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Farmers' Awareness and Purchasing Behaviour Towards Biofertilizers: A Case Study from Kachchh District, Gujarat, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Abstract

This cross-sectional study examined farmers' awareness and purchasing behaviour towards biofertilizers among 200 purposively selected farmers across ten villages in five talukas (Anjar, Bhuj, Mundra, Mandvi and Nakhatrana) of Kachchh district, Gujarat, India, using structured personal interviews conducted from January to March 2026. Data were analysed using descriptive statistics, Weighted Average Mean (WAM) and Garrett's Ranking Technique. As sampling was purposive rather than random, the findings are indicative of the study area and should not be generalised to all farmers in Gujarat. Most respondents (53 per cent) belonged to the middle-aged group (36-50 years); all were male and about 89 per cent were married. Primary-level education was most common (37 per cent), and roughly two-thirds were small or marginal landholders

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with annual incomes below Rs. 2,50,000. Awareness of biofertilizers was high (94 per cent), with dealers and fellow farmers as the dominant information sources; however, only about 43 per cent of users had purchased biofertilizers more than once, indicating limited repeat purchase behaviour. Product performance (WAM: 4.29), biofertilizer quality (4.14) and dealer advice (3.89) emerged as the strongest purchase-decision factors, while packaging quality (3.19) and promotional activity (3.39) had the least influence. Lack of technical knowledge (Garrett score: 73.35), poor local availability (61.95) and delayed visible results (53.34) were the most severe adoption constraints. The findings suggest that extension agencies and biofertilizer suppliers should prioritise farmer training and strengthen local distribution networks to convert high awareness into sustained adoption. As the sample was restricted to purposively selected male respondents, the results should be interpreted within this limitation.

Keywords: Biofertilizers; awareness; purchasing behaviour; constraints.

1. Introduction

Agriculture has historically served as India's economic cornerstone, ensuring food security, generating rural employment and supplying industrial raw materials. The sector contributes 18.3 per cent of India's Gross Value Added (GVA) and employs over 54 per cent of the workforce, underscoring its central position in the country's development (Ministry of Finance, 2023 - the most recent officially published Economic Survey figures at the time of writing). While the Green Revolution of the 1960s and 1970s transformed productivity through high-yielding varieties, expanded irrigation and intensive chemical fertilizer use, it simultaneously ushered in long-term sustainability challenges (Hasan *et al*., 2025). Modern agriculture is increasingly shifting from input-intensive production systems towards sustainable and climate-resilient approaches that integrate efficient water management, soil health restoration, precision agriculture, biological inputs and digital technologies, thereby improving resource-use efficiency and long-term agricultural sustainability (Kumar *et al*., 2025; Kumar *et al*., 2026). Excessive chemical fertilizer use has deteriorated soil quality, including organic matter depletion, disrupted soil microbiomes, nutrient imbalances and groundwater contamination (Ataei *et al*., 2022). These fertilizers reduce soil water retention, increase salinity and adversely affect soil organisms, diminishing long-term productive potential (Savci, 2012). Recognising the limitations of chemical-intensive farming, researchers, policymakers and agribusinesses have turned towards biologically based inputs as sustainable alternatives. Biofertilizers have emerged as a promising solution to enhance soil fertility and crop productivity while reducing the ecological footprint of modern agriculture.

Biofertilizers are microbial inoculants containing living or dormant nitrogen-fixing, phosphate-solubilising and cellulose-decomposing microorganisms in carrier-based products for seeds, plant surfaces, or soil (Raimi et al., 2017). When applied, these microorganisms colonise the rhizosphere or plant interior, promoting growth by increasing nutrient availability through natural processes such as nitrogen fixation, phosphorus solubilisation and growth-promoting substance synthesis (Bhardwaj *et al*., 2014; Kour *et al*., 2020). Unlike chemical fertilizers, biofertilizers are natural, organic and economical, contributing significantly to integrated nutrient management as a tool for environmental protection and sustainable development (Mohammadi & Sohrabi, 2012). Climate variability, declining water availability and land degradation have further increased the need for sustainable nutrient management practices that improve soil biological activity while enhancing resilience against environmental stresses. The case for widespread biofertilizer adoption is compelling. Chemical fertilizer overuse has led to nitrate accumulation in crops, posing health risks and costing governments millions in subsidies. Farmers' awareness is a critical precondition for adoption. Research in Gondal taluka, Gujarat, found that while 92 per cent of surveyed farmers were aware of bio-products, awareness and behavioural gaps constrained adoption (Savaliya *et al*., 2023). Agricultural extension services, training workshops, demonstration farms and information dissemination are therefore paramount in shaping farmers' knowledge and attitudes towards biological inputs.

