PLANT SCIENCE TODAY
ISSN 2348-1900 (online)
Vol 11(sp4): 01–05
https://doi.org/10.14719/pst.5899

HORIZON
e-Publishing Group
HePG

RESEARCH ARTICLE

# A study on the promotion of biofertilizer: an application of the plackett-luce model

**Ramesh Shivarayi Horatti[1], S Hemalatha[1*], Moghana Lavanya[1], M Shanthasheela[2] & Vanitha G[3]**

[1] Department of Agricultural and Rural Management, Tamil Nadu Agricultural University, Coimbatore 641 301, Tami Nadu, India

[2] Directorate of Agribusiness Management, Tamil Nadu Agricultural University, Coimbatore 641 003, Tami Nadu, India

[3] Department of Computer Science, Tamil Nadu Agricultural University, Coimbatore 641 003, Tami Nadu, India

*Email: armhema@tnau.ac.in

OPEN ACCESS

**ARTICLE HISTORY**
Received: 17 October 2024
Accepted: 26 October 2024
Available online
Version 1.0 : 09 December 2024

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.

**Reprints & permissions information** is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

**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**
Horatti RS, Hemalatha S, Lavanya M, Shanthasheela M, Vanitha G. A study on the promotion of biofertilizer: an application of the plackett-luce model. Plant Science Today.2024;11(sp4):01-05.
https:/doi.org/10.14719/pst.5899

## Abstract

The research focuses on understanding the elements that drive Agro-input dealers to promote biofertilizers and highlights the challenges encountered in their adoption. With increasing environmental concerns over chemical fertilizers, biofertilizers are promoted as a sustainable alternative that improves soil fertility through beneficial microorganisms. The research was conducted in Hassan district, Karnataka, where 40 dealers were surveyed using structured questionnaires. The Plackett-Luce model was employed to analyze ranked data and understand the relative importance of variables. Results show that high promotional activities (worthiness=0.80, P=<0.001), profitability (worthiness=0.42, P=<0.001) and Service by Company Staff (worthiness=0.23, P=<0.001) significantly impact dealers' promotion efforts, whereas brand image (worthiness=-0.56, P=0.349) has minimal influence. Constraints such as farmers' negative attitudes (worthiness=2.65, P=<0.001), insufficient market facilities (worthiness=1.41, P=<0.005) and limited dealer knowledge (worthiness=-2.02, P=<0.001) were identified as significant barriers. Promotional strategies like field trials (worthiness=0.93, P=<0.001), farmers' meetings (worthiness=0.83, P=<0.001) and jeep campaigns (worthiness=0.61, P=<0.001) emerged as the most effective methods for engaging farmers. The study highlights the need for improved dealer training, better market infrastructure and supportive government policies to enhance biofertilizer promotion, fostering sustainable agricultural practices.

## Keywords

biofertilizers; plackett-luce model; promotion; sustainable agriculture

## Introduction

The rising global population has significantly heightened the demand for food production, driving extensive use of chemical fertilizers in agriculture. While these fertilizers have enabled countries to meet food supply demands, they have also caused substantial environmental damage and soil degradation. Chemical fertilizers have harmful impacts, including air, water and soil pollution, depletion of soil fertility and adverse effects on living organisms (1, 2). In response to these challenges, biofertilizers have emerged as a sustainable alternative. The potential application of biofertilizers enhanced soil fertility and promoted plant growth by harnessing beneficial microorganisms (3,4). The global push towards sustainable agriculture has intensified the adoption of biofertilizers due to their eco-friendly nature and

cost-effectiveness. Unlike chemical fertilizers, biofertilizers improve soil health without causing long-term harm, supporting concepts like soil preservation and the One Health approach, which links the health of ecosystems, animals and humans. They also aid in climate resilience by promoting biotic and abiotic stress tolerance in crops, which is crucial in changing environmental conditions (5, 6).

In India, eleven types of bio-fertilizers have been notified and included in the Fertilizer (Control) Order, 1985. These include Rhizobium, Azotobacter, Azospirillum, Phosphate Solubilizing Bacteria, Mycorrhizal Bio-fertilizers, Potassium Mobilizing Bio-fertilizers (KMB), Zinc Solubilizing Bio-fertilizers (ZSB), Acetobacter, Carrier-Based Consortia, Liquid Consortia and Phosphate Solubilizing Fungus. The quality standards for these bio-fertilizers are specified under the FCO, 1985 (7). The Indian Council of Agricultural Research has reported that bio-fertilizers can enhance crop yields by 10-25% and reduce the reliance on costly chemical fertilizers (N, P) by nearly 20-25% when used in conjunction with them without compromising production.

