Original Research Article

Assessing the Bio-Pesticide Market in Khordha District of Odisha, India: A Study on Market Intermediaries' Attitudes and Behaviors

.

ABSTRACT

|  |
| --- |
| **Aims:** This research analyses and explores the market status of bio-pesticides, attitudes and behaviour of intermediaries, the responsible factors and constraints in Khordha district of Odisha to deliver meaningful insights for the all the stakeholders involved.**Study design:** A descriptive and exploratory research design was utilized in this study.**Place and Duration of Study:** This research, conducted in the crop year 2023–24, was confined to the Khordha district of Odisha.**Methodology:** This research is based on descriptive and exploratory research design. The primary data was collected for the crop year 2023–24, using experts’ advice based structured schedules via snowball sampling (n=27), complemented by secondary data. Snowball sampling was used for its cost-effectiveness and this method leveraged existing social networks of the researcher. The sample was limited to 27 in number because of time-constraints and availability of the intermediaries during the data collection process. Based on the literature review and suitability of the data, statistical tools and techniques such as One-way ANOVA, Chi-square, Multiple Linear Regression, and Logistic Regression, etc. were analysed using MS Office and IBM SPSS software.**Results:** This research revealed annual turnover of bio-pesticide to be positively influenced by number of villages served and number of dealerships of bio-pesticide based companies, while credit period for farmers (days) had a negative impact (F(14,12)=5.393, *P*=.01, R2=0.937). Among the dealers and retailers, DAESI (Diploma in Agricultural Extension Services for Input Dealers) certification was founf to be the significant and influencing factor in selling bio-pesticides (coefficient 4.252, Pseudo R2=0.673). Dealers and retailers largely preferred national level tours (59 percent), and 52 percent favoured doing business with local companies. They valued working with business-oriented company representatives (63 percent). Their preferred method of business transaction with farmers was cash (56 percent), and 81 percent of the respondents had plan for business expansion. As of promotion, posters/banners (96.30 percent) and farmer meetings (92.59 percent) were the most preferred tools among the dealers and retailers. Major constraints in pesticide business included high transportation costs (mean score: 3.41), lack of farmer knowledge (mean score: 3.22), and High cost of labour (mean score: 3.15).**Conclusion:** To promote sustainable agriculture, stakeholders should consider expanding awareness initiatives to educate farmers, retailers and dealers about the benefits of bio-pesticides. Bio-pesticide companies can play a vital role by boosting promotional efforts about the advantages of using bio-pesticides. Moreover, companies should prioritize ethical sales and distribution practices. This study also lays the groundwork for further in-depth research into bio-pesticide sales and marketing strategies, offering opportunities for future exploration and development. |

*Keywords: Bio-pesticides; Market Intermediaries; Influencing factors; Attitude; Constraints*

**1. INTRODUCTION**

**1.1. Background of the Study**

In modern agriculture, pesticide usage has played a crucial role by empowering farmers to mitigate crop losses and ensure food security; however, the incessant application of chemical pesticides has led to serious health issues and environmental concerns. As per World Health Organization (WHO), acute occupational pesticide poisoning affects about twenty-five million people, each year in developing countries, resulting in nearly twenty thousand fatalities worldwide. Therefore, as part of sustainable agriculture practices, it became imperative to explore alternative pest management techniques including biopesticides, which are non-toxic natural derivatives from plants, animals, and microorganisms, effective in controlling pest populations and offering safer alternatives to chemical pesticides and promising solutions for minimizing crop losses without posing any environmental concerns. Particularly, the microbial pesticides such as the bacterium Bacillus thuringiensis (Bt) have tremendous potential in controlling certain pests by producing crystalline proteins that target specific insect species. Aligning with the principles of sustainable development incorporating social adequacy, economic productivity, and environmental protection, biopesticides are poised to play a crucial role in integrated pest management programs, providing a targeted and safer approach to pest management as the world focuses on more sustainable agriculture practices [1].

