PLANT SCIENCE TODAY
ISSN 2348-1900 (online)
Vol 12(sp1): 01–06
https://doi.org/10.14719/pst.6022

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RESEARCH ARTICLE

Farmers' awareness on bio inputs in coconut cultivation based on education in Thondamuthur block of Coimbatore district, Tamil Nadu, India

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OPEN ACCESS

ARTICLE HISTORY
Received: 21 October 2024
Accepted: 25 October 2024
Available online
Version 1.0 : 07 February 2025
Version 2.0 : 13 February 2025

Check for updates

Additional information
Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

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Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

CITE THIS ARTICLE
Manikandan P, Sivakumar SD, Velavan C, Karthikeyan S, Vanitha G. Farmers' awareness on bio inputs in coconut cultivation based on education in Thondamuthur block of Coimbatore district, Tamil Nadu, India. Plant Science Today. 2025;12(sp1):01-06. https:/doi.org/10.14719/pst.6022

Abstract

This study investigated farmers' awareness and use of bio-inputs in coconut farming in Thondamuthur block, Coimbatore district, Tamil Nadu, India. Given agriculture's significance in India's economy, bio-inputs are an alternative to chemical fertilizers amidst population increase and climate change. The study evaluates the level of awareness amongst farmers, factors that influence the buying behaviour of bio-inputs like bio-fertilizers and bio-pesticides and constraints to their use. Statistical analysis included percentage analysis, Chi-square test and factor analysis on data from 140 respondents. Factors like yield, price, experience, knowledge and government subsidies influenced buying behaviour mainly. The findings revealed that although farmers are aware of bio-inputs, constraints such as availability, poor government support and quality concerns limit their utilization. The paper emphasized that given these constraints, there is a need for more policy support as well as training programs to enhance bio-input utilization in sustainable agriculture in the study area.

Keywords

bio inputs; farmer awareness; constraints; sustainable agriculture

Introduction

The agriculture sector has historically played a critical role in India's economy, although its contribution to the GDP has decreased from 51.8 % in 1950-51 to 16 % in 2022-23 (1). Despite this decline, agriculture continues to be a major source of employment, particularly in rural areas, where it supports over half of the population (2). Rapid population growth and climate change are adding significant stress to farming systems and are expected to reduce crop yields by 25 %. Bio inputs offer a sustainable alternative to chemical inputs in agriculture (3). These include bio fertilizers and bio pesticides that help to improve nutrient availability and control pests respectively (4). In regions like Coimbatore, particularly in coconut cultivation, the use of bio inputs not only reduces dependency on chemical fertilizers but also enhances the resilience of plants to environmental stresses (5). In addition to their positive environmental impact, bio inputs play a vital role in fostering long-term soil health. Unlike chemical fertilizers, which can degrade soil organic matter and disrupt microbial communities, bio inputs work to maintain a balanced and healthy soil ecosystem. The microorganisms in bio fertilizers form beneficial relationships with plants, improving nutrient absorption and encouraging sustainable

farming methods. As concerns about the detrimental effects of chemical pesticides and fertilizers continue to grow globally, more farmers are adopting bio inputs as part of the shift toward organic and sustainable agriculture. This transition not only helps to restore ecological harmony but also meets the increasing consumer demand for chemical-free, healthier agricultural products. With ongoing advancements in research and development, bio inputs are expected to see broader adoption, playing an important role in shaping the future of agriculture in India.

This study focuses on farmers' awareness and buying behaviour of bio inputs in the Thondamuthur block of Coimbatore district. It aims to identify factors influencing buying behaviour and the challenges farmers face in incorporating bio inputs into their practices.

Materials and Methods

Thondamuthur block is situated in the western part of Coimbatore district, Tamil Nadu and is noted for its rich soil and large-scale coconut farming was chosen as the study area. Thondamuthur block covers a total area of 367,097 ha where about 165,260 ha are under cultivation of which coconut is the chief plantation crop grown in about 85,831 hectares. Many farmers of the region have started using bio-inputs which include bio-fertilizers and bio-pesticides which can enhance the soil and the productivity in the region as part of a more sustainable farming system. The sample size of 140 farmers from all 10 villages of Thondamuthur block was selected using a simple random sampling method as the study design.

