

RESEARCH ARTICLE

Factors Influencing Farmers' Adoption of IPM Technology Developed by TNAU for Coconut Whitefly Management

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ABSTRACT

The coconut rugose spiraling whitefly (*Aleurodicus rugioperculatus Martin*) has developed as a major pest of coconut production in southern India, leading to extensive reliance on chemical pesticides and raising environmental concerns. To address this issue, Tamil Nadu Agricultural University (TNAU) developed an Integrated Pest Management (IPM) technique for long-term whitefly management. The current study aimed to determine the factors influencing farmers' adoption of IPM technology in the Coimbatore district of Tamil Nadu. A descriptive research approach was adopted, and data were collected from 180 coconut farmers using a structured interview schedule. The results identified three key factors influencing adoption: perceived benefits, institutional support, and socio-economic influence, which together explain 71.85 per cent of the total variance. The findings highlight that visible pest reduction, improved yield, reduced manual spraying, strong extension support, and peer influence play a crucial role in promoting IPM adoption.

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INTRODUCTION:

Coconut (*Cocos nucifera* L.), a perennial palm belonging to the family Arecaceae, is a vital plantation crop in India, recognized for providing food, oil, fibre, and industrial raw materials to millions. India produced about 21,373.62 million nuts from an area of 2.33 million hectares in the fiscal year 2023–2024, with an average productivity of about 9,871 nuts per hectare, making it one of the world's top producers (Coconut Development Board, 2024). The major coconut-

producing states such as Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh account for nearly 90% of the country's total coconut production and cultivated area.

The coconut rugose spiraling whitefly (RSW), or *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae), is a highly polyphagous pest that has quickly become a major threat to Indian coconut farming. This pest was first identified on coconuts in

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the Pollachi tract of Tamil Nadu's Coimbatore district in 2016. Since then, it has quickly spread to other areas that grow coconuts. Heavy RSW infestations have resulted in dense colonies on the leaflets, excessive honeydew secretion, and severe sooty mold deposition in the Pollachi region, which is characterized by large commercial plantations. Blackened fronds, decreased photosynthesis, reduced nut growth, and a general decline in palm vigor were the effects of these infestations.

Coconut farmers in southern India, including those in Pollachi, have traditionally relied heavily on chemical pesticides for RSW control, often leading to indiscriminate and excessive use. Pesticide resistance, pest resurgence, secondary pest outbreaks, residues in contaminated food and water, detrimental effects on human health, and widespread destruction of non-target organisms are all consequences of such misuse (Halder *et al.*, 2014, 2016).

Tamil Nadu Agricultural University (TNAU) developed an Integrated Pest Management (IPM) technology specifically designed for RSW management in coconuts to address these problems. This comprehensive method successfully eliminates honeydew and sooty mold using yellow sticky traps, canopy sanitation, high-volume water-jet spraying, and the parasitoid *Encarsia guadeloupeae*. To reduce chemical inputs while maintaining efficient pest control, the strategy also includes the targeted application of neem oil spray and other safer insecticides. Through front-line demonstrations and extension programs throughout Tamil Nadu, these biological and cultural techniques, along with careful application of insecticides, have been widely promoted (TNAU, 2025). However, there remains a lack of systematic empirical data on the factors influencing farmers' adoption and application of Integrated Pest Management (IPM) techniques in coconut cultivation, especially compared with traditional chemical-based pest control methods (Sardana *et al.*, 2012). Thus, the current study was conducted to investigate the major institutional, technological, and socioeconomic factors influencing farmers' adoption and application of the IPM technology developed by TNAU for controlling coconut rugose spiraling whiteflies.

REVIEW OF LITERATURE:

Suriya *et al.* (2023) investigated the seasonality, population dynamics, and distribution of exotic coconut whiteflies in southern Tamil Nadu. Although the study

largely focused on pest ecology, it highlighted the increasing severity of whitefly infestations on coconut and the importance of implementing Integrated Pest Management measures for long-term management. The study indirectly promotes IPM adoption by demonstrating that chemical control alone is ineffective, thereby increasing farmers' reliance on integrated, and environmentally friendly management approaches.

Coconut Development Board (2021) documented IPM interventions for key coconut pests in India and found that farmers' adoption of IPM technologies increased following demonstrations in pest-affected villages. The analysis recognized the availability of excellent planting material, biological control agents, and institutional convergence as critical variables driving adoption.

Kranthi *et al.* (2017) investigated farmers' attitudes to pest control technology and found that over-reliance on chemical pesticides lowered farmers' confidence in alternative pest management methods. The study found that awareness of pesticide resistance and environmental concerns substantially influenced farmers' adoption of IPM methods, demonstrating that perceptions of long-term benefits are important in adoption decisions.