Biopesticides has been categorized mainly into three types by the United States environmental protection agency: Microbial pesticides, Biochemical pesticides & Plant incorporated protectants. Microbial pesticides comprise of fungi viruses, bacteria and nematodes targeting specific pests and controlling wide range of diseases, weeds and insects. Biochemical pesticide that includes semiochemicals and plant regulators utilising non-toxic mechanisms to modify pest behaviour and physiology. Plant-incorporated protectants (PIPs) which are bio-pesticidal compounds formed by genetically modified crops such as those expressing the Bt toxin or dsRNA to fight against pests. With potential for integrated pest management and sustainable agriculture these categories of biopesticides deliver effective alternatives to chemical pesticides. Valued at USD 8.73 billion in 2024, the global pesticide market is projected to grow to USD 28.61 billion by 2032 at a CAGR of 16 percent. North America is the market leader of biopesticides with a share of 36.8 percent and US is expected to reach USD 7.34 billion by 2032 driven by the rising demand for organic food and sustainable agricultural methods. Recently, several companies have also invested in research and development with the launch of various bio pesticide products like a bioinsecticide Tackler by UPL limited in 2024, made from the fungus named 'Beauveria bassiana', another microbiological fungicide named Frontier Control by the company Simbiose with notable developments from companies like Vestaron Corporation's USD 10 million dollar funding bio pesticide research and development, Croda International's launch of Altox BS-50 for spore forming microbes and FMC Corporations introduction of its Biològicos da FMC bio pesticide brand in Brazil. With the increasing adoption of biopesticides in countries like India, Japan, China and Australia, the Asia Pacific region provides tremendous market opportunities for biopesticide manufacturers due to the rising demand for organic farming and concerns over synthetic pesticide use. The Indian bio pesticide market is indeed growing rapidly. Valued at USD 82.2 million in 2024, it is expected to reach USD 204.1 million by 2033 at a CAGR of 9.23 percent [2].

With 130 private and 280 government-owned units, India has a total of 410 biopesticide production units. This development has been possible due to the support of the government towards the production of biopesticides through various initiatives and institutions like ICAR and state agricultural universities involved in its production. Also, government organizations and private companies like Biotech International Limited and Crop Care Limited are major players in the industry. In spite of this growth, the biopesticide market accounts for a very small share of the total pesticide industry with around 9 percent consumption only [3].

However, with an anticipated annual growth rate of 2.5 percent, the bio pesticide consumption is projected to reach 50 percent of the market by 2050. The Insecticides Act of 1968 regulates biopesticide production, with the Central Insecticide Board and Registration Committee (CIBRC) overseeing the registration and quality control of these pesticides. Presently, 970 biopesticide products have been registered, with market domination of fungal biopesticides like Trichoderma-based products, in particular. In order to promote the commercialisation of biopesticides, the government can extend its efforts towards forming international policies and standards to streamline the regulatory procedures and facilitate global trade. The biopesticide market is witnessing significant growth and development owing to various biopesticides (including Microbial, plant based and essential oils), offering promising solutions for sustainable pest management, as well as the role of key industrial players like UPL Group, Coromandel International, and Gujarat State Fertilizers and Chemicals Limited (GSFC) in introducing new products and partnerships, driving growth in the market. Recently, notable actions by key industrial players include the launch of Eco Neem Plus Bio-fungicide by Coromandel, UPL's acquisition of Bio-fungicide OptiCHOS, its partnership with AgBiTech, and GSFC's partnership with Arysta LifeScience for biopesticides marketing in India. Through their new product launches, research & development, strategic alliances, and expansion of their businesses in the eco-friendly agriculture solutions space, these companies have become instrumental in driving growth and development in the sector [4].

**1.2. Review of Literature**

The global agricultural landscape is witnessing a notable shift towards bio-pesticides, driven by factors such as increased return on investment, growing restrictions on chemical pesticides, and concerns regarding pesticide residue management. Bio-pesticides currently constitute approximately 10 percent of the global pesticide market, with new technologies like RNAi and systemic metabolites expected to further impact the market in the coming decade Despite the recognized need for new herbicides, particularly bio-herbicides, their market share remains low due to challenges in developing competitive alternatives to existing chemical options. Investment in bio-pesticide discovery and development is often perceived as high-risk, leading to a greater focus on categories like bio-stimulants and bio-nutrients [5].

The burgeoning use of bio-pesticides is contributing to sustainable agricultural practices globally, including in agriculturally dominant economies like India. Research indicates that both buyer (farmer) and seller attitudes are significantly influenced by the overall attributes of bio-pesticides, with buyer attitudes being more affected by performance measures, and seller attitudes by experience and expectations [6]. This highlights the importance of understanding the perspectives of both ends of the supply chain.