Percentage Analysis

Percentage analysis is a statistical technique that quantifies and expresses a value as a fraction of one hundred, making it easy to make comparisons across distinct datasets by providing them with a common denominator. This method is very useful in data presentation as it allows for the condensation of data (6).

In this study, it is used to analyse the demographical characteristics of the farmers. the formula is (7):

Percentage = (No. of samples taken/ Total Sample) X 100

Chi-Square Test

A Chi-Square test is a statistical method that measures the relationship between two variables when both of them are categorical. It compares the real counts within the groups in the sample on hand to what was expected under the condition that the two variables are independent of one another (8). The chi-square test was used in this research to study the association between farmers' education level and awareness, the formula for the chi-square test is (9):

$$\chi^2 = \Sigma [(O - E)^2 / E$$

Where:

χ^2 is the chi-square test statistic.

Σ represents the summation

O is the observed frequency

E is the expected frequency

Factor Analysis

Principal component analysis was utilized in order to obtain the factor loadings. The main aim of taking Principal component analysis was to identify the most significant factors determining the buying behaviour of Thondamuthur farmers to practice bio inputs in their coconut farming. The component model is expressed as follows (10):

$$Zi = ai_1X_1 + ai_2X_2 + ai_3X_3 + \ldots + ai_pX_p$$

Where:

Zi: Magnitude of the variable.

ai_p: The factor loading of variable i on factor p.

X_p: The uncorrelated trait measured by factor 'p' which is possessed by the variable.

i: Factor loading with reference to indicators 1, 2, 3, ... p.

p: A set of common factors (1, 2, ... p).

ai_pX_p: Factor coefficient or loading of variable i on factor p.

For determining the number of components, principal components with Eigenvalues of one or more were retained and positive values from the rotated component matrix (Varimax rotation method) were selected to extract the variables from the structural components (11).

The scree plot was utilized in this study to determine the optimal number of factors to retain during the factor analysis. It provides a graphical representation of the eigenvalues associated with each factor, plotted in descending order of magnitude. The point at which the curve flattens, known as the "elbow," indicates the number of factors that sufficiently explain the variance in the dataset. This approach ensures that only the most significant factors are considered, avoiding overfitting and simplifying the interpretation of results.

In this study, factor analysis was used to analyse the factors that influence the buying behaviour of Thondamuthur farmers' in purchasing bio inputs to incorporate into their farming practices.

Garrett ranking

Garrett ranking is a method of research used to rank several different attributes based on either preferences or importance to respondents. It uses the percentage position formula to convert ranks into scores, followed by getting the mean score for each factor. The factor with the highest mean score is considered the most important or preferred by the respondent.

In this study, the Garett ranking is used to analyse the constraints faced by Thondamuthur farmers in adopting bio inputs in their cultivation.

Garett ranking has been calculated by using the following formula(12):

Position percentage = 100 * (Rij - 0.5)/Nj

Where:

Rij is the rank assigned to the *i*th constraint by the jth individual.

Nj represents the total number of constraints ranked by the *j*th individual.

This formula is used to calculate the percentage position of a particular rank, which is then converted to Garrett scores using a table.

Results

Farmers' Demographic Characters

Table 1 shows the demographic profile of 140 farmers in Thondamuthur block, Coimbatore district, Tamil Nadu out of which 74.29 % were male and the females' percentage was 25.71. The most prevalent age group of farmers falls under 41-50 years (39.29 %) and this was followed by a 23.57 percent population over 50. 17.14 % of the population were between 21 & 30 years old and below 21 years occupy 20 % of the population. Out of the sample seen, 57.85 percent with primary education was the highest level completed and a sizeable 31.43 % were illiterates. A smaller portion had higher qualifications with 4.29 % being graduates, 3.57 % having secondary education and 2.86 % were postgraduates. In terms of the number of years in farming, the largest respondent percentage constituted 35 % who had farming experience of 11 to 20 years. This was followed by 24.29 % with 5 to 10 years, 21.42 % with over 20 years and 19.29 % with less than 5 years. From the analysis of land holdings, 26.43 % of farmers owned 2 to 4 acres, followed by 25.71 % of farmers with land holdings of 1 to 2 acres. Further, 20 % had land with 4-10 acres, 18.57 % owned land less than 1 acre and 9.29 % had land ownership with more than 10 acres.

