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RESEARCH ARTICLE

A study on factors influencing the usage of bioinputs among the curry leaf farmers in Tamil Nadu

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Abstract

Plant extracts, microbial cultures, enzymes, proteins and other biomolecules are used as bioinputs in the cultivation process. This study addresses the environmental and health concerns associated with conventional farming practices, particularly the overuse of chemical fertilizers and pesticides. It explores bioinputs as a sustainable solution to these issues, aiming to promote environmentally friendly farming practices while maintaining crop productivity. The study analyzed the usage of bioinputs among curry leaf farmers in the Karamadai block of Coimbatore district, Tamil Nadu, India. A purposive sampling method selected 90 farmers for the research. Data was gathered through structured interviews and analyzed using percentage analysis, factor analysis and the Garrett ranking technique. The findings revealed that most farmers were aware of and used bioinputs. Factor analysis identified three key elements influencing adoption: product preference, derived benefits and promotional efficacy. The Garrett ranking technique highlighted significant challenges, including unavailability of bioinputs and lack of technical knowledge. Farmers expressed satisfaction with improved market demand for organically produced crops and higher yields due to bioinputs. However, addressing challenges such as inconsistent product quality and slow results is crucial for broader adoption. The study recommends enhancing farmer education, improving local bioinput availability and ensuring consistent product quality to support sustainable farming practices.

Keywords

awareness; bioinputs; challenges; factor influencing; satisfaction level

Introduction

Bioinputs, such as biofertilizers, biopesticides and biofungicides, are environmentally sustainable alternatives to traditional chemical inputs. Unlike chemical fertilizers and pesticides, which may cause soil degradation, environmental pollution and adverse health effects, bioinputs promote soil health, improve crop resilience and reduce ecological harm. Traditional inputs typically offer faster results but at the cost of long-term soil fertility and increased input dependency. In contrast, bioinputs enhance natural soil processes and promote organic farming practices, aligning with the growing consumer demand for healthier, eco-friendly produce. This shift towards bioinputs reflects farmers' efforts to balance productivity with sustainability, despite challenges like slower results and limited technical knowledge.

In India's economic environment, agriculture is crucial as it makes a substantial contribution to both GDP and jobs in the country. Unfortunately, the industry is facing increasing difficulties because of the pervasive use of chemical pesticides and fertilizers, which are causing environmental damage and health issues (1). Sustainable farming methods have become increasingly popular in response to these problems, especially with the use of biological products in place of chemical inputs (2, 3).

Grand View Research (2023) projects that the global market for biocontrol products will expand at a compound annual growth rate (CAGR) of more than 12 percent, with a predicted value of USD 10.2 billion by 2030 (4, 5). This pattern emphasizes how important it is for agriculture to find sustainable solutions. Curry leaf is a major component of the Indian spice industry, which plays a significant role in the international market (6). With a yearly market value of almost Rs 40000 crore (USD 6.42 billion), India leads in the production, consumption and export of spices (7). Native to India, curry leaf (Murrayakoenigii) is widely grown across the nation's many agroclimatic zones. Due to its distinct flavor and therapeutic qualities, it is especially prized in South Indian cuisine (8). With almost 1000 hectares under cultivation, the Karamadai block in the Coimbatore district in Tamil Nadu stands out as a significant hub for curry leaf production. The integration of diverse agricultural methods into the farming system approach has gained popularity as a way to improve the income and standard of living for small and marginal farmers (1). This strategy places a strong emphasis on material recycling among various agricultural businesses, which successfully lowers production costs and generates new revenue streams.

There is an urgent need to investigate and promote sustainable solutions in curry leaf agriculture, given the health and environmental risks connected to traditional farming practices. Bioinputs, such as biofungicides, biopesticides and biofertilizers, present viable ways to deal with these issues while maintaining productivity (9, 10). The primary goal of this study is to evaluate how bioinputs affect curry leaf farming in the Karamadai block of the Coimbatore district. The study's objectives are to assess the biological products' market potential, examine the competitive environment, and pinpoint the elements influencing farmers' acceptance of these products. Through an analysis of the obstacles farmers face when implementing biocontrol products, the study aims to create focused marketing plans to overcome these obstacles.

The results of this study could have a big impact on how curry leaf farming in Karamadai is done in a way that is more environmentally friendly and sustainable. Furthermore, the knowledge acquired may be relevant to comparable farming environments, opening the door for wider use of bioinputs in Indian agriculture. This study is novel in evaluating the role of bioinputs specifically in curry leaf farming, an area with limited prior research despite its economic significance. Unlike existing studies, it combines factor analysis and Garrett ranking to identify unique adoption drivers and constraints, offering actionable insights tailored to the region.