Notwithstanding the potential of biofertilizers, farmers still face practical challenges to adoption. These include a lack of awareness and technical knowledge of application methods, poor shelf life and quality control issues in available products, limited availability through local markets, delayed or less visible results compared with chemical fertilizers and insufficient guidance from extension workers. Additionally, many small and marginal farmers lack access to credit and face financial constraints that make the cost of transitioning to biological inputs a barrier. In the Jammu study, 71 per cent of respondents were marginal farmers holding 1 to 2.5 acres of land

(Dwivedi *et al*., 2020). In India, adoption remains uneven because of low awareness, inadequate technical knowledge, limited local availability and insufficient extension support. Understanding farmers' socio-economic characteristics, awareness levels, purchasing behaviour, institutional support and adoption constraints is essential for developing effective policies that promote sustainable agricultural technologies. Studies conducted in Gujarat have demonstrated that socio-economic factors, institutional participation and access to extension services significantly influence technology adoption and rural livelihood improvement (Kumari *et al*., 2026). Although several studies have investigated farmers' awareness and adoption of biofertilizers in different regions of India (Kumar *et al*., 2025; Kumari *et al*., 2026), very limited empirical evidence exists regarding farmers' purchasing behaviour, repeat purchase decisions and adoption constraints under the arid agro-ecological conditions of Kachchh district, Gujarat. Furthermore, previous studies have generally examined awareness or adoption independently, whereas limited attention has been given to integrating socio-economic characteristics, awareness, purchasing behaviour, and adoption constraints within a single analytical framework. Therefore, the present study attempts to address this research gap by examining the socio-economic profile of farmers, assessing their awareness of biofertilizers, analysing the factors influencing their purchasing behaviour, and identifying the major constraints affecting biofertilizer adoption in Kachchh district, Gujarat.

2. Materials and Methods

The study was conducted from 1 January 2026 to 31 March 2026 across selected villages in five talukas of Kachchh district, namely Anjar, Bhuj, Mundra, Mandvi and Nakhatrana. A descriptive research design was adopted. Primary data were collected through personal interviews using a structured interview schedule. The schedule was developed from the study objectives and relevant literature, reviewed by subject-matter experts for content and face validity, and pre-tested on 20 farmers (10 per cent of the intended sample) in a non-study village of Kachchh district; ambiguous items were reworded, and the wording of the Likert-scale statements was clarified based on this pilot before the main survey. Verbal informed consent was obtained from each respondent before the interview, and confidentiality and anonymity of responses were assured; no personally identifying information was recorded. A total of 200 farmers were selected using non-probability purposive sampling, with 20 farmers selected from each of the 10 study villages (two per taluka). Secondary data were obtained from published journals, research articles and government and private agency reports. Descriptive statistics (frequencies, percentages, and means) were used to analyse socio-economic characteristics and awareness levels. The Weighted Average Mean (WAM) technique was applied to Likert-scale responses to identify and rank the key factors influencing purchasing behaviour. Garrett's Ranking Technique was used to prioritise the constraints faced by farmers in the adoption of biofertilizers, using the formula given below.

$$\text{Weighted Average Mean } (X) = (F_1X_1 + F_2X_2 + ... + F_nX_n) / X_t$$

Garrett's Ranking:

$$\text{Percentage position} = 100 \times (R_{ij} - 0.5) / N_j$$

Where,

R_{ij} = rank given for the i^{th} variable by j^{th} respondent and
N_j = number of variables ranked by j^{th} respondent