Several studies have explored the factors influencing the purchase and adoption of pesticides, with varying focuses on chemical and bio-pesticides. Price is consistently identified as a primary consideration in bio-pesticide purchases, followed by quality and brand name. Constraints such as lack of credit facilities and high input costs also impede bio-pesticide usage. For agri-input dealers, major challenges include high competition, low profit margins, and rising costs [7]. Product demonstrations and farmer meetings have a positive influence on purchasing decisions for bio-pesticides [7], [8], [9], [10], [11], [12], [13]. Quality, effective results, and positive crop growth are crucial aspects affecting purchase decisions for both chemical and bio-pesticides, with farmers valuing products that offer value for money and are safe for both crops and soil [8], [14], [15].

The enduring loyalty to chemical pesticides is often attributed to their immediate efficacy, with farmers frequently relying on local retailers for procurement and information [16], [17]. Farmers' purchase intentions for chemical pesticides are strongly influenced by descriptive norms and their attitude towards these products, despite the known detrimental environmental and health impacts [18]. Studies reveal that agro-service centers offering quality products and reliable recommendations are highly preferred by farmers. Retailer suggestions, demonstrations, and wall paintings are effective promotional activities influencing farmer purchasing decisions [16].

In developing countries, where public extension services are often inadequate, farmers frequently depend on the opinions of agricultural input traders (Motalleb et al., 2023). Research in Bangladesh suggested that profit-maximizing traders, when providing unbiased information, can help mitigate market failures [19]. Dealers and retailers play a significant role in pesticide advertising and promotional strategies, with companies like UPL, BASF, and PI being top-ranked in the Indian market for promotional activities [16].

Farmers' buying behavior for pesticides is influenced by factors like the availability of products at the right time, with many preferring local markets and purchasing from dealers and retailers. The majority of farmers make their own purchasing decisions, often on credit, highlighting the need for companies to provide credit facilities. Brand loyalty is observed, with farmers often sticking to specific brands and quantities even with price increases, switching only when preferred brands are unavailable. This emphasizes the importance of timely product availability to meet seasonal demand [20].

Agro-input dealers face various constraints, including financial issues, problems with input availability, challenges in delivering extension services, product performance issues, and managerial constraints. Financial challenges are often ranked as the most significant hurdle, while timely availability of inputs is perceived as less critical by dealers [21]. Furthermore, infrastructure and awareness issues, such as lack of market access, inadequate knowledge, and poor storage facilities, pose significant problems for agro-input dealers, necessitating supportive institutional and policy environments for market growth [22].

A critical aspect identified is the lack of scientific knowledge among pesticide salespersons, with many possessing limited awareness regarding product handling, health risks, and regulatory policies. This calls for strict compliance with legal aspects, effective monitoring, and active involvement of the public sector to improve knowledge and practices in pesticide sales and delivery [23].

**1.3. Justification of the Study**

The pesticide market in the state of Odisha faces challenges from dynamic conditions, competition, and climate changes. A significant knowledge gap exists in understanding the market intermediaries; their attitudes, preferences, constraints, etc. This research investigates these aspects among the pesticide market intermediaries including dealers and retailers, especially in Khordha district of Odisha.

The Null Hypothesis of the study is given below:

* There is no mean difference of business annual turnover among three group of intermediaries such as high-come, medium-income and low-income group

The research objectives are stated as follows:

1. To identify different types of major pesticides sold in the study area
2. To study about the demographic variable(s) influencing the pesticide business
3. To examine the factors influencing the business of bio-pesticides
4. To assess the attitude of pesticide dealers/retailers towards different sales and marketing activities of pesticides
5. To identify the constraints faced by dealers/retailers in pesticide business

**2. MATERIAL AND METHODS**

This study was based on descriptive and exploratory research design. Data were collected in the crop year 2023–24. Snowball sampling method was followed to identify the respondents. Snowball sampling was used for its cost-effectiveness and this method leveraged existing social networks of the researcher. The sample was limited to 27 in number because of time-constraints and availability of the intermediaries during the data collection process. Primary data were gathered using structured schedules comprising both open-ended and close-ended questions, developed with critical literature review. Secondary data were also utilized to complement the primary information. For data analysis, Microsoft Office (MS 2021) and IBM SPSS Statistics (29.0.1.0 trial version) were used. Descriptive statistics, including tabular and graphical presentations (bar diagrams), percentages, and averages, were employed to summarize the data. To test the hypothesis and analyse the objectives, suitable statistical techniques were applied like One-way ANOVA, Chi-square ($χ^{2}$) test of independence; Multiple Linear Regression (MLR); Logistic (Logit) Regression; Arithmetic Mean; etc.