Methodology

Selection of study area and sampling procedure

The study was conducted in the Karamadai block of Coimbatore District, Tamil Nadu. A sample of 90 farmers was selected using a purposive sampling method from four villages within the Karamadai block. Purposive sampling was chosen to ensure the inclusion of curry leaf farmers actively using bioinputs, as they are key to addressing the study's objectives. This method allowed the selection of participants with relevant experience and knowledge, ensuring targeted and insightful data collection. This resulted in a block-wise sample distribution of farmers across four villages, totaling 90 farmers. Velliangadu has the largest representation, with 35 farmers, accounting for 38.9 percent of the total sample. Tholambalayam follows with 26 farmers, making up 28.9 percent of the sample. Odanthurai contributes 19 farmers, representing 21.1 percent of the total. Nellithurai has the smallest representation, with 10 farmers, comprising 11.1 percent of the sample. The data collection was carried out during April and May 2024, with 2024 serving as the reference year for the study.

Data collection

Primary data

Primary data was collected using a carefully designed interview schedule. The objectives of the study were clearly explained to the respondents to ensure accurate information and minimize errors. The structured interview schedule was validated through a pilot test with a subset of farmers to ensure clarity, relevance and reliability of the questions. Feedback from the pilot test was incorporated to refine the questionnaire, enhancing its suitability for the target respondents. The interviews focused on gathering information about sociodemographic profiles (age, gender, education, annual income, occupation, farming experience, land holdings), factors influencing the adoption of bioinputs, awareness levels, willingness to purchase, challenges encountered and suggestions for promoting increased use of bioinputs. Secondary data on bioinput products trade, productivity and consumption at both international and national levels were compiled from various publications, annual reports, articles and websites. Additional information about the research area, including climate, soil composition and rainfall patterns, was gathered from published and official sources of Krishi Vigyan Kendra, Coimbatore.

Tools of analysis

The following statistical tools were used for the analysis and interpretation of data. Percentage analysis and factor analysis was used for analyzing. Basic percentage analysis was applied to interpret socio-demographic variables and other relevant factors. The constraints were analyzed using the Garrett ranking technique.

Factor analysis

Exploratory factor analysis was employed to examine the factors influencing farmers' use of biofertilizer products (11). The analysis used 15 variables, including experience with biofertilizers, the impact of advertising, affordability, customer loyalty, accessibility, effectiveness, crop performance, the influence of extension officers, government subsidies, the influence of other farmers and dealers, personal interest, chemical-free production, environmental benefits and increased produce prices. The methodology employed factor analysis to identify key factors influencing bioinput adoption. Variables were selected based on their relevance to the study's objectives and their theoretical significance in prior research. Factors with eigenvalues greater than 1 were retained, aligning with the Kaiser criterion for meaningful component extraction. Varimax rotation was applied to enhance interpretability, and factor loadings above 0.5 were considered significant for assigning variables to components. These thresholds ensured a robust and reliable analysis of the underlying dimensions impacting bioinput usage.

Results and Discussion

The demographic characteristics of the farmers–gender, marital status, age classification, family type, family size, family income, educational status, farming experience, farm size and occupation type-were analyzed and the results are presented.

Demographic characteristics of the respondent

The socio-economic and agricultural profile of the sample reveals a group that is largely middle-aged, married and engaged in small to medium-scale farming with varying levels of education and income. The information suggests a traditional rural setting with a focus on agriculture and livestock, where most individuals have significant farming experience but relatively modest land holdings and income levels, which are analyzed and results are presented in Table 1. The sample is predominantly male (88 percent) and married (92 percent), with the largest age group being 35-44 years (48 percent). Most respondents live in nuclear families (80 percent) of medium size with 4-5 members (52 percent). The majority earn less than 5 lakhs per year (53 percent), with 46 percent having completed senior secondary education. In terms of agricultural characteristics, half the sample has 21-30 years of farming experience, with 44 percent classified as small farmers (2.5-5 acres) and 40 percent as medium farmers (5-10 acres). The primary occupation for 51 percent is agriculture combined with livestock, while 38 percent focus solely on agriculture.

Awareness of bioinput products

The awareness and source of information-oral recommendations, modern farming practices, dealers or retailers, the effect of input sector advocacy and regulated market-were analyzed and presented in Table 2.