3. Results and Discussion

3.1 Socio-economic Profile of Farmers

The socio-economic characteristics of the 200 sample farmers are presented in Table 1. The majority of farmers (53 per cent) belonged to the middle age group of 36-50 years, followed by 26 per cent in the 51-and-above group and 21 per cent below 35 years. All 200 respondents were male, reflecting the male-dominated nature of farming decisions in the study area. Regarding education, the majority (37 per cent) had primary-level education, followed by secondary (21 per cent) and higher secondary (16 per cent), while 12.50 per cent were illiterate. Agriculture alone was the primary income source for 54 per cent of farmers, while 37 per cent combined farming with animal husbandry. More than half the sample (68 per cent) comprised small and marginal farmers, and 56 per cent earned annual incomes below Rs. 2,50,000, underscoring the resource-

constrained nature of the farming community in Kachchh. The largest proportion of farmers (48 per cent) had medium farming experience of 10-20 years, indicating an experienced farming community. Similar socio-economic characteristics of rural households in Gujarat have also been reported by Kumari *et al.* (2026), who observed that landholding size, education level and income substantially influence farmers' participation in agricultural development activities. Taken together, this profile is important for interpreting the results that follow. A predominantly middle-aged, primary-educated, small/marginal and resource-constrained farming population is typically more risk-averse and more dependent on visible, low-cost proof of a new input's performance before adopting it. This helps explain why product performance and dealer advice later emerge as the strongest purchase-decision factors and why sustained repeat purchase (Section 3.2) remains limited despite high awareness. That all respondents were male also means the results reflect male household decision-makers only; women's roles in biofertilizer awareness and purchase decisions could not be captured and are discussed further under limitations.

Table 1. Socio-economic profile of sample farmers

Sr. No.	Particulars	Respondents(n)	Percentage (per cent)
1	**Age**		
	Less than 35 (Young)	42	21.00
	36-50 (Middle)	106	53.00
	51 and above (Old)	52	26.00
2	**Education**		
	Illiterate	25	12.50
	Can Read and Write	15	7.50
	Primary School	74	37.00
	Secondary School	42	21.00
	Higher Secondary	32	16.00
	Graduate & Above	12	6.00
3	**Marital Status**		
	Married	177	88.50
	Unmarried	23	11.50
4	**Land Holding**		
	Marginal (<1 ha)	60	30.00
	Small (1-2 ha)	76	38.00
	Semi-Medium (2-4 ha)	20	10.00
	Medium (4-10 ha)	16	8.00
	Large (>10 ha)	28	14.00
5	**Occupation**		
	Agriculture	108	54.00
	Agriculture + Animal Husbandry	74	37.00
	Agriculture + Other	18	9.00
6	**Annual Income (Rs.)**		
	Less than Rs. 2,50,000	112	56.00
	Rs. 2,50,001 - Rs. 5,00,000	56	28.00
	Above Rs. 5,00,000	32	16.00
7	**Farming Experience**		
	Low (Below 10 years)	36	18.00
	Medium (10-20 years)	96	48.00
	High (Above 20 years)	68	34.00

3.2 Farmers' Awareness Level towards Biofertilizers

Out of 200 sampled farmers, 93.50 per cent were aware of biofertilizers, while only 6.50 per cent were unaware. Among the 187 aware farmers, dealers were the dominant source of information (29.95 per cent), followed by fellow farmers (26.20 per cent), pamphlets or posters (13.90 per cent), social media (12.85 per cent), company staff (12.30 per cent) and newspapers (4.80 per cent). Together, dealers and fellow farmers accounted for over 56 per cent of awareness sources, highlighting the critical role of interpersonal channels in information dissemination. Of the 187 aware farmers, 72.73 per cent had actually used biofertilizers in their fields, while

27.27 per cent had knowledge but had never used them. Among the 136 users, 42.65 per cent had purchased biofertilizers only once, 31.60 per cent twice, 15.45 per cent three times and 10.30 per cent more than three times. The high proportion of one-time buyers indicates limited repeat purchase behaviour, suggesting that initial trials have not consistently translated into sustained adoption, possibly due to the constraints identified in Section 3.4.