The problem of environmental degradation due to chemical fertilizers is of critical interest as it directly impacts food security, soil health and biodiversity. The hypothesis underlying the investigation into biofertilizers is that these natural inputs can mitigate the adverse effects of chemical fertilizers while sustaining agricultural productivity. Therefore, this study aims to identify the factors influencing dealers in promoting biofertilizers and explore the constraints dealers face in adopting them. By understanding these factors and constraints, the research aims to provide insights to facilitate the broader adoption of biofertilizers, thereby contributing to sustainable agricultural practices.

## Materials and Methods

The research focuses on promoting biofertilizers as the object of study, with specific attention to dealers as the subjects.

### Study area and sampling framework

The Hassan district is situated in the southwestern part of Karnataka, India. Located between 12° 13' and 13° 33' North latitudes and 75° 33' and 76°38' East longitude (Fig. 1.). The geography is mixed with the western ghats to the west and southwest characterized by rugged, mountainous terrain dense forests and high rainfall and the plains regions to the north, south and east characterized by flat terrain and fertile plains suitable for Agriculture. A purposive sampling strategy was employed to select 40 dealers in the Hassan district who were actively selling biofertilizers. These dealers were screened based on their engagement in biofertilizer adoption and promotion. Through structured interviews, insights were gathered on the factors influencing biofertilizer