Factors influencing the farmers' buying behaviour

KMO and Bartlett's test was applied to check the adequacy of the sample. The values are given in Table 2 and they revealed that the sample size was adequate for factor analysis since the KMO value was more than 0.5(0.624).

Table 1. Farmers' demographic characters

Sr. No	Particulars	No. of Respondents (n=140)	Percentage
1	**Gender**		
	Male	104	74.29
	Female	36	25.71
2	**Age**		
	21-30	24	17.14
	31-40	28	20.00
	41-50	55	39.29
	Above 50	33	23.57
3	**Education**		
	Graduate	6	4.29
	Illiterate	44	31.43
	Post graduate	4	2.86
	Primary	81	57.85
	Secondary	5	3.57
4	**Experience Level**		
	Less than 5 years	27	19.29
	5-10 years	34	24.29
	11-20 years	49	35
	More than 20 years	30	21.42
5	**Land Holdings**		
	2-4 acres	37	26.43
	1-2 acres	36	25.71
	4-10 acres	28	20
	Less than 1 acre	26	18.57
	More than 10 acres	13	9.29

Table 2. KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.624
Bartlett's Test of Sphericity	Approx. Chi-Square	173.945
	Df	78
	Sig.	0.000

Principal Component analysis and Varimax rotation were used to study the factors influencing the buying behaviour of the bio inputs farmers. The results of the factor analysis are given in Table 3. Seven dimensions were extracted and analysed in the principal component analysis. The percent variations of the seven dimensions illustrated in Table 4 are 15.807, 10.791, 9.834, 9.625, 9.323, 8.845 and 8.707 respectively and the cumulative percent is 72.932 %. The Scree Plot for all the factors is shown in Fig. 1, which illustrates the eigenvalues of the factors derived from the analysis. The plot shows a distinct "elbow" after the seventh factor, indicating that these seven factors account for the majority of the variance in the data. This finding aligns with the percentage of variance explained by the seven dimensions, cumulatively contributing 72.932 %. By using the scree plot, the study identified the most relevant factors influencing farmers' adoption of bio inputs while excluding less impactful dimensions.

First Dimension

The first dimension comprised four factors (15.807 percent of the total variation) with the highest factor loadings of Yield (13) at 0.853 followed by Price (14), Past experience (15) and Government Subsidies (16) with Factor loadings of 0.745, 0.640 and 0.588 respectively. Thus Yield, Price and Past Experience are significant factors as the value lies above 0.7.

Second Dimension

The second dimension comprised two factors: Knowledge and Training and Recommendations from Farmers with factor loading 0.815 and 0.653 and contributed 10.791 % of the total variation. The factor "Knowledge and Training" is considered very important.

Third Dimension

The third dimension explained 9.834 % of the total variation. It consists of only one factor Compatibility with farming activities with a factor loading of 0.822.

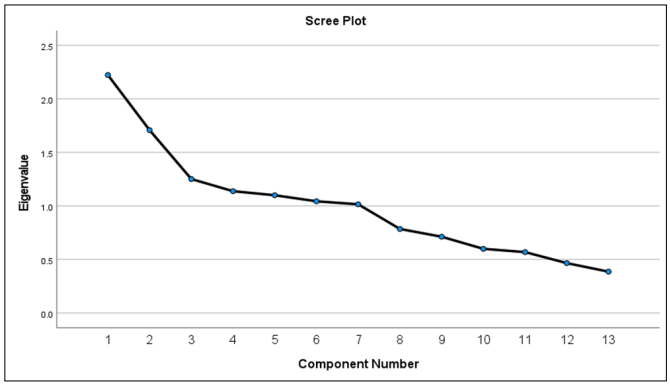

Fig. 1. Scree plot.