**3. RESULTS AND DISCUSSION**

**Table 1. One-way-ANOVA among three income groups of business intermediaries**

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of respondents** | **Income Groups** | **Mean of business turnover per annum** | **F value** |
| Business intermediaries | High (>INR 100 lakhs) | 337.429 | 13.486\*\* |
| Medium (INR 25–100 lakhs) | 69.375 |
| Low (<INR 25 lakhs) | 13.667 |

*\*\* Significant at one per cent level of probability*

*Source: Researcher’s computation from the primary data*

The results revealed that there was a significant mean difference in business annual turnover among the three group of market intermediaries based on annual business turnover: high-income, medium-income, and low-income intermediaries (F(2,24) = 13.486, *P*= .01), rejecting the null hypothesis and indicating that the incomes of the three groups vary with different business turnover.

**Table 2. Socio-economic profile of the respondents**

|  |  |  |
| --- | --- | --- |
| **Business type** | **Frequency** | **Percent** |
| Wholesaling | 15 | 55.56 |
| Retailing | 12 | 44.44 |
| Total | 27 | 100.00 |
| **Age** | **Frequency** | **Percent** |
| Below 35 years | 8 | 29.63 |
| 36-49 years | 11 | 40.74 |
| 50 years and above | 8 | 29.63 |
| Total | 27 | 100.00 |
| **Caste** | **Frequency** | **Percent** |
| Gen | 20 | 74.07 |
| OBC | 4 | 14.82 |
| SC | 3 | 11.11 |
| Total | 27 | 100.00 |
| **Education** | **Frequency** | **Percent** |
| Under Matric | 4 | 14.82 |
| Matriculation | 6 | 22.22 |
| Graduation | 17 | 62.96 |
| Total | 27 | 100.00 |
| **Annual income** | **Frequency** | **Percent** |
| High (>INR 100 lakhs) | 7 | 25.93 |
| Med (INR 25-100 lakhs) | 8 | 29.63 |
| Low (<INR 25 lakhs) | 12 | 44.44 |
| Total | 27 | 100.00 |

*Source: Researchers computation from primary data*

The respondents were primarily found to be involved in wholesaling (55.56 percent) pesticide businesses, with the remaining 44.44 percent in retailing business. Regarding age, the largest group was 36–49 years old (40.74 percent). In terms of ca

ste, General caste respondents were of 74.07 percent, with OBC at 14.82 percent and SC at 11.11 percent. It was found that most respondents were graduates (62.96 percent), followed by matriculates (22.22 percent) and under-matric (14.81 percent). The income distribution showed 44.44 percent to be in the low-income group, followed by 29.63 percent in the medium-income group, and 25.93 percent in the high-income group.

**Figure 1. Major products (Insecticides) in the study area**

*Source: Researcher’s computation from the primary data*

15 percent of dealers and retailers frequently cited Dhanuka Agritech Ltd.'s 'Super Killer' (Cypermethrin 25% EC) as their top insecticide product, followed by ‘Terminator of HPM Chemicals & Fertilizers Ltd. (Chloropyriphos 50% + Cypermethrin 5% EC) with 10 per cent’, ‘Rogor of HPM Chemicals & Fertilizers Ltd. (Dimethoate 30% EC) with 10 per cent’, ‘Cannon of NACL Industries Ltd. (Chloropyriphos 50% + Cypermethrin 5% EC) with 10 per cent’, and ‘Zailo of Zuari FarmHub Ltd. (Chloropyriphos 50% + Cypermethrin 5% EC) with 6 per cent’.

**Figure 2. Major products (Fungicides) in the study area**

*Source: Researcher’s computation from the primary data*

24 per cent of dealers and retailers cited Saaf of UPL Ltd. (Carbendazim 12% + Mancozeb 63% WP) as their top fungicide product, followed by ‘Indofil M45 of Indofil Industries Ltd. (Mancozeb 75% WP) with 15 per cent’, ‘Bavistin of Crystal Crop Protection Ltd. (Carbendazim 50% WP) with 13 per cent’, ‘Blitox of Rallis India Ltd. (Copper Oxy-Cholride 50% WP) with 13 per cent’, ‘Sixer of Dhanuka Agritech Ltd. (Carbendazim 12% + Mancozeb 63% WP) with 12 per cent’.