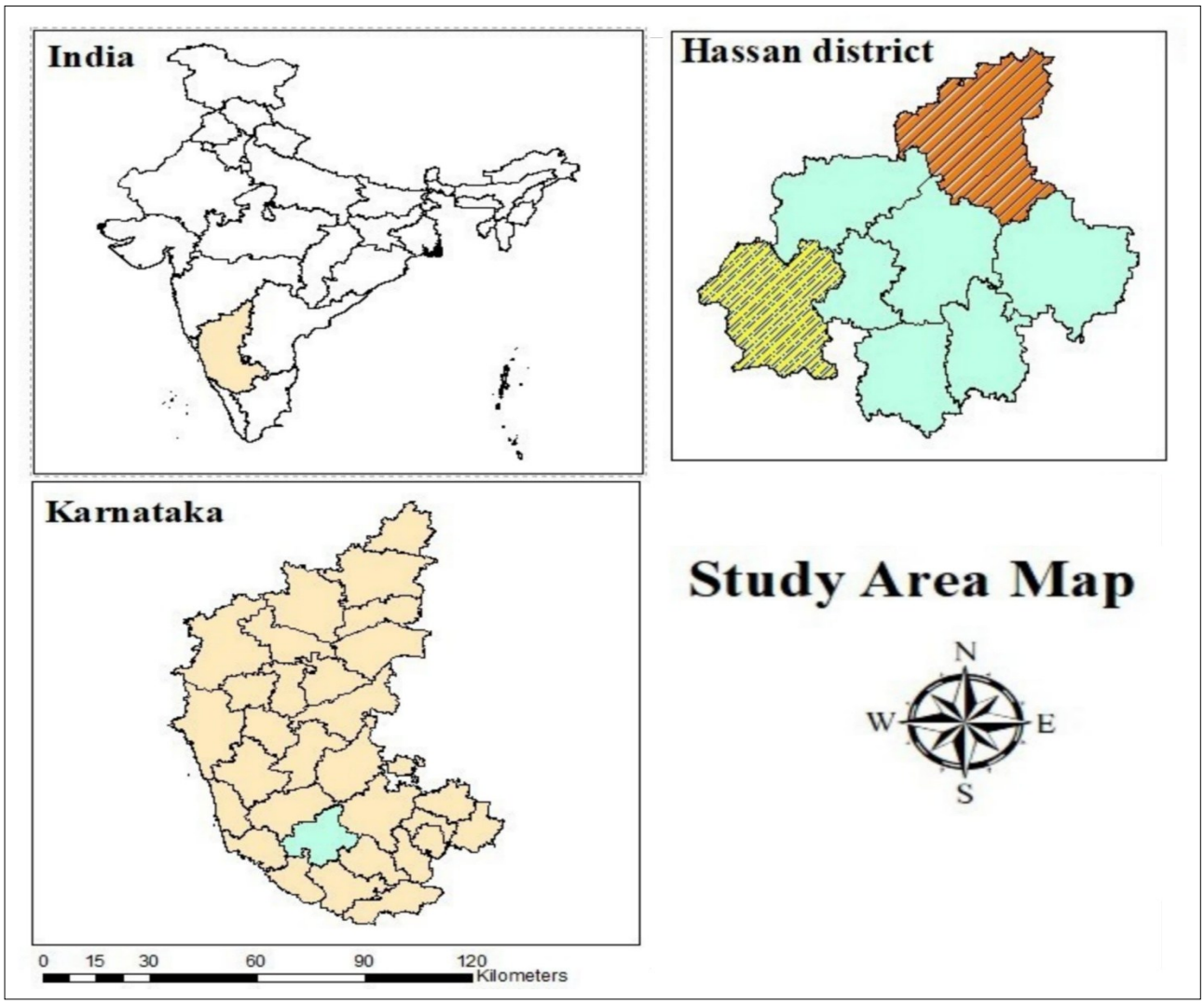


**Fig. 1**. Study area map Hassan district.

promotion and the constraints faced during adoption. This approach ensured a focused and comprehensive understanding of biofertilizer usage and challenges in the region. Questionnaires were designed to address the research questions and divided into two sections. The questionnaires were pre-tested with a small group of dealers to evaluate clarity, consistency and coherence to ensure reliability. Feedback from the pre-test was used to refine the questions. The first section of each questionnaire collected information on dealers. The second section focused on the research questions, capturing the factors influencing the promotion of biofertilizers and the constraints faced by dealers in adoption. Respondents ranked variables based on their perceptions.

The statistical model used for this study is the Plackett-Luce model, used to analyze and interpret ranked data, making it an ideal choice for this research. This model was chosen due to its ability to effectively evaluate the relative importance of variables in each research question, providing significant insights into the factors influencing the promotion of biofertilizers and constraints faced by dealers to adoption. The Plackett-Luce analysis was conducted using R software, ensuring robust statistical interpretation of the ranked data and enhancing the overall validity of the study's findings.

### Plackett-luce model

The Plackett-Luce model is a statistical tool used to analyze ranked data, particularly when understanding the relative importance of multiple items based on preferences (8). In this study, it is applied to assess the factors and constraints influencing the promotion of biofertilizers by dealers.

### Model description

For a set of n items, let $\theta_i$ represent the worth parameter of item *i*. The probability of a specific ranking $(i_1,i_2,\ldots, i_n)$, where i1 is the top-ranked item and $i_n$ is the bottom-ranked item, is given in Equation 1:

$$P(i1, i2, \ldots, in) = \prod_{j=1}^{n} \frac{\theta_{ij}}{\sum_{k=j}^{n} \theta_{ij}} \quad \text{(Eqn.01)}$$

Each dealer's ranking of factors is recorded for analysis in the model.

### Log-likelihood function

The log-likelihood function for a set of N observed rankings $\{R_1,R_2,\ldots, R_N\}$ is given in Equation 2

$$L(\theta) = \sum_{m=1}^{N} \sum_{j=1}^{n_m} (log\, \theta_{ij}^{j} - log \sum_{k=j}^{nm} \theta_{ik}^{m}) \quad \text{(Eqn.02)}$$

where:

- $R_m$ represents the $m^{th}$ observed ranking.
- $i_j^m$ denotes the item ranked at position j in the $m^{th}$ ranking.
- $n_m$ is the number of items in the $m^{th}$ ranking.

### Insights and applications

The estimated $\theta_i$ values reveal the relative importance of factors and constraints, providing a basis for targeted strategies to enhance biofertilizer promotion. This approach enables data-driven interventions by highlighting key priorities.

### Assumptions

The Plackett-Luce model assumes that dealers rank factors consistently based on their perceived importance, with rankings unaffected by the inclusion or exclusion of other factors (independence of irrelevant alternatives). It also assumes that rankings are complete and do not allow for ties, ensuring each factor is uniquely ordered and essential.

### Limitations

The model's reliance on strict rankings limits its ability to handle tied or incomplete data, which might arise in real-world dealer responses. Additionally, it assumes uniform preferences across all dealers, potentially overlooking individual or contextual differences that could influence ranking decisions. Accurate and unbiased data is critical, as any inconsistency or bias in the rankings could lead to skewed results.

## Results and Discussion

Understanding the primary information of dealers, whether at a micro or macro level, is essential for the success of any business. Table 1 illustrates the demographic characteristics of the respondents, highlighting several key trends.

### Information of dealer

Table 1 below shows that the dealer population is predominantly male, 95%, with most aged 31-45 years (62.5 %) holding certification courses (45 %). A significant portion has 5-10 years of experience in agro inputs (42.5 %). This demographic suggests that the industry is male-dominated, with a well-experienced and moderately educated workforce, which may influence their product preferences and promotion strategies.