Ranga Rao (2010) conducted a detailed assessment of the state and acceptance of Integrated Pest Management (IPM) in Indian agriculture. The study examined farmers' adoption patterns across crops and regions and found major factors of IPM adoption. The study found that farmers' education, knowledge level, access to extension services, availability of IPM inputs, and perceived effectiveness of the technique all had a substantial impact on uptake. Among these characteristics, lack of awareness and inadequate follow-up assistance were identified as key barriers to adoption. In contrast, training and demonstration programs were shown to have the most positive impact.

OBJECTIVE OF THE STUDY:

To find out the factors influencing farmers' adoption of TNAU-developed IPM technology for managing coconut rugose spiraling whitefly.

METHODOLOGY:

This study employed a descriptive research methodology to identify the



factors influencing farmers’ adoption and use of the TNAU-developed IPM technology for managing coconut rugose spiraling whitefly. Purposive sampling was employed as a sampling technique. Farmers in the Coimbatore district who had previously employed IPM technologies were included in the study. In all, 180 farmers were selected for the study. Data was acquired through well-structured interview schedule. A 5-point Likert scale was used to record the farmers’ responses to farmers’ responses to factors influencing their adoption of IPM practices for controlling whitefly in coconut. (5=Strongly Agree), (1=Strongly Disagree), (2=Disagree), (3=Neutral), and (4=Agree). Exploratory factor analysis (EFA) was utilised to achieve the goal while taking into account the following variables:

Exploratory factor analysis was used to determine the characteristics that influence farmers’ adoption and application of TNAU-developed IPM technology for managing coconut rugose spiraling whitefly. Two tests were performed to determine whether the data were suitable for factor analysis: the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and

Bartlett’s Test of Sphericity. These tests were used to determine whether there was a significant association between the variables and to assess statistical significance.

Table 2 shows that the KMO value was 0.887 (>0.5), indicating that the sample was acceptable and suitable for conducting the factor analysis. Bartlett’s test provided an approximate chi-square statistic of 1852.844 with 105 degrees of freedom, which was significant at the 0.01 level. It is possible to conclude that factor analysis is a good technique for future data analysis.

Principal component analysis (PCA) was used to determine the relationships between factors and variables in the study. It might technically be called as factor loadings. These factor loadings clearly showed the relationships among the variables, but they did not properly categorize them into the factors. Table 3 clearly showed that three components had an Eigenvalue greater than 1. These three components account for approximately 71.85% of the variance.

Table 1: Variables

| List of variables | |
|--|--|
| Improved yield and tree health encouraged continued use. | |
| The technology saved time compared to earlier methods. | |
| The technology reduced the need for manual spraying, improving safety. | |
| I adopted the technology because it aligns with sustainable farming practices. | |
| I adopted the technology to avoid major crop losses caused by whiteflies. | |
| The technology was simple and practical to use on my farm. | |
| Visible pest reduction sustained my continued use of the technology. | |
| Training and demonstrations influenced me to adopt the technology. | |
| Extension staff support after adoption influenced my decision. | |
| The TNAU recommendation influenced my decision to adopt the technology. | |
| Guidance from local Krishi Vigyan Kendra encouraged me to adopt the technology. | |
| Seeing other farmers succeed with the technology encouraged me to adopt it. | |
| Guidance from the progressive farmers influenced them to adopt the technology. | |
| The cost of adopting the technology was affordable. | |
| Technology use by nearby farmers triggered pest movement to my field, influencing my adoption. | |

Table 2: KMO and Bartlett’s Test

| | | |
|---|--------------------|----------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy | | .887 |
| Bartlett’s Test of Sphericity | Approx. Chi-Square | 1852.844 |
| | Df | 105 |
| | Sig. | .000 |



Table 3: Total Variance Explained

| Component | Initial Eigen values | | | Extraction sums of squared loadings | | |
|-----------|----------------------|---------------|--------------|-------------------------------------|---------------|--------------|
| | Total | % of variance | Cumulative % | Total | % of variance | Cumulative % |
| 1 | 5.457 | 36.377 | 36.377 | 5.457 | 36.377 | 36.377 |
| 2 | 3.301 | 22.006 | 58.384 | 3.301 | 22.006 | 58.384 |
| 3 | 2.021 | 13.476 | 71.859 | 2.021 | 13.476 | 71.859 |
| 4 | .973 | 6.490 | 78.349 | | | |
| 5 | .613 | 4.084 | 82.433 | | | |
| 6 | .445 | 2.970 | 85.403 | | | |
| 7 | .352 | 2.350 | 87.753 | | | |
| 8 | .305 | 2.036 | 89.789 | | | |
| 9 | .274 | 1.828 | 91.617 | | | |
| 10 | .259 | 1.725 | 93.342 | | | |
| 11 | .236 | 1.571 | 94.913 | | | |
| 12 | .217 | 1.449 | 96.362 | | | |
| 13 | .201 | 1.338 | 97.700 | | | |
| 14 | .180 | 1.203 | 98.903 | | | |
| 15 | .165 | 1.097 | 100.000 | | | |