Table 2 shows high awareness of bioinput products among farmers, with 87 out of 90 respondents (97 percent) being informed, while only 3 (3 percent) lack knowledge. Information sources vary, with 26 farmers (29.41 percent) relying on peer

Table 1. Demographic characteristics of the respondent

Demographic characteristics				
S.No.	**Profile**	**Characteristics**	**Frequency (N=90)**	**Percentage**
1.	Gender	Male	79	88
		Female	11	12
2.	Marital status	Unmarried	7	8
		Married	83	92
3.	Age classification	15-24	3	3
		25-34	7	8
		35-44	43	48
		45-54	26	29
		55<(above)	11	12
4.	Family type	Nuclear	72	80
		Joint	18	20
5.	Family size	Small <3	19	21
		Medium 4-5	47	52
		Big >5	24	27
6.	Average family income/ year	Less than 5 lakhs	48	53
		5 to 10 lakhs	36	40
		More than 10 lakhs	6	7
7.	Educational status	Illiterate	10	11
		Elementary school	19	20
		Senior secondary	41	46
		Undergraduate	15	17
		Postgraduate	5	6
8.	Farming experience (years)	20 or less	32	36
		21-30	45	50
		31-40	8	9
		41-50	2	2
		Above 51	3	3
9.	Farm size	Marginal farmer (up to 2.5 acres)	9	10
		Small farmer (2.5 to 5 acres)	40	44
		Medium farmer (5 to 10 acres)	35	40
		Big farmer (above 10 acres)	6	6
10.	Occupation type	Agriculture	34	38
		Agriculture + Livestock	46	51
		Agriculture + Business	10	11

Table 2. Awareness on bioinputs products

S. No	Profile	Awareness on bioinput products characteristics	Frequency	Percentage
1.	Awareness	Aware	87	97
		Unaware	3	3
2.	Source of information	Oral recommendations (from other farmers)	26	29.41
		Modern farming practices and Reforms	21	24.13
		Dealers / Retailers	27	30.43
		Effect of inputs sector advocacy	14	16.03

recommendations. Modern farming practices and reforms inform 21 individuals (24.13 percent), while 17 (19.22 percent) learn from dealers or retailers. Input sector advocacy reaches 14 farmers (16.03 percent) and regulated markets inform 10 (11.21 percent). Fig. 1 highlights the effectiveness of multiple channels in spreading information about bioinputs, with personal connections and agricultural advancements playing significant roles. The substantial awareness level suggests successful outreach efforts, utilizing diverse methods to educate farmers about these alternative agricultural inputs. The scree plot was used to determine the optimal number of factors to retain in the analysis by visualizing the point where the eigenvalues level off, indicating diminishing explanatory power. In this study, the plot showed a clear "elbow" after three factors, confirming their selection as the most significant components. This supports the robustness of the factor analysis in explaining the variance in bioinput adoption.

Table 3 shows that biological control agents which are used by the farmers can be effective in managing curry leaf crop issues while maintaining satisfactory yields, offering potential alternatives to conventional pest and disease management methods. It concluded the four curry leaf varieties cultivated in

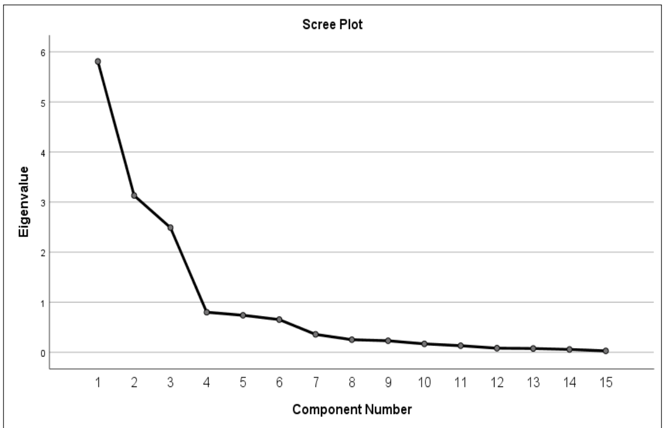

Fig. 1. Scree plot of total variance.

Tamil Nadu: Sengampu, Gamthi, Dharwad-1 and PKM-1. It details the number of farmers growing each variety, ranging from 16 for PKM-1 to 32 for Sengampu. Each variety faces specific problems, such as anthracnose leaf spot for Sengampu and citrus butterfly for PKM-1. The table also lists bioinputs used to address these issues, including *Trichoderma viride* for Sengampu and Azadirachtin for PKM-1. Dosage rates vary from 0.5 percent to 3 percent. Yield data is provided, with Gamthi showing the highest at 383 kg and Dharwad-1 the lowest at 323 kg. This information offers insights into the cultivation practices and challenges associated with different curry leaf varieties in the region.