**Table 1**. Dealers profile

| Characteristics | Category | Frequency | % |
|---|---|---|---|
| **Gender** | Male | 38 | 95 |
| | Female | 2 | 5 |
| | **Total** | **40** | **100** |
| **Age** | 18-30 years | 3 | 7.5 |
| | 31-45 years | 25 | 62.5 |
| | 46-55 years | 10 | 25 |
| | >55 years | 2 | 5 |
| | **Total** | **40** | **100** |
| **Educational Status** | Certification Course | 18 | 45 |
| | Diploma | 13 | 32.5 |
| | Graduation and above | 9 | 22.5 |
| | **Total** | **40** | **100** |
| **Experience in Agro -Inputs** | <5 Years | 14 | 35 |
| | 5-10 Years | 17 | 42.5 |
| | 10-20 Years | 9 | 22.5 |
| | **Total** | **40** | **100** |

## Factors influencing dealers in the promotion of biofertilizers

Table 2 outlines the factors influencing dealers' promotion of biofertilizers, emphasizing the varied significance of each variable. High promotional activities (Worthiness = 0.80, P < 0.001) emerged as the most critical factor, underscoring the importance of active marketing in enhancing dealers' willingness to promote these products. Quality biologicals (Worthiness = 0.50, P = 0.021) and profitability through high margins (Worthiness = 0.42, P < 0.001) also play significant roles, highlighting dealers' focus on product quality and financial incentives. In contrast, Brand Image (Worthiness = -0.56, P = 0.349) exhibited a negative, non-significant influence, suggesting that reputation may not powerfully drive promotion decisions in this context. Other factors, such as Timely availability (P < 0.005), Good packaging (P = 0.014) and better service by company staff (P < 0.001), showed varying degrees of impact. These findings reflect the multifaceted considerations that influence dealer behaviour, with a global perspective aligning with similar trends in agricultural markets, where marketing strategies and product quality remain pivotal for sustainable product promotion.

**Table 2**. Factors influence dealers

| Factors | Worthiness | Standard Error | Z | P |
|---|---|---|---|---|
| High Margin | 0.42 | 0.42 | 2.36 | <0.001 |
| Timely Availability | 0.39 | 0.31 | 0.38 | <0.005 |
| Good Packaging | 0.18 | 0.26 | 1.94 | 0.014 |
| High Promotional Activities | 0.80 | 0.27 | 7.17 | <0.001 |
| Good Quality Biofertilizers | 0.50 | 0.27 | 3.51 | 0.021 |
| Better Service by Company Staff | 0.23 | 0.28 | 0.95 | <0.001 |
| Brand image | -0.56 | 0.31 | -0.93 | 0.349 |

The increased promotional activities are essential to boost agricultural biological sales, aligning with the present study's findings on the importance of effective marketing strategies (9).

## Constraints faced by dealers in the promotion of biofertilizers

Table 3 highlights the critical constraints faced by dealers in promoting biofertilizers. The negative attitude of farmers was the most significant barrier (Worthiness = 2.65, Z = 3.45, P < 0.001), followed by insufficient market facilities (Worthiness = 1.41, Z = 4.03, P < 0.005). Conversely, the lack of government support showed a negative impact (Worthiness = -1.36, Z = -4.40, P = 1.085). Dealer knowledge emerged as a critical challenge, with a highly negative worthiness of -2.02 and a Z-value of -6.03 (P < 0.001). Positively timely availability of biologicals was a supportive factor, with a worthiness of 1.86 and a significant Z-value of 5.43 (P = 5.69). These findings underscore the need for interventions to improve farmers' attitudes, strengthen market infrastructure and enhance dealer training and knowledge. Addressing these constraints could foster a more conducive environment for biofertilizer promotion, aligning with global efforts to advance sustainable agricultural practices.

**Table 3.** Constraints faced by dealers

| Factors | Worthiness | Standard Error | Z | P |
|---|---|---|---|---|
| Negative Attitude of Farmers | 2.65 | 0.31 | 3.45 | <0.001 |
| Insufficient Market Facility | 1.41 | 0.35 | 4.03 | <0.005 |
| Lack of Government Support | -1.36 | 0.31 | -4.40 | 1.085 |
| Lack of Knowledge | -2.02 | 0.33 | -6.03 | <0.001 |
| Timely Availability of Biologicals in Critical Time | 1.86 | 0.34 | 5.43 | 5.69 |

The dealers face significant challenges due to farmers' negative attitudes, mirroring the present studys' findings on constraints in promoting agricultural biologicals (9).