3.3 Factors Affecting Purchasing Behaviour of Farmers for Biofertilizers

The factors influencing farmers' purchase decisions for biofertilizers were analysed using WAM and are presented in Table 2 and Fig. 1. Product performance emerged as the most influential factor (WAM: 4.29), indicating that demonstrated field-level efficacy is the primary driver of purchase decisions. This was followed by quality of the biofertilizer (WAM: 4.14) and dealer advice (WAM: 3.89), reflecting farmers' reliance on proven results and trusted guidance. Price of the biofertilizer (WAM: 3.84), availability (WAM: 3.75) and brand image (WAM: 3.59) formed a secondary cluster of important factors. Promotional activity (WAM: 3.39) and packaging quality (WAM: 3.19) were comparatively the least influential.

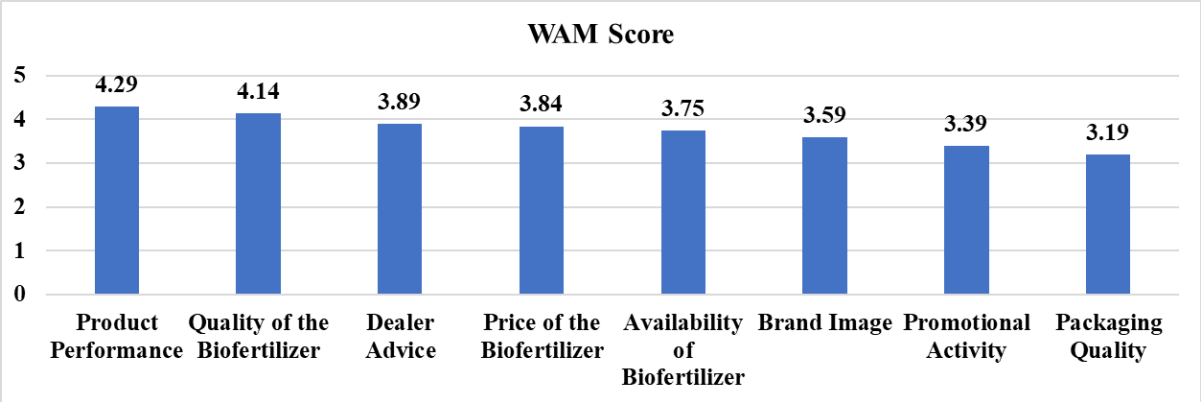

Fig. 1. Ranking of factors influencing biofertilizer purchase decisions (WAM Scores, on a 1-5 importance scale)

Table 2. Factors affecting purchasing behaviour of farmers for biofertilizers (WAM analysis)

Sr. No.	Factor	WAM Score	Rank
1	Product Performance	4.29	1
2	Quality of the Biofertilizer	4.14	2
3	Dealer Advice	3.89	3
4	Price of the Biofertilizer	3.84	4
5	Availability of Biofertilizer	3.75	5
6	Brand Image	3.59	6
7	Promotional Activity	3.39	7
8	Packaging Quality	3.19	8

(WAM scores derived from a 5-point importance scale: 1 = Not at all Important, 2 = Slightly Important, 3 = Moderately Important, 4 = Important, 5 = Extremely Important, indicating the degree to which each factor influenced farmers' purchase decisions)

3.4 Problems Faced by Farmers in the Adoption of Biofertilizers

The adoption constraints faced by the 136 biofertilizer-using farmers were analysed using Garrett's Ranking Technique, as presented in Table 3. Lack of technical knowledge about biofertilizers was ranked first with the highest Garrett's mean score of 73.35, indicating that knowledge gaps in correct application, dosage, timing and compatibility are the most critical barriers. Non-availability of biofertilizers locally at times when needed was ranked second (mean score: 61.95), confirming that supply chain deficiencies remain a major barrier, as also observed by Joshi *et al*. (2019) in Saurashtra. Results not being visible immediately ranked third (mean score: 53.34), reflecting farmers' preference for quick and observable agricultural outcomes. Lack of guidance from

extension personnel was ranked fourth (46.51), poor shelf life was ranked sixth (31.43), and the negative attitude of neighbouring farmers was ranked last (22.40), indicating that peer influence, though present, is the least significant constraint. These findings collectively underscore that informational, supply chain and product communication gaps are the primary bottlenecks in wider biofertilizer adoption in Kachchh.