Reasons for utilizing bioinput products

The farmers were asked about the reasons for utilizing the bioinput products and the results are presented in Table 4. The table illustrates various motivations for farmers to adopt bioinput products. Out of the surveyed group, 82 farmers (91 percent) implement these products. The primary driver is enhanced yield, cited by 75 respondents (83 percent). Advice from bioinput suppliers influences 50 farmers (56 percent), while environmental concerns motivate 43 individuals (48 percent). Government financial support plays a role for 40 farmers (44 percent), and regional availability of bioinputs is a factor for 38 respondents (42 percent). These figures demonstrate that farmers are drawn to bioinputs for multiple reasons, with productivity gains being the most compelling.

Exploratory factor analysis was employed to examine the factors influencing farmers' use of biofertilizer products. Table 5 shows that the KMO (Kaiser-Meyer-Olkin) statistic value was 0.771 (exceeding the 0.5 threshold), suggesting that the sample was sufficient and appropriate for factor analysis. Additionally, Bartlett's test yielded an approximate chi-square statistic of 1360.884 with 105 degrees of freedom, which was significant at the 0.01 level. This indicates that factor analysis is a suitable technique for further examining the data.

Table 3. Bioinputs utilized by farmers for curry leaf cultivation

Varieties	No of farmers	problems	Bioinputs	Dosage	yield
Sengampu	32	Anthracnose leaf spot	*Trichoderma viride* (Sanjeevi)	1.15 percent (WB)	342 Kg
Gamthi	19	Psyllid bug and scale	*Verticillium lecanii* (Varunastra)	1.15 percent (WB)	383 Kg
Dharwad-1	23	*Cercospora* leafspot	*Pseudomonas* and *Bacillus* (Bactvibe and Mildown)	0.5 percent (WB)	323 Kg
PKM-1	16	Citrus butterfly	Azadirachtin	3 percent	350 kg

Table 4. Reasons for utilizing bioinputs products

S.No.	Particulars	Frequency	Percentage
1	To safeguard the environment	82	91
2	Enhanced yield from using bioinputs	75	83
3	Resistance to pest and disease	50	56
4	To ensure consumer health and safety	43	48
5	To protect the soil health	40	44
6	To ensure plant growth and health	38	42

Table 5. KMO and Bartlett's Test

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy		0.771
Bartlett's Test of Sphericity	Approx. Chi-Square	1360.884
	Df	105
	Sig.	0.000

Table 6 indicates that three components had Eigenvalues greater than one and these three components collectively account for approximately 76.189 percent of the variance. The principal component analysis (PCA) method revealed the connections between factors and variables in the analysis, which are referred to as factor loadings (12). These loadings showed the relationships among variables but did not distinctly group all of them with the factors.

Table 7 shows the factor loadings obtained after applying varimax rotation. Factor loadings with values of 0.5 or higher are considered significant. The first component had seven factor loadings with values above 0.5, while the second and third components each had four factor loadings with values exceeding 0.5. These components were then assigned appropriate names based on their factors.

Challenges encountered by farmers in using bioinput products

Based on the pilot survey, several constraints were identified for the study, including: i) Unavailability of bioinputs in the local area, ii) Insufficient knowledge about bioinput usage, iii) Challenges in storage and handling, iv) Low farmer interest in using bioinputs, v) Lack of technical support, vi) Inadequate pricing for the produce, vii) Inconsistent product quality and viii) Delayed results. These components and constraints were analysed using the Garrett ranking technique and presented in Table 8 and Table 9.

The primary challenge for farmers was the unavailability of bioinputs in nearby locations, with a Garrett score of 68.63, making it the most significant issue. Most farmers relied solely on dealers for purchasing bioinput products. Additionally, many farmers used bioinputs without a

Table 6. Total Variance Explained

Component	Initial eigenvalues			Extraction of the sums of squared loadings		
	Total	**Percentage of variance**	**Cumulative Percentage**	**Total**	**Percentage of variance**	**Cumulative Percentage**
1	5.808	38.723	38.723	5.808	38.723	38.723
2	3.131	20.871	59.594	3.131	20.871	59.594
3	2.489	16.596	76.189	2.489	16.596	76.189
4	0.799	5.328	81.518			
5	0.739	4.925	86.442			
6	0.653	4.353	90.796			
7	0.358	2.386	93.182			
8	0.251	1.674	94.855			
9	0.230	1.534	96.390			
10	0.168	1.122	97.512			
11	0.131	0.873	98.385			
12	0.082	0.548	98.933			
13	0.075	0.503	99.436			
14	0.057	0.377	99.813			
15	0.028	0.187	100.000			