Table 3. Rotated Component Matrix

Rotated Component Matrix								
Sr. No.	Variables	Component						
		1	2	3	4	5	6	7
1.	Yield	**0.853**	-0.105	0.077	-0.026	0.036	-0.064	-0.148
2.	Price	**0.745**	0.078	0.111	-0.063	0.106	-0.088	0.319
3.	Past Experience	**0.640**	0.180	-0.406	-0.042	0.025	0.119	-0.002
4.	Government Subsidies	**-0.588**	0.339	0.109	-0.239	0.173	-0.234	-0.037
5.	Knowledge and Training	-0.001	**0.815**	-0.003	0.030	-0.146	0.094	-0.140
6.	Recommendations from Farmers	-0.067	**0.653**	-0.019	-0.203	0.278	-0.378	0.191
7.	Compatibility with farming practices	-0.003	0.001	**0.822**	0.090	0.098	0.180	-0.097
8.	Availability	-0.012	-0.199	0.004	**0.803**	-0.021	-0.051	0.186
9.	Environmental Impact	-0.015	0.228	0.430	**0.552**	-0.102	-0.094	-0.089
10.	Quality	0.030	-0.071	0.112	-0.114	**0.865**	-0.066	0.053
11.	Peer Influence	-0.081	-0.218	0.430	-0.383	**-0.549**	-0.233	0.270
12.	Easy to Use	0.005	-0.033	0.121	-0.106	-0.005	**0.890**	0.153
13.	Market Demand for Bio-Certified Products	0.066	-0.055	-0.107	0.129	0.002	0.149	**0.894**

Extraction Method: Principal Component Analysis.

Table 4. Percent of variance of the factors

Factors	Total	Percent of Variance	Cumulative Percent
1	2.055	15.807	15.807
2	1.403	10.791	26.597
3	1.278	9.834	36.431
4	1.251	9.625	46.056
5	1.212	9.323	55.379
6	1.150	8.845	64.224
7	1.132	8.707	72.932

Fourth Dimension

The fourth dimension explained 9.625 % of the total variation. It consists of two factors: Availability and Environmental Impact with factors loading of 0.803 and 0.552.

Fifth Dimension

The fifth dimension contributed 9.323 % of the total variation and consists of two factors: Quality and Peer Influence with factor loadings of 0.865 and 0.549 respectively.

Sixth Dimension

The sixth dimension contributed 8.845 % of the total variation. It consists of only one factor Easy to Use with a factor loading of 0.890.

Seventh Dimension

The seventh dimension contributed 8.707 % of the total variation and consists of one factor Market Demand for Bio Certified Products. The factor loading is 0.894.

Association Between Farmers' Education and Awareness

H0: The null hypothesis states that there is no relationship between farmers' education and awareness levels. H1: There is relationship between farmers' education and awareness level.

According to Table 5, the chi-square value is 22.94 and the ***P*** Value is less than 0.05 so this suggests that there is a significant correlation between the farmers' education and awareness level.

Constraints

The results from Table 6 revealed the farmers' major constraints in using Bio Inputs of Thondamuthur Block of Tamil Nadu. The Results indicated that the "Lack of availability" (17) of Bio Inputs is the major constraint with a Garrett score of 81. The second major constraint is the "Lack of government support and subsidy" with a Garrett score of 70. This reflects farmers' concerns over inadequate financial incentives or policy support from the government, which may discourage them from adopting bio inputs. "Poor quality" (19) of bio inputs is ranked third with a Garett score of 67.7,

Table 5. Education and awareness cross-tabulation

			Awareness		Total
			No	Yes	
Education	Graduate	Count	0	6	6
		Expected Count	1.3	4.7	6
		% of Total	0.00%	4.30%	4.30%
	Illiterate	Count	20	24	44
		Expected Count	9.4	34.6	44
		% of Total	14.30%	17.10%	31.40%
	Post Graduate	Count	0	4	4
		Expected Count	0.9	3.1	4
		% of Total	0.00%	2.90%	2.90%
	Primary	Count	9	72	81
		Expected Count	17.4	63.6	81
		% of Total	6.40%	51.40%	57.90%
	Secondary	Count	1	4	5
		Expected Count	1.1	3.9	5
		% of Total	0.70%	2.90%	3.60%
Total		Count	30	110	140
		Expected Count	30	110	140
		% of Total	21.40%	78.60%	100.00%
X^2 Value= 22.94 P Value= 0.001					