**Figure 3. Major products (Herbicides) in the study area**

*Source: Researcher’s computation from the primary data*

The most favoured herbicide product among the respondents was found to be HPM Chemicals & Fertilizers Ltd.'s 'All Clear' (Paraquat Dichloride 24% SL), with 12% of respondents stating it, followed by ‘Garud of HPM Chemicals & Fertilizers Ltd. (Glyphosate 41% SL) with 9 per cent’, ‘Noweed of Dhanuka Agritech Ltd. (Glyphosate 41% SL) with 8 per cent’, ‘Heera of HPM Chemicals & Fertilizers Ltd. (2,4-d Ethyl Ester 38% EC) with 6 per cent’, and ‘Saathi of UPL Ltd. (Pyrazosulfuron Ethyl 10% WP) with 5 per cent’.

**Table 3. Association of demographic factors with type of business**

|  |  |  |
| --- | --- | --- |
| **Demographic parameters** | **Pearson’s Chi-square** | ***P* value** |
| **Annual income (high or medium or low)** | **19.74\*\*** | **0.00** |
| **Shop location (urban or rural)** | **9.09\*\*** | **0.00** |
| **Shop ownership (owned or rented)** | **3.48\*** | **0.04** |
| Age (below 35 or 35–49 or 50 and above | 3.02NS | 0.22 |
| Education (under matric or matriculation or graduate) | 0.39NS | 0.82 |
| Caste (general or OBC or SC or ST) | 0.20NS | 0.90 |
| Trainings attended (yes or no) | 0.01NS | 0.92 |

*Note: Dependent variable: Type of Pesticides business (wholesaling or retailing)*

*\* Significant at five per cent level of probability*

*\*\* Significant at one per cent level of probability*

*Source: Researcher’s computation from field data through SPSS*

The findings revealed a significant relationship between the type of pesticide business (wholesale or retail) and key demographic factors. Especially, ‘shop location (χ2(1)= 9.095, *P*= .01)’, ‘shop ownership (χ2(1)= 3.481, *P*= .05)’ and ‘annual income (χ2(2)= 19.744, *P*= .01)’ were the found to be the most influential and decisive factors in choosing the type of doing pesticide business whether wholesaling or retailing.

**Table 4. Predictors determining sale of bio-pesticides**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables** | **Coefficient (β)** | **Standard Error (β)** | **t** | **Significance (p)** |
| **Villages served (numbers)** | **0.188\*\*** | **0.054** | **3.459** | **0.005** |
| **Dealership of bio-pesticide based companies (numbers)** | **1.189\*** | **0.434** | **2.739** | **0.018** |
| **Credit period for farmers (days)** | **-0.031\*** | **0.015** | **-2.093** | **0.048** |
| Competitors within 10km radius (numbers) | -0.268NS | 0.153 | -1.751 | 0.105 |
| Dealership of Indian companies (numbers) | 0.173 NS | 0.163 | 1.062 | 0.309 |
| Business age (years) | -0.048 NS | 0.052 | -0.924 | 0.374 |
| Average farmers served in Rabi season (numbers) | 0.048 NS | 0.084 | 0.577 | 0.574 |
| Average farmers served per day (numbers) | 0.042 NS | 0.076 | 0.552 | 0.591 |
| Average farmers served in Kharif season (numbers) | -0.043 NS | 0.080 | -0.530 | 0.606 |
| Dealership of chemical pesticide-based companies (numbers) | 0.082 NS | 0.259 | 0.318 | 0.756 |
| Manpower at shop (numbers) | 0.118 NS | 0.398 | 0.296 | 0.772 |
| Dealerships of MNCs (numbers) | -0.226 NS | 0.901 | -0.251 | 0.806 |
| Average farmers served in Summer season (numbers) | -0.011 NS | 0.103 | -0.106 | 0.918 |
| Godown capacity (tonnes) | 0.001 NS | 0.035 | 0.028 | 0.978 |
| (Constant) | -0.062 NS | 1.803 | -0.034 | 0.973 |
| **Model values** |
| F value (14, 12)= 12.805, p<0.01 |
| R square= 0.937 |