Table 3. Problems faced by farmers in the adoption of biofertilizers (Garrett's Ranking)

Sr. No.	Problem	Garrett's Mean Score	Rank
1	Lack of Technical Knowledge about Biofertilizers	73.35	1
2	Non-availability of Biofertilizers Locally	61.95	2
3	Results not Visible Immediately	53.34	3
4	Lack of Guidance from Extension Personnel	46.51	4
5	Lack of Awareness about Benefits of Biofertilizers	39.02	5
6	Poor Shelf Life of Biofertilizers	31.43	6
7	Negative Attitude of Neighbouring Farmers	22.40	7

A notable pattern in these findings is the gap between very high general awareness of biofertilizers (93.50 per cent) and the fact that lack of technical knowledge was nevertheless ranked as the single most severe adoption constraint. This apparent contradiction suggests that awareness in this context is largely superficial – farmers know biofertilizers exist and are broadly beneficial, but many lack the procedural knowledge needed to apply them correctly (correct dosage, timing, storage and compatibility with existing practices), which is consistent with diffusion of innovations theory's distinction between awareness-knowledge and how-to-knowledge (Rogers, 2003) and with the Theory of Planned Behaviour, in which favourable attitudes do not translate into behaviour without adequate perceived behavioural control (Ajzen, 1991). A similar disconnect between awareness and actual adoption was reported by Savaliya *et al*. (2023) in Gondal taluka and by Dwivedi *et al*. (2020) in Jammu, indicating that the pattern is not unique to Kachchh but reflects a broader shortfall in hands-on, application-level extension support across Indian smallholder settings. Bridging this gap is therefore less a matter of further information campaigns and more a matter of practical, demonstration-based training – for example, field demonstrations, dosage calculators and dealer-led application guidance – delivered close to the point of purchase.

4. Conclusion

The findings indicate that high awareness of biofertilizers does not necessarily translate into sustained adoption among farmers in Kachchh district. The major barrier is inadequate practical knowledge regarding their application rather than a lack of awareness. Dealers and fellow farmers remain the primary sources of information, highlighting the importance of interpersonal communication in promoting biofertilizer adoption. This reframes biofertilizer promotion policy away from generic awareness campaigns and towards three concrete, actionable interventions. First, dealer-led demonstration and coaching should be formalised and incentivised, since dealers already reach the largest share of farmers but are not currently equipped as a structured extension channel; short certified training modules for dealers on dosage, timing and storage could convert an existing trust relationship into a reliable knowledge channel. Second, local supply chains need to be strengthened – for example, through seasonal stocking agreements with input dealers or village-level distribution points – to address the second-ranked constraint of non-availability at the point of need. Third, given that delayed visibility of results discourages repeat purchase, extension agencies and companies should invest in visible, field-level demonstration plots so that farmers can observe comparative performance before committing to repeat use. Beyond Kachchh, these findings contribute to the broader literature on sustainable agricultural technology adoption by showing that the awareness-to-adoption transition in biological inputs is better explained by perceived behavioural control and practical know-how than by information availability alone, a distinction that future biofertilizer promotion strategies in comparable smallholder, dryland farming contexts should consider.

5. Limitations

This study was limited to 200 purposively selected farmers from ten villages in five talukas of Kachchh district, so the findings may not represent all farmers in Gujarat. All respondents were male, which limits the understanding of women farmers' awareness and purchasing behaviour. The study relied on self-reported

responses, which may involve recall or response bias. The analysis was descriptive and did not test causal relationships between socio-economic characteristics and adoption behaviour. Future studies should include larger and more diverse samples, women farmers, probability sampling, and statistical modelling to identify the determinants of sustained biofertilizer adoption.

Declaration of AI Use

This manuscript was prepared through the combined contributions of all author(s), including contributions to the study design, data, content development, results, interpretation, and related scholarly work. The author(s) acknowledge the use of Grammarly and ChatGPT to assist with grammar checking, language refinement, and reference formatting. These AI-assisted tools were not used by the author (s) and did not replace the intellectual contributions or scholarly judgment of the author(s). These AI-assisted tools did not replace the intellectual contributions or scholarly judgment of the authors. They were used solely for language refinement, grammar checking and reference formatting. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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