Table 6. Constraints faced by the farmers

S. No.	Constraints	Garrett Score	Rank
1.	Lack of availability	81	I
2.	Lack of government support and subsidy	70	II
3.	Poor quality	67.7	III
4.	Difficulty in application	64.57	IV
5.	High cost	63.51	V
6.	Uncertainty about effectiveness	63.37	VI
7.	Lack of training	63	VII

suggesting that even when available, the quality of bio inputs is a significant issue. The fourth constraint, "Difficulty in application" (score: 64.57), indicates the complexity or lack of knowledge regarding the proper use of bio inputs thus making it harder for farmers to integrate them into their farming practices. “High cost" with a Garrett score of 63.51 is also a considerable constraint at the fifth rank. The other constraints include “Uncertainty about Effectiveness ranked sixth and Lack of Training ranked Seventh.

Discussion

The demographic analysis reveals that the majority of farmers in Thondamuthur block are male and fall within the middle-aged group of 41-50 years. This demographic is typically more experienced, which could facilitate easier adoption of bio inputs if adequate information and resources are provided. However, the high percentage of illiteracy (31.43 %) and farmers with only primary education (57.85 %) presents a challenge in effectively communicating the benefits and usage of bio inputs. This necessitates the development of simplified, practical training modules that utilize visuals and hands-on demonstrations. Landholding patterns indicate that most farmers own small to medium-sized lands, further emphasizing the need for affordable bio input options. Ensuring financial incentives like subsidies and low-interest credit for smallholders could help mitigate the economic constraints associated with adopting bio inputs.

The factor analysis provides valuable insights into the determinants of farmers’ buying behaviour. Economic factors such as yield, price and experience were identified as the most influential drivers, accounting for 15.807 % of the total variance. Farmers are more likely to adopt bio inputs when they perceive tangible economic benefits. Therefore, demonstrating cost-effectiveness through trials and success stories should be prioritized by policymakers and extension services. The second dimension highlights the role of knowledge and training, along with peer recommendations, in adoption decisions. This underscores the importance of capacity-building initiatives and peer-to-peer learning models that encourage information exchange among farmers. Additionally, factors such as compatibility with existing farming practices and the environmental impact of bio inputs emerged as significant, indicating a growing awareness of sustainable agricultural practices.

The chi-square analysis establishes a significant association between farmers’ education levels and awareness of bio inputs, reinforcing the importance of literacy in improving comprehension and adoption. However, the identified constraints are lack of availability, inadequate government support and concerns over the quality of bio inputs are major barriers that need immediate attention. Strengthening supply chain networks to ensure consistent availability, implementing strict quality control measures and enhancing government policies with targeted subsidies and technical support are crucial steps. Furthermore, addressing application difficulties through farmer friendly product designs and providing regular training sessions can ease the integration of bio inputs into farming systems, encouraging long-term sustainability.

Conclusion

The factor analysis examining farmers' buying behaviour of bio inputs revealed that among the thirteen variables studied, four variables-Yield, Price, Experience and Government Subsidies exhibited the highest factor loadings in the first dimension and thus are the main factors affecting the buying behaviour of the farmers. There is a correlation between farmers’ education and awareness levels. The major constraints faced by the farmers are the lack of availability, lack of government support and subsidy and poor quality.

Acknowledgements

The authors express their sincere gratitude to all individuals and organizations who have contributed to the successful publications of this research.

Authors' contributions

PM and SDS were responsible for designing the study, conducting the statistical analysis, developing the protocol and drafting the initial manuscript. All other authors contributed to the manuscript and made revisions.

Compliance with ethical standards

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

Ethical issues: None

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