## Effective promotional activities to promote biofertilizers

Table 4 presents the promotional activities recommended by dealers for biofertilizer outreach, emphasizing their varying effectiveness. Field trials, with the highest score (Worthiness = 0.93), emerged as the most impactful strategy, offering farmers direct, hands-on exposure to biofertilizer benefits and significantly boosting adoption rates. Farmers' meetings (Worthiness = 0.83) were also highly effective, fostering trust and enabling in-depth discussions. The Jeep campaign, scoring 0.61, stood out for its ability to engage farmers through direct and visible interactions in local contexts. Pamphlets, with a score of 0.47, were helpful for essential awareness but most effective when combined with other methods. While reaching a wide audience (Worthiness = 0.26), social media lacked the personal touch needed for deeper engagement, serving better as a complementary tool. These findings highlight the need for a multifaceted promotional approach that combines direct interaction, experiential learning and broad outreach to promote biofertilizers among farmers effectively.

**Table 4.** Effective promotional activity

| Factors | Worthiness | Standard | Z | p |
|---|---|---|---|---|
| Pamphlets | 0.47 | 0.18 | 2.22 | 0.026 |
| Jeep campaign | 0.61 | 0.12 | 4.92 | <0.001 |
| Social Media | 0.26 | 0.10 | 2.34 | 0.045 |
| Farmers meeting | 0.83 | 0.15 | 5.33 | <0.001 |
| Field trials | 0.93 | 0.05 | 2.50 | <0.001 |

## Conclusion

The study highlights the significant potential of biofertilizers as a sustainable alternative to chemical fertilizers, particularly in addressing the environmental challenges posed by conventional agricultural practices. For dealers, the promotion activities (worthiness score: 0.80, p < 0.001) were primarily influenced by practical marketing activities and product quality. However, challenges such as negative attitudes from farmers (worthiness score: 2.65, p < 0.001) and inadequate market facilities limit their ability to promote these eco-friendly inputs effectively. Field trials (worthiness score: 0.93, p<0.001) were the most effective tool to reach farmers in promoting biofertilizers. Addressing these barriers through targeted education, better market infrastructure and

strict quality control measures could significantly enhance the adoption and promotion of biofertilizers, leading to more sustainable and environmentally friendly agricultural practices.

Government bodies and agricultural agencies should put supportive policies and programs in place to boost the use of biofertilizers. These could involve subsidies to lower the cost of biofertilizers, comprehensive training programs to enhance farmers' technical knowledge and stricter regulations to ensure the authenticity and quality of biofertilizer products in the market. Furthermore, investing in improved market infrastructure and providing incentives for dealers to promote biofertilizers could help overcome existing barriers. By taking these steps, policymakers can create a more favourable environment for sustainable agricultural practices, ultimately contributing to long-term food security and environmental health.

## Acknowledgements

The authors thank the Department of Agricultural and Rural Management, Tamil Nadu Agriculture University, Coimbatore, for providing valuable guidance and technical support throughout this research.

## Authors' contributions

RSH carried out experimentation and drafted the manuscript, and SH planned, supervised and edited it. All authors were involved in the planning and analysis and provided critical feedback on 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

## References

1. Sujanya S, Chandra S. Effect of part replacement of chemical fertilizers with organic and bio-organic agents in ground nut (*Arachis hypogea*). J Algal Bio Utilizn. 2011;2(4):38-41
2. Savci S. An agricultural pollutant: chemical fertilizer. Int J Environ Sci Develop. 2012;3(1):73.
3. Vessey, J.K. Plant growth promoting rhizobacteria as biofertilizers. Plant and Soil**.** 2003;255:571-86. https://doi.org/10.1023/A:1026037216893
4. Bardi L, Malusà E. Drought and nutritional stresses in plants: alleviating role of rhizospheric microorganisms. abiotic stress. New Research. 2012; 1-57.
5. Ibáñez A, Garrido-Chamorro S, Vasco-Cárdenas MF, Barreiro C. From lab to field: biofertilizers in the 21st century. Horticulturae. 2023;9(12):1306. https://doi.org/10.3390/horticulturae9121306
6. Chaudhary P, Singh S, Chaudhary A, Sharma A, Kumar G. Overview of biofertilizers in crop production and stress management for sustainable agriculture. Front Plant Sci. 2002.13:930340. https://doi.org/10.3389/fpls.2022.930340
7. Government of India. Press Information Bureau [Internet]. [Accessed on June 26, 2024]. Available from: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1897011
8. Finch H. An introduction to the analysis of ranked response data. Practical Assessment, Research & Evaluation. 2022;27:1-20.
9. Patel SA, Patel JK, Patel VM. Constraints experienced by the input dealers in providing agro services to the farmers. Guj J Ext Edu. 2019; 153-55.