Extraction Method: Principal Component Analysis

RESULTS AND DISCUSSION:

Socio-economic characteristics of sample respondents

The socioeconomic data from the sample respondents were examined to gain a better understanding of the individuals. The socio-economic profile of the 180 respondents is categorised in detail.

The respondents' demographic details are shown in Table 4. According to the results, male farmers (95%) were more likely than female farmers (5%) to adopt TNAU-developed IPM technology. The majority of respondents were between the ages of 35 and 44 (33%) and 45 and 54 (27%), suggesting that middle-aged farmers are the main adopters of IPM. Regarding marital status, 92% of farmers were married. Nuclear families (88%) greater than joint families (12%) in terms of family composition. The distribution of farming experience suggested that relatively younger and moderately experienced farmers using IPM techniques were prevalent, with 40% of respondents having 20 years or less. Medium-sized families accounted for 44% of all families, with large and small families coming in second and third. Medium-sized farmers (37%) were more likely than small and marginal farmers to use IPM technology. Lastly, agriculture accounted for 59% of the respondents'

primary occupation, indicating that IPM adoption is primarily among those who depend entirely on farming for their livelihood.

Factors influencing farmers towards adoption of IPM to control whitefly in coconut- Factor analysis

Table 5 shows that factor loadings arrive after varimax rotation. Factor loadings of 0.5 or greater are evaluated. The first component had seven factor loadings with eigenvalues greater than 0.5. The second component has four factor loadings, as does the third and both have eigenvalues greater than 0.5. These components were given appropriate component names based on their characteristics.

It could be inferred from the table 6, the first component was named as Perceived Benefits and Effectiveness comprising of Improved yield and tree health encouraged continued use, The technology saved time compared to earlier methods, The technology reduced the need for manual spraying and improving safety, The technology aligns with sustainable farming practices, Adoption of the technology helps to avoid major crop loss from whitefly, The technology was simple and practical to use on farm, Visible pest reduction



Table 4: Demographic characteristics of respondents

| Demographic characteristics of respondents' farmers | | |
|---|---------------------------|-------------------|
| Gender | No of respondents (n=180) | Percentage (100%) |
| Male | 171 | 95 |
| Female | 9 | 75 |
| Age (Years) | | |
| 15-24 | 14 | 8 |
| 25-34 | 40 | 22 |
| 35-44 | 59 | 33 |
| 45-54 | 49 | 27 |
| 55 and above | 18 | 10 |
| Marital status | | |
| Unmarried | 14 | 8 |
| Married | 166 | 92 |
| Family type | | |
| Nuclear | 160 | 88 |
| Joint | 20 | 22 |
| Family size | | |
| Small | 39 | 21 |
| Medium | 79 | 44 |
| Big | 62 | 35 |
| Educational status | | |
| Illiterate | 3 | 2 |
| Primary school | 57 | 32 |
| Higher secondary | 71 | 39 |
| Graduation | 29 | 16 |
| Post graduate | 20 | 11 |
| Farming experience (Years) | | |
| 20 or less | 72 | 40 |
| 21-30 | 68 | 38 |
| 31-40 | 28 | 15 |
| 41-50 | 9 | 5 |
| Above 51 | 3 | 2 |
| Farm size | | |
| Marginal farmer | 38 | 21 |
| Small farmer | 61 | 34 |
| Medium farmer | 66 | 37 |
| Big farmer | 15 | 8 |
| Occupation type | | |
| Agriculture | 107 | 59 |
| Agriculture + other | 73 | 41 |