*Note: Dependent Variable: Annual turnover of bio-pesticides (lakhs)*

*\* Significant at five per cent level of probability*

*\*\* Significant at one per cent level of probability*

*Source: Researcher’s computation from field data through SPSS*

From the Table 4, it is observed that there were 26 independent variables where, three predictors were found significant with an association of dependent variable i.e. annual turnover of bio-pesticides (lakhs), out of which two variables viz. ‘Villages served (numbers) (0.188)’, ‘Dealership of bio-pesticide based companies (numbers) (1.189) ’ were found to be positive and one variable i.e. ‘Credit period for farmers (days) (-0.031) was found to be negative. The model was significant with F Value (14, 12)= 5.393, p<0.01) and found to be fit with R square value of 0.937. The findings were in moderate accordance with respect of literature reviewed [8], [9], [10], [11], [12], [13],

**Table 5. Factors influencing preference of selling bio-pesticides over chemical pesticides**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Coefficient (β)** | **Significance (*P*)** |
| **DAESI certification (1: yes; 0: no)** | **4.252\*** | **0.015** |
| Knowledge about safety use of pesticide (1: aware; 0: unaware) | 20.411 NS | 0.999 |
| Farmers served per day (numbers) | -0.141 NS | 0.223 |
| Villages served (numbers) | -0.114NS | 0.395 |
| Business enhancement plan (1: yes; 0: no) | -0.068 NS | 0.965 |
| Knowledge about Economic Threshold Level (ETL) (1: yes; 0: no) | -18.799 NS | 0.999 |
| Constant | 0.337 NS | 0.884 |
| **Model Values** |
| Chi-square ($χ^{2}$(6)= 18.848, *P*= .01) |
| Nagelkerke (Pseudo) R square= 0.673 |

Note: Dependent variable: Preference of selling bio-pesticides over chemical pesticides (yes or no)

*\* Significant at five per cent level of probability*

*\*\* Significant at one per cent level of probability*

*Source: Researcher’s computation from field data through SPSS*

Out of the ten independent variables which included both categorical and continuous variables, a significant association was found between one categorical predictor i.e. ‘DAESI (Diploma in Agricultural Extension Services for Input Dealers) certification’ with the categorical dependent variable i.e. ‘preference of selling bio-pesticides over chemical pesticides’ with a coefficient value of 4.252 with one percent level of probability. In the logistic regression model, Pseudo (Nagelkerke) R square was found to be 0.673, indicating a better fit of the model, as shown in the Table 5. The findings were in moderate accordance with respect of literature reviewed [8], [9], [10], [11], [12], [13],

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |

**Figure 4. Attitudinal pattern of dealers/retailers towards companies’ strategies**

*Source: Researcher’s computation from the primary data*

It was found from the Figure 4 that 59 per cent of the respondents had preference for national level tours and only 7 per cent of the respondents showed their interest for international level tours. While conducting business with national and multinational companies, 52 per cent of the respondents preferred to do business with local level companies followed by 26 per with all types of companies, 18 per cent with national level and only four per cent with international level companies. For the smooth running of business, 63 per cent of sample dealers and retailers preferred company representatives with business-oriented attributes, followed by helpfulness with 19 per cent and friendliness with 18 per cent. While taking into consideration monetary transaction, 56 per cent of the sample dealers and retailers preferred to do pesticide business in cash and 22 percent each for credit and both credit as well as cash transaction. Taking business expansion, 81 per cent of sample had business enhancement plan and rest had no plan. The findings were in moderate accordance with respect of literature reviewed [16], [17], [18].

**Figure 5. Preference of sales and promotional tools by the dealers/retailers**

*Source: Researcher’s computation from the primary data*

From the Figure 5, it can be observed that the major promotional tool preferred by the dealers and retailers are ‘outside posters/ banners (96.30 per cent)’, ‘followed by farmers meeting (92.59 per cent)’, ‘field visits (88.89 per cent)’, ‘point of purchase materials (85.19 per cent)’, ‘promotional schemes or packages (77.78 per cent)’, ‘jeep campaigning (66.67 per cent)’, ‘personal accessories for dealers (59.26 per cent)’, ‘channel partners meeting (55.56)’, ‘mega farmers meetings (48.15 per cent)’, ‘crop seminars (37.04 per cent)’and ‘need company staff at store (29.63 per cent)’. The findings were in moderate accordance with respect of literature reviewed [6], [19] [24].