Extraction Method: Principal Component Analysis

Table 7. Rotated component matrix

	Factors	**C 1**	**C 2**	**C 3**
1	Effectiveness in enhancing crop performance	0.707		0.575
2	Brand allegiance	0.698	0.221	-0.172
3	Availability of bioinput products	0.695	0.376	0.240
4	Effect of advertising	0.689	0.359	-0.109
5	Impact of dealers	0.688	0.328	-0.543
6	Affordable bioinputs	0.675	0.179	
7	Environmental advantages	0.674	0.317	-0.564
8	Influence from fellow farmers	0.652	-0.645	
9	Quality of bioinput products	0.645		0.628
10	Experience with bioinput use	0.603	0.348	-0.600
11	Production without chemicals	0.580	-0.729	
12	Increased price for the produce	0.635	-0.718	
13	Government-provided subsidies		0.663	0.469
14	Impact of extension officers	0.604	-0.611	0.106
15	Personal interest	0.418	0.413	0.674

Table 8 Components and factor

Components	Factor labels	Explained variance
1.	Preference for the product	38.723
2.	Gained benefits	20.871
3.	Effectiveness of promotions	16.596

Table 9 Challenges encountered by farmers in the use of bioinput products

S.No.	Constraints	Garrett scores	Rank
1	Does not provide immediate results	68.63	I
2	Insufficient knowledge about how to use bioinputs	62.27	II
3	Unavailability of bioinputs in nearby locations	56.25	III
4	Limited farmer interest in using bioinputs	55.86	IV
5	Insufficient technical support	55.17	V
6	Inconsistency in product quality	52.74	VI
7	Challenges with storing and handling bioinputs	51.82	VII
8	Not obtaining a high price for the produce	42.77	VIII
9	Validation of the products	40.64	IX

full understanding of their composition or recommended dosage. This lack of knowledge and expertise about bioinputs was another major constraint, ranking second with a score of 62.27. The slow effect or absence of immediate results from bioinputs on vegetable production was a notable issue, ranking third with a score of 56.25, as their impact was slower compared to chemical fertilizers. Farmers' preference for quick results contributed to their reduced interest in bioinputs, which was ranked fourth with a score of 55.86.

Effective use of new technologies and advancements often requires technical guidance and support. The lack of such technical assistance was identified as a significant barrier, ranking fifth with a score of 55.17. Quality aspects such as efficiency, effectiveness and performance are crucial, and variations in the quality of bioinputs were also a constraint, placing sixth with a score of 52.74. Difficulty in storing and handling bioinputs was another challenge, ranked seventh with a score of 51.82. Although bioinputs are generally more cost-effective compared to chemical fertilizers, the issue of not receiving a high price for the produce had a score of 42.77, Validation of the products was the least significant constraint, ranking last with a score of 40.64.

Conclusion

This study investigated the usage and acceptance of bioinputs by curry leaf growers in the Tamil Nadu district of Coimbatore's Karamadai block. The study found that farmers had a high level of awareness (97 percent) and use of bioinputs, with peer recommendations serving as their main source of information. The primary drivers of bioinput adoption were improved yield and the perceived benefits of deployment. Three crucial elements that impact the adoption of bioinputs were found through factor analysis: product preference, derived benefits, and promotional efficacy. The most important variables were perceived crop performance impact, farmers' experience with bioinputs and environmental benefits. The adoption of bioinputs in curry leaf farming demonstrates their potential to enhance sustainability, improve soil health and meet growing consumer demand for organic produce. These findings can serve as a model for broader application in other crops, promoting environmentally friendly farming practices. Expanding bioinput adoption could contribute significantly to reducing chemical dependency in agriculture, ensuring long-term ecological and economic benefits.

Farmers expressed the most satisfaction with the robust market demand for products produced organically and with the higher crop yields resulting from the use of bioinputs. However, they also faced difficulties, chief among them being the absence of quick outcomes and inadequate understanding of how to use bioinputs correctly. To encourage broader uptake of bioinputs, the following areas should be prioritized- increasing the accessibility of bioinputs locally, increasing farmer awareness of advantages and proper use, delivering improved technical assistance and taking consistent product quality into account.

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Authors' contributions

AN carried out the experiment, took observations and analysed the data. MD guided the research by formulating the research concept, helped in securing research funds and approved the final manuscript. RA contributed by imposing the experiment, helped in editing, summarizing and revising the manuscript. KM helped in procuring research grants. PR helped in summarizing and revising the manuscript.

Compliance with ethical standards

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

Ethical issues: None

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