Table 5: Rotated component matrix

| | Factors | C 1 | C 2 | C 3 |
|----|--|------|------|------|
| 1 | Improved yield and tree health encouraged continued use. | .897 | | |
| 2 | The technology saved time compared to earlier methods. | .890 | | |
| 3 | The technology reduced the need for manual spraying, improving safety. | .882 | | |
| 4 | I adopted the technology because it aligns with sustainable farming practices. | .874 | | |
| 5 | I adopted the technology to avoid major crop loss from whitefly. | .868 | | |
| 6 | The technology was simple and practical to use on my farm. | .863 | | |
| 7 | Visible pest reduction sustained my continued use of the technology. | .862 | | |
| 8 | Training and demonstrations influenced me to adopt the technology. | | .905 | |
| 9 | Extension staff support after adoption influenced my decision. | | .898 | |
| 10 | The TNAU recommendation influenced my decision to adopt the technology. | | .890 | |
| 11 | Guidance from the local Krishi Vigyan Kendra encouraged me to adopt the technology. | | .879 | |
| 12 | Seeing other farmers succeed with the technology encouraged me to adopt it. | | | .855 |
| 13 | Guidance from progressive farmers influenced them to adopt the technology. | | | .810 |
| 14 | The cost of adopting the technology was affordable. | | | .744 |
| 15 | Technology use by nearby farmers triggered pest movement to my field, influencing my adoption. | | | .712 |

sustained continued use of the technology with variance of 36.377 percentage, the second component was named as Institutional and Technical support comprising of Training and demonstrations influenced to adopt the technology, Extension staff support after adoption influenced the decision, Recommendation by TNAU influenced the decision to adopt the technology, Guidance from local Krishi Vigyan Kendra encouraged to adopt the technology with variance of 22.006 percentage and the Third component was named as Social and Economic Influences comprising of Seeing other farmers succeed with the technology encouraged the adoption, Guidance from progressive farmers influenced to adopt the technology, The cost of adopting the technology was affordable, Technology use by nearby farmers triggered pest movement to my field, influencing my adoption with variance of 13.476 percentage. It could be inferred from the factor analysis that Improved yield and tree health encouraged

continued use, The technology saved time compared to earlier methods, The technology reduced the need for manual spraying, improving safety, I adopted the technology because it aligns with sustainable farming practices, I adopted the technology to avoid major crop loss from whitefly, The technology was simple and practical to use on my farm, Visible pest reduction sustained my continued use of the technology were the most influential factors in the adoption of IPM practices to control whitefly in coconut among the farmers.

CONCLUSION

The study reveals that farmers’ adoption of TNAU-developed IPM technology for controlling the coconut rugose spiraling whitefly is primarily driven by perceived benefits and effectiveness. The most important factors were increased output and tree health, visible pest



Table 6: Components and Factor

| Components | Factor names | Variance explained | Factor loadings | Variables |
|------------|--------------------------------------|--------------------|-----------------|---|
| 1 | Perceived Benefits and Effectiveness | 36.377 | .897 | Improved yield and tree health encouraged continued use |
| | | | .890 | The technology saved time compared to earlier methods |
| | | | .882 | The technology reduced the need for manual spraying, improving safety |
| | | | .874 | I adopted the technology because it aligns with sustainable farming practices |
| | | | .868 | I adopted the technology to avoid major crop loss from whitefly |
| | | | .863 | The technology was simple and practical to use on my farm |
| | | | .862 | Visible pest reduction sustained my continued use of the technology |
| 2 | Institutional and Technical support | 22.006 | .905 | Training and demonstrations influenced me to adopt the technology |
| | | | .898 | Extension staff support after adoption influenced my decision |
| | | | .890 | Recommendation by TNAU influenced my decision to adopt the technology |
| | | | .879 | Guidance from the local Krishi Vigyan Kendra encouraged me to adopt the technology |
| 3 | Social and Economic Influences | 13.476 | .855 | Seeing other farmers succeed with the technology encouraged my adoption |
| | | | .810 | Guidance from progressive farmers influenced them to adopt the technology |
| | | | .744 | The cost of adopting the technology was affordable |
| | | | .712 | Technology use by nearby farmers triggered pest movement to my field, influencing my adoption |

reduction, reduced manual spraying, and compatibility with sustainable agricultural practices. Institutional support, including as training, demonstrations, extension services, and guidance from TNAU and Krishi Vigyan Kendras, considerably increased farmers’ trust in the technology. Social and economic factors such as peer learning, progressive farmer mentoring, and affordability all influenced adoption. Overall, the findings underscore the importance of effective extension support and persistent demonstrations of economic and environmental benefits, in encouraging coconut producers to adopt IPM practices more widely.

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Authors’ contributions

KS collected and analysed the data. VPN, KM and RA conceived the study and participated in its design and coordination. MD and PR participated in the study design. KS and RA participated in the design of the study and performed the analysis. All authors read and approved the final manuscript.

Compliance with ethical standards

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



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Declaration of generative AI and AI-assisted technologies in the writing process:

While preparing this work, the authors used the Grammarly AI tool to improve grammar and increase the article's readability. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the content of publication.

Data Availability

The data used in this study are available from the corresponding author upon reasonable request.

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