**Table 6. Constraints in pesticide business**

|  |  |
| --- | --- |
| **Constraining factors** | **Mean score** |
| **High cost of transportation** | **3.41** |
| **Lack of farmer’s knowledge about the product** | **3.22** |
| **High cost of labour** | **3.15** |
| Delay in payment by farmers | 2.96 |
| Reception of near expiry products from companies | 2.15 |
| Compulsion of sale by companies | 2.11 |
| Malpractices by company personnel | 1.96 |
| High fluctuation of billing price | 1.78 |
| Problem of storage | 1.44 |
| Discrepancies in assurance by companies | 1.44 |
| Malpractices by government stakeholders | 1.41 |
| Untrustworthy company personnel | 1.37 |
| Distress sale of product to farmers | 1.33 |
| Unavailability of required field staff | 1.30 |
| Lack of promotional activities | 1.15 |

*Note: (Level of Severity: 1–5; lowest to highest)*

*Source: Researcher’s computation from the primary data*

From the Table 6, it is observed by analysing the mean scores that the major constraints faced by the dealers and retailers in pesticide business are ‘high cost of transportation (3.41)’, ‘followed by lack of farmer’s knowledge about the product (3.22)’, ‘high cost of labour (3.15), delay in payment by farmers (2.96)’, ‘reception of near expiry products from companies (2.15)’, ‘compulsion of sale by companies (2.11)’, ‘malpractices by company personnel (1.96)’, ‘high fluctuation of billing price (1.78)’, ‘problem of storage (1.44)’, ‘discrepancies in assurance by companies (1.44)’, ‘malpractices by government stakeholders (1.41)’, ‘untrustworthy company personnel (1.37)’, ‘distress sale of product to farmers (1.33)’, ‘unavailability of required field staff (1.30)’, ‘lack of promotional activities (1.15)’. The findings were in accordance with respect of literature reviewed [7], [21], [22], [23].

**4. CONCLUSION**

This study, examining pesticide market intermediaries in Khordha district, Odisha, revealed significant variations in annual business turnover across different income groups, with a majority of respondents engaged in wholesaling and falling within the 36-49 age bracket, predominantly from the general caste and holding graduate degrees. While a substantial portion (44 percent) reported an annual turnover of less than INR 25 lakhs, the sector is characterized by the widespread availability of key insecticide, fungicide, and herbicide products from major brands.

The research identified several critical factors influencing business dynamics. Shop location and annual income showed significant associations with the type of pesticide business (wholesaling or retailing). Bio-pesticide annual turnover was positively influenced by "villages served" and "dealerships of bio-pesticide based companies," but negatively by "credit period for farmers." Notably, DAESI certification emerged as a significant predictor for a retailer's preference towards selling bio-pesticides over chemical alternatives.

Dealers and retailers primarily prefer cash transactions (56 percent) and exhibit a strong inclination for business expansion plans (81 percent). Their promotional strategies heavily rely on outside posters/banners, farmer meetings, and field visits. Key motivational factors for intermediaries include national tours and business with local companies, prioritizing business-oriented company representatives. However, the sector faces substantial challenges, including high transportation costs, farmers' limited product knowledge, high labor costs, and delayed payments from farmers. Other concerns include receiving near-expiry products, compulsory sales targets, and inconsistencies in company assurances.

