	39	0	20	19	8	0
Dissatisfied	0	40	0	28	13	20	0
Neutral	0	23	0	24	25	31	34
satisfied	63	3	74	33	48	44	47
Highly satisfied	42	0	31	0	0	2	24
Sum	105	105	105	105	105	105	105
Weighted Mean	4.4	2.29	4.3	2.61	2.97	3.11	3.9
SD	0.49	1.1	0.72	1.08	1.07	1.01	0.85

Table 4. Degree of agreement among farmers on satisfaction using TNAU Coconut tonic: Kendall’s Coefficient of Concordance (W)

Rank	Factor	Mean Value	Rank
1	Effect on yield	5.88	I
2	Product quality	5.6	II
3	Environmental safety	4.8	III
4	Ease of application	3.49	IV
5	Availability at sale points	3.39	V
6	Price perception	3.09	VI
7	Soil health improvement	1.76	VII
Particulars		Value	
Sample size (N)		105	
Kendall’s W		0.655	
Chi - square		349.772	
df		6	
Significance level		0	

Table 5. Challenges faced by farmers in using TNAU Coconut tonic

Sl. No	Factors	Sum of Scores	Total	RPI	Rank
1	High price	452	105	0.895	I
2	Labour requirement	373	105	0.739	II
3	Delayed results	347	105	0.687	III
4	Limited knowledge on application	342	105	0.677	IV
5	Limited availability	310	105	0.614	V
6	Storage issues	248	105	0.491	VI

Constraints faced by farmers in using TNAU Coconut tonic

The constraints faced by farmers in using TNAU Coconut tonic were analysed using the Response Priority Index (RPI). The results indicate that high price (RPI = 0.895) was ranked as the most severe constraint, followed by labor requirement (RPI = 0.739) and delayed results (RPI = 0.687). Limited knowledge of application (RPI = 0.677) and limited availability (RPI = 0.614) ranked fourth and fifth respectively. Storage issues (RPI = 0.491) were the least severe constraints. Overall, economic and operational factors, particularly high costs and labour demand, emerged as major challenges affecting the adoption and use of TNAU Coconut tonic among farmers. The constraints faced by farmers are presented in Table 5.

Overall, the study reinforces existing evidence that while extension support and perceived benefits encourage adoption, economic and practical constraints can limit wider diffusion. Therefore, policy interventions such as subsidies, awareness programmes and strengthening extension services are essential to improve adoption and sustained use of agricultural technologies like TNAU Coconut tonic.

Conclusion

The present study demonstrated a positive association between the application of TNAU Coconut tonic and increased Coconut yield. Farmers reported high levels of satisfaction, particularly with respect to yield enhancement and product quality, which emerged as the primary factors influencing adoption and continued use. Nevertheless, the high cost of the tonic and labour requirements were identified as major constraints limiting its wider adoption.

Overall, the tonic shows considerable potential for improving Coconut productivity; however, its broader utilisation depends on addressing these economic and operational challenges. Policy interventions, including subsidies, improved distribution networks, awareness programmes and on-farm demonstrations, are recommended to enhance accessibility, encourage adoption and ensure sustained productivity in Coconut cultivation.

Authors' contributions

CHS conceptualised the study, carried out data collection, performed data analysis and prepared the original draft of the manuscript. NVP contributed to the study design, provided overall guidance and supervised the research work. MC reviewed and edited the manuscript critically for important intellectual content. MK assisted in data analysis and interpretation and contributed to manuscript refinement. PSR supported statistical analysis and contributed to reviewing the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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