**DISCLAIMER**

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

References

1. Tudi, M., Daniel Ruan, H., Wang, L., Lyu, J., Sadler, R., Connell, D., ... & Phung, D. T. (2021). Agriculture development, pesticide application and its impact on the environment. *International journal of environmental research and public health*, *18*(3): 1112.
2. Fortune Business Insights (2025). Biopesticides Market, **retrieved from** <https://www.fortunebusinessinsights.com/industry-reports/biopesticides-market-100073> as on 26.05.2025.
3. Chakraborty, N., Mitra, R., Pal, S., Ganguly, R., Acharya, K., Minkina, T., ... & Keswani, C. (2023). Biopesticide Consumption in India: Insights into the Current Trends. *Agriculture* 2023: 13, 557.
4. Custom Market Insights (2024). **India Biopesticides Market 2024–2033, retrieved from** <https://www.custommarketinsights.com/report/india-biopesticides-market/> as on 26.05.2025.
5. Marrone, P. G. (2023). Status of the biopesticide market and prospects for new bioherbicides. *Pest Management Science*.
6. Deshmukh, R., & Kulkarni, S. (2023). A study on understanding the attitude of buyers and sellers of biopesticides in an agriculture based country: India. *Central European Management Journal*, 31(2): 184–194.
7. Vasoya, R. R., Vahoniya, D. R., & Rajwadi, A. (2023). Farmers’ Purchasing Behaviour of Insecticides in Cumin (Cuminum cyminum) and Problems Faced by Farmers for Cumin in Dhrol Taluka of Jamnagar District, Gujarat, India. *Asian Journal of Agricultural Extension, Economics & Sociology*, 41(9): 462-474.
8. Khimani, S. H., Vahoniya, D. R., & Rajwadi, A. (2023). Farmers’ Purchasing Behaviour of Corteva Agriscience’s Products (Galileo Sensa and Delegate) for Chilli in Umreth Taluka of Anand District, India. *Asian Journal of Agricultural Extension, Economics & Sociology*, 41(9): 528-540.
9. Vachhani, D. R., & Panigrahy, S. R. (2023). Farmers’ purchasing behaviour towards fungicide for groundnut crop in Maliya Hatina Taluka of Junagadh district, Gujarat, *The Pharma Innovation*, SP-12(6): 151-155.
10. Gohel, P. R., Panigrahy, S. R., & Zala, S. (2023). Farmer’s purchasing behavior and satisfaction level towards insecticide for cotton in Mangrol Taluka of Junagadh District, Gujarat. *Age*, 15(25): 5–8.
11. Panda, S., & Sharma, A. (2025). Analyzing the Factors Influencing the Adoption of Integrated Pest Management (IPM) Technology in Cotton in Rajasthan. *Indian Journal of Agricultural Research*, *59*(1): 147–152.
12. Muduli, D., Panda, S. and Biswas, S. (2024). Analysing factors influencing the pesticide business among the intermediaries in Khordha district of Odisha, India. The Pharma Innovation, 13(1): 01–04.
13. Muduli, D., Panda, S. and Biswas, S. (2024). Behavioural pattern of pesticide dealers towards sales-promotional strategies in Khordha district of Odisha, India. The Pharma Innovation, 13(1): 46–50.
14. Panda, S., Sharma, A., and Biswas, S. (2023). Assessment of awareness level and constraints of cotton farmers following Integrated Pest Management (IPM) technology in Rajasthan, India. The Pharma Innovation, SP-12(10): 2037–2040.
15. Panda, S., Sharma, A., & Tyagi, S. (2022). Integrated Pest Management Technology as a Means to Cost Efficiency for Cotton Crop in Rajasthan, India. Asian Journal of Agricultural Extension, Economics & Sociology, 40(9): 53-63.
16. Sahu, P., & Pathak, H. (2023). Analysis of factors influencing preferences for sources and brands of pesticides in Bemetara district of Chhattisgarh. *The Pharma Innovation*, SP-12(7): 1480-1483.
17. Kachroo, J., Chalotra, G., Singh, S. P., & Hamid, N. (2023). Factors influencing farmer’s buying behavior towards pesticides in Jammu and Kashmir (UT). *SKUAST Journal of Research*, 25(3): 426-436.
18. Police, K., Gautam, V., Chandakavate, S., & Dwesar, R. (2023). Modeling determinants of farmers’ purchase behavior: A case of chemical pesticides. *Environment, Development and Sustainability*, 1-29.
19. Mottaleb, K. A., Rahut, D. B., & Shakur, S. (2023). Exploring the role of pesticide traders in protecting farmers' benefit. *Review of Development Economics*.
20. Faldu, N. V., Dubey, L. R., Savaliya, N. G., Chudasama, V. R., & Modi, R. P. (2023). Analysis of the Marketing Status of Insecticide Brands and Buying Behavior of Chilli Growers in Rajkot District, Gujarat, India. *Asian Journal of Agricultural Extension, Economics & Sociology*, 41(10): 709-715.
21. Kumar, S., & Kumar, S. (2021). Constraints faced by Agri-input Dealers in Dissemination of Information to Farmers. *Biological Forum – An International Journal*, 13(3a): 643-648.
22. Kaur, S. Agri input marketing models and market perspective. *Recent Trends in Agricultural Economics and Agricultural Extension*, 72–79.
23. Indira Devi, P.I., Jayasree, M.G. Sarada, A.P. & Rajesh K. Raju, R.K. (2017). Sales Practices in Pesticides Retail: A Case Study of Kerala. *Indian Journal of Agricultural Economics*, 72(1): 102–116.
24. Kumar KN, Radhika P, Seema, Chary DS. A Study on Biopesticides Market in Telangana. S. Asian J. Soc. Stud. Econ. [Internet]. 2021 Apr. 30 [cited 2025 May 29];10(3):38-43. Available from: https://journalsajsse.com/index.php/SAJSSE